OpenShift Container Platform 4.5

Installing on IBM Z and LinuxONE

Installing OpenShift Container Platform IBM Z clusters

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Legal Notice

Abstract

This document provides instructions for installing OpenShift Container Platform clusters on IBM Z.

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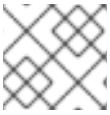
CHAPTER 1. INSTALLING ON IBM Z

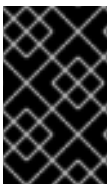
1.1. INSTALLING A CLUSTER ON IBM Z AND LINUXONE

In OpenShift Container Platform version 4.5, you can install a cluster on IBM Z or LinuxONE infrastructure that you provision.



NOTE

While this document refers only to IBM Z, all information in it also applies to LinuxONE.



IMPORTANT

Additional considerations exist for non-bare metal platforms. Review the information in the guidelines for deploying OpenShift Container Platform on non-tested platforms before you install an OpenShift Container Platform cluster.

1.1.1. Prerequisites

- Before you begin the installation process, you must move or remove any existing installation files. This ensures that the required installation files are created and updated during the installation process.
- Provision persistent storage using NFS for your cluster. To deploy a private image registry, your storage must provide **ReadWriteMany** access modes.
- Review details about the OpenShift Container Platform installation and update processes.
- If you use a firewall, you must configure it to allow the sites that your cluster requires access to.

NOTE

Be sure to also review this site list if you are configuring a proxy.

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. Machine requirements for a cluster with user-provisioned infrastructure

For a cluster that contains user-provisioned infrastructure, you must deploy all of the required machines.

1.1.3.1. Required machines

The smallest OpenShift Container Platform clusters require the following hosts:

- One temporary bootstrap machine
- Three control plane, or master, machines
- At least two compute machines, which are also known as worker machines.

NOTE

The cluster requires the bootstrap machine to deploy the OpenShift Container Platform cluster on the three control plane machines. You can remove the bootstrap machine after you install the cluster.

IMPORTANT

To improve high availability of your cluster, distribute the control plane machines over different z/VM instances on at least two physical machines.

The bootstrap and control plane machines must use Red Hat Enterprise Linux CoreOS (RHCOS) as the operating system.

Note that RHCOS is based on Red Hat Enterprise Linux (RHEL) 8 and inherits all of its hardware certifications and requirements. See Red Hat Enterprise Linux technology capabilities and limits .

1.1.3.2. Network connectivity requirements

All the Red Hat Enterprise Linux CoreOS (RHCOS) machines require network in **initramfs** during boot to fetch Ignition config files from the Machine Config Server. The machines are configured with static IP addresses. No DHCP server is required. Additionally, each OpenShift Container Platform node in the cluster must have access to a Network Time Protocol (NTP) server.

1.1.3.3. IBM Z network connectivity requirements

To install on IBM Z under z/VM, you require a single z/VM virtual NIC in layer 2 mode. You also need:

- A direct-attached OSA or RoCE network adapter

- A z/VM VSWITCH set up. For a preferred setup, use OSA link aggregation.

1.1.3.4. Minimum resource requirements

Each cluster machine must meet the following minimum requirements:

Machine	Operating System	vCPU [1]	Virtual RAM	Storage
Bootstrap	RHCOS	4	16 GB	120 GB
Control plane	RHCOS	4	16 GB	120 GB
Compute	RHCOS	2	8 GB	120 GB

1. 1 vCPU is equivalent to 1 physical core when simultaneous multithreading (SMT), or hyperthreading, is not enabled. When enabled, use the following formula to calculate the corresponding ratio: (threads per core × cores) × sockets = vCPUs.

1.1.3.5. Minimum IBM Z system requirements

You can install OpenShift Container Platform version 4.5 on the following IBM hardware:

- IBM Z: z13, z13s, all z14 models, all z15 models
- LinuxONE: all models

Hardware requirements

- 1 LPAR with 3 IFLs that supports SMT2
- 1 OSA or RoCE network adapter

Operating system requirements

- One instance of z/VM 7.1

On your z/VM instance, set up:

- 3 guest virtual machines for OpenShift Container Platform control plane machines
- 2 guest virtual machines for OpenShift Container Platform compute machines
- 1 guest virtual machine for the temporary OpenShift Container Platform bootstrap machine

Disk storage for the z/VM guest virtual machines

- FICON attached disk storage (DASDs). These can be z/VM minidisks, fullpack minidisks, or dedicated DASDs, all of which must be formatted as CDL, which is the default. To reach the minimum required DASD size for Red Hat Enterprise Linux CoreOS (RHCOS) installations, you need extended address volumes (EAV). If available, use HyperPAV to ensure optimal performance.
- FCP attached disk storage

Storage / Main Memory

- 16 GB for OpenShift Container Platform control plane machines
- 8 GB for OpenShift Container Platform compute machines
- 16 GB for the temporary OpenShift Container Platform bootstrap machine

1.1.3.6. Preferred IBM Z system requirements

Hardware requirements

- 3 LPARs with 6 IFLs each that support SMT2
- 1 or 2 OSA or RoCE network adapters, or both
- Hipersockets, which are attached to a node either directly as a device or by bridging with one z/VM VSWITCH to be transparent to the z/VM guest. To directly connect Hipersockets to a node, you must set up a gateway to the external network via a RHEL 8 guest to bridge to the Hipersockets network.

Operating system requirements

- 2 or 3 instances of z/VM 7.1 for high availability

On your z/VM instances, set up:

- 3 guest virtual machines for OpenShift Container Platform control plane machines, one per z/VM instance
- At least 6 guest virtual machines for OpenShift Container Platform compute machines, distributed across the z/VM instances
- 1 guest virtual machine for the temporary OpenShift Container Platform bootstrap machine

Disk storage for the z/VM guest virtual machines

- FICON attached disk storage (DASDs). These can be z/VM minidisks, fullpack minidisks, or dedicated DASDs, all of which must be formatted as CDL, which is the default. To reach the minimum required DASD size for Red Hat Enterprise Linux CoreOS (RHCOS) installations, you need extended address volumes (EAV). If available, use HyperPAV and High Performance FICON (zHPF) to ensure optimal performance.
- FCP attached disk storage

Storage / Main Memory

- 16 GB for OpenShift Container Platform control plane machines
- 8 GB for OpenShift Container Platform compute machines
- 16 GB for the temporary OpenShift Container Platform bootstrap machine

1.1.3.7. Certificate signing requests management

Because your cluster has limited access to automatic machine management when you use infrastructure that you provision, you must provide a mechanism for approving cluster certificate signing requests (CSRs) after installation. The **kube-controller-manager** only approves the kubelet client CSRs. The

machine-approver cannot guarantee the validity of a serving certificate that is requested by using kubelet credentials because it cannot confirm that the correct machine issued the request. You must determine and implement a method of verifying the validity of the kubelet serving certificate requests and approving them.

Additional resources

- See Bridging a HiperSockets LAN with a z/VM Virtual Switch in the IBM Knowledge Center.
- See Scaling HyperPAV alias devices on Linux guests on z/VM for performance optimization.

1.1.4. Creating the user-provisioned infrastructure

Before you deploy an OpenShift Container Platform cluster that uses user-provisioned infrastructure, you must create the underlying infrastructure.

Prerequisites

- Review the OpenShift Container Platform 4.x Tested Integrations page before you create the supporting infrastructure for your cluster.

Procedure

1. Set up static IP addresses.
2. Set up an FTP server.
3. Provision the required load balancers.
4. Configure the ports for your machines.
5. Configure DNS.
6. Ensure network connectivity.

1.1.4.1. Networking requirements for user-provisioned infrastructure

All the Red Hat Enterprise Linux CoreOS (RHCOS) machines require network in **initramfs** during boot to fetch Ignition config from the machine config server.

During the initial boot, the machines require an FTP server in order to establish a network connection to download their Ignition config files.

Ensure that the machines have persistent IP addresses and host names.

The Kubernetes API server, which runs on each master node after a successful cluster installation, must be able to resolve the node names of the cluster machines. If the API servers and worker nodes are in different zones, you can configure a default DNS search zone to allow the API server to resolve the node names. Another supported approach is to always refer to hosts by their fully-qualified domain names in both the node objects and all DNS requests.

You must configure the network connectivity between machines to allow cluster components to communicate. Each machine must be able to resolve the host names of all other machines in the cluster.

Table 1.1. All machines to all machines

Protocol	Port	Description
ICMP	N/A	Network reachability tests
TCP	**1936**	Metrics
	9000-**9999**	Host level services, including the node exporter on ports **9100**-**9101** and the Cluster Version Operator on port**9099**.
	10250-**10259**	The default ports that Kubernetes reserves
	10256	openshift-sdn
UDP	**4789**	VXLAN and Geneve
	6081	VXLAN and Geneve
	9000-**9999**	Host level services, including the node exporter on ports **9100**-**9101**.
TCP/UDP	**30000**-**32767**	Kubernetes node port

Table 1.2. All machines to control plane

Protocol	Port	Description
TCP	**6443**	Kubernetes API

Table 1.3. Control plane machines to control plane machines

Protocol	Port	Description
TCP	**2379**-**2380**	etcd server and peer ports

Network topology requirements

The infrastructure that you provision for your cluster must meet the following network topology requirements.

IMPORTANT

OpenShift Container Platform requires all nodes to have internet access to pull images for platform containers and provide telemetry data to Red Hat.

Load balancers

Before you install OpenShift Container Platform, you must provision two load balancers that meet the following requirements:

1. **API load balancer**: Provides a common endpoint for users, both human and machine, to interact with and configure the platform. Configure the following conditions:

   - Layer 4 load balancing only. This can be referred to as Raw TCP, SSL Passthrough, or SSL Bridge mode. If you use SSL Bridge mode, you must enable Server Name Indication (SNI) for the API routes.
   - A stateless load balancing algorithm. The options vary based on the load balancer implementation.

NOTE

Session persistence is not required for the API load balancer to function properly.

Configure the following ports on both the front and back of the load balancers:

Table 1.4. API load balancer

Port	Back-end machines (pool members)	Internal	External	Description
6443	Bootstrap and control plane. You remove the bootstrap machine from the load balancer after the bootstrap machine initializes the cluster control plane. You must configure the **/readyz** endpoint for the API server health check probe.	X	X	Kubernetes API server
22623	Bootstrap and control plane. You remove the bootstrap machine from the load balancer after the bootstrap machine initializes the cluster control plane.	X		Machine config server

NOTE

The load balancer must be configured to take a maximum of 30 seconds from the time the API server turns off the **/readyz** endpoint to the removal of the API server instance from the pool. Within the time frame after **/readyz** returns an error or becomes healthy, the endpoint must have been removed or added. Probing every 5 or 10 seconds, with two successful requests to become healthy and three to become unhealthy, are well-tested values.

2. **Application Ingress load balancer**: Provides an Ingress point for application traffic flowing in from outside the cluster. Configure the following conditions:

   - Layer 4 load balancing only. This can be referred to as Raw TCP, SSL Passthrough, or SSL Bridge mode. If you use SSL Bridge mode, you must enable Server Name Indication (SNI) for the Ingress routes.
   - A connection-based or session-based persistence is recommended, based on the options available and types of applications that will be hosted on the platform.

Configure the following ports on both the front and back of the load balancers:

Table 1.5. Application Ingress load balancer

Port	Back-end machines (pool members)	Internal	External	Description
443	The machines that run the Ingress router pods, compute, or worker, by default.	X	X	HTTPS traffic
80	The machines that run the Ingress router pods, compute, or worker, by default.	X	X	HTTP traffic

TIP

If the true IP address of the client can be seen by the load balancer, enabling source IP-based session persistence can improve performance for applications that use end-to-end TLS encryption.

NOTE

A working configuration for the Ingress router is required for an OpenShift Container Platform cluster. You must configure the Ingress router after the control plane initializes.

NTP configuration

OpenShift Container Platform clusters are configured to use a public Network Time Protocol (NTP) server by default. If you want to use a local enterprise NTP server, or if your cluster is being deployed in a disconnected network, you can configure the cluster to use a specific time server. For more information, see the documentation for *Configuring chrony time service* .

Additional resources

- Configuring chrony time service

1.1.4.2. User-provisioned DNS requirements

DNS is used for name resolution and reverse name resolution. DNS A/AAAA or CNAME records are used for name resolution and PTR records are used for reverse name resolution. The reverse records are important because Red Hat Enterprise Linux CoreOS (RHCOS) uses the reverse records to set the host name for all the nodes. Additionally, the reverse records are used to generate the certificate signing requests (CSR) that OpenShift Container Platform needs to operate.

The following DNS records are required for an OpenShift Container Platform cluster that uses user-provisioned infrastructure. In each record, **<cluster_name>** is the cluster name and **<base_domain>** is the cluster base domain that you specify in the **install-config.yaml** file. A complete DNS record takes the form: **<component>.<cluster_name>.<base_domain>.**.

Table 1.6. Required DNS records

Component	Record	Description

Component	Record	Description
Kubernetes API	**api.<cluster_name>.<base_domain>.**	Add a DNS A/AAAA or CNAME record, and a DNS PTR record, to identify the load balancer for the control plane machines. These records must be resolvable by both clients external to the cluster and from all the nodes within the cluster.
	api-int.<cluster_name>.<base_domain>.	Add a DNS A/AAAA or CNAME record, and a DNS PTR record, to identify the load balancer for the control plane machines. These records must be resolvable from all the nodes within the cluster.  **IMPORTANT** The API server must be able to resolve the worker nodes by the host names that are recorded in Kubernetes. If the API server cannot resolve the node names, then proxied API calls can fail, and you cannot retrieve logs from pods.
Routes	***.apps.<cluster_name>.<base_domain>.**	Add a wildcard DNS A/AAAA or CNAME record that refers to the load balancer that targets the machines that run the Ingress router pods, which are the worker nodes by default. These records must be resolvable by both clients external to the cluster and from all the nodes within the cluster.
Bootstrap	**bootstrap.<cluster_name>.<base_domain>.**	Add a DNS A/AAAA or CNAME record, and a DNS PTR record, to identify the bootstrap machine. These records must be resolvable by the nodes within the cluster.
Master hosts	**<master><n>.<cluster_name>.<base_domain>.**	Add DNS A/AAAA or CNAME records and DNS PTR records to identify each machine for the master nodes. These records must be resolvable by the nodes within the cluster.
Worker hosts	**<worker><n>.<cluster_name>.<base_domain>.**	Add DNS A/AAAA or CNAME records and DNS PTR records to identify each machine for the worker nodes. These records must be resolvable by the nodes within the cluster.

TIP

You can use the **nslookup <hostname>** command to verify name resolution. You can use the **dig -x <ip_address>** command to verify reverse name resolution for the PTR records.

The following example of a BIND zone file shows sample A records for name resolution. The purpose of the example is to show the records that are needed. The example is not meant to provide advice for choosing one name resolution service over another.

Example 1.1. Sample DNS zone database

```
$TTL 1W
@ IN SOA ns1.example.com. root (
   2019070700 ; serial
   3H  ; refresh (3 hours)
   30M  ; retry (30 minutes)
   2W  ; expiry (2 weeks)
   1W )  ; minimum (1 week)
 IN NS ns1.example.com.
 IN MX 10 smtp.example.com.
;
;
ns1 IN A 192.168.1.5
smtp IN A 192.168.1.5
;
helper IN A 192.168.1.5
helper.ocp4 IN A 192.168.1.5
;
; The api identifies the IP of your load balancer.
api.ocp4  IN A 192.168.1.5
api-int.ocp4  IN A 192.168.1.5
;
; The wildcard also identifies the load balancer.
*.apps.ocp4  IN A 192.168.1.5
;
; Create an entry for the bootstrap host.
bootstrap.ocp4 IN A 192.168.1.96
;
; Create entries for the master hosts.
master0.ocp4  IN A 192.168.1.97
master1.ocp4  IN A 192.168.1.98
master2.ocp4  IN A 192.168.1.99
;
; Create entries for the worker hosts.
worker0.ocp4  IN A 192.168.1.11
worker1.ocp4  IN A 192.168.1.7
;
;EOF
```

The following example BIND zone file shows sample PTR records for reverse name resolution.

Example 1.2. Sample DNS zone database for reverse records

```
$TTL 1W
@ IN SOA ns1.example.com. root (
   2019070700 ; serial
   3H  ; refresh (3 hours)
   30M  ; retry (30 minutes)
   2W  ; expiry (2 weeks)
   1W )  ; minimum (1 week)
 IN NS ns1.example.com.
;
; The syntax is "last octet" and the host must have an FQDN
; with a trailing dot.
97 IN PTR master0.ocp4.example.com.
```

```
98 IN PTR master1.ocp4.example.com.
99 IN PTR master2.ocp4.example.com.
;
96 IN PTR bootstrap.ocp4.example.com.
;
5 IN PTR api.ocp4.example.com.
5 IN PTR api-int.ocp4.example.com.
;
11 IN PTR worker0.ocp4.example.com.
7 IN PTR worker1.ocp4.example.com.
;
;EOF
```

1.1.5. 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 the installation program. You can use this key to access the bootstrap machine in a public cluster to troubleshoot installation issues.

NOTE

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

IMPORTANT

Do not skip this procedure in production environments where disaster recovery and debugging is required.

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 ed25519 -N '' \
  -f <path>/<file_name> 1
```

1 Specify the path and file name, such as **~/.ssh/id_rsa**, of the new SSH key. If you have an existing key pair, ensure your public key is in the your **~/.ssh** directory.

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

NOTE

If you plan to install an OpenShift Container Platform cluster that uses FIPS Validated / Modules in Process cryptographic libraries on the **x86_64** architecture, do not create a key that uses the **ed25519** algorithm. Instead, create a key that uses the **rsa** or **ecdsa** algorithm.

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

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

Example output

```
Agent pid 31874
```

If your cluster is in FIPS mode, only use FIPS-compliant algorithms to generate the SSH key. The key must be either RSA or ECDSA.

1. 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.

1.1.6. Obtaining the installation program

Before you install OpenShift Container Platform, download the installation file on your provisioning machine.

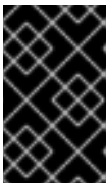
Prerequisites

- You must install the cluster from a machine that runs Linux, for example Red Hat Enterprise Linux 8.
- You need 500 MB of local disk space to download the installation program.

Procedure

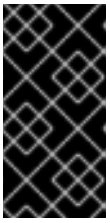
1. Access the Infrastructure Provider page on the Red Hat OpenShift Cluster Manager site. If you have a Red Hat account, log in with your credentials. If you do not, create an account.

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.

1.1.7. 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**.

1.1.7.1. 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>
```

1.1.7.2. 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>
```

1.1.7.3. 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>
```

1.1.8. Manually creating the installation configuration file

For installations of OpenShift Container Platform that use user-provisioned infrastructure, you manually generate your installation configuration file.

Prerequisites

- Obtain the OpenShift Container Platform installation program and the access token for your cluster.

Procedure

1. Create an installation directory to store your required installation assets in:

   ```
   $ mkdir <installation_directory>
   ```

   IMPORTANT

   You must create a 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.

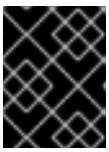
2. Customize the following **install-config.yaml** file template and save it in the **<installation_directory>**.

   NOTE

   You must name this configuration file **install-config.yaml**.

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 next step of the installation process. You must back it up now.

1.1.8.1. Sample install-config.yaml file for IBM Z

You can customize the **install-config.yaml** file to specify more details about your OpenShift Container Platform cluster's platform or modify the values of the required parameters.

```
apiVersion: v1
baseDomain: example.com 1
compute: 2
```

```
- hyperthreading: Enabled 3
  name: worker
  replicas: 0 4
controlPlane: 5
  hyperthreading: Enabled 6
  name: master
  replicas: 3 7
metadata:
  name: test 8
networking:
  clusterNetwork:
  - cidr: 10.128.0.0/14 9
    hostPrefix: 23 10
  networkType: OpenShiftSDN
  serviceNetwork: 11
  - 172.30.0.0/16
platform:
  none: {} 12
fips: false 13
pullSecret: '{"auths": ...}' 14
sshKey: 'ssh-ed25519 AAAA...' 15
```

1 The base domain of the cluster. All DNS records must be sub-domains of this base and include the cluster name.

2 5 The **controlPlane** section is a single mapping, but the **compute** section is a sequence of mappings. To meet the requirements of the different data structures, the first line of the **compute** section must begin with a hyphen, **-**, and the first line of the **controlPlane** section must not. Although both sections currently define a single machine pool, it is possible that future versions of OpenShift Container Platform will support defining multiple compute pools during installation. Only one control plane pool is used.

3 6 Whether to enable or disable simultaneous multithreading (SMT), or **hyperthreading**. By default, SMT is enabled to increase the performance of your machines' cores. You can disable it by setting the parameter value to **Disabled**. If you disable SMT, you must disable it in all cluster machines; this includes both control plane and compute machines.

NOTE

Simultaneous multithreading (SMT) is enabled by default. If SMT is not enabled in your BIOS settings, the **hyperthreading** parameter has no effect.

IMPORTANT

If you disable **hyperthreading**, whether in the BIOS or in the **install-config.yaml**, ensure that your capacity planning accounts for the dramatically decreased machine performance.

4 You must set the value of the **replicas** parameter to **0**. This parameter controls the number of workers that the cluster creates and manages for you, which are functions that the cluster does not perform when you use user-provisioned infrastructure. You must manually deploy worker machines for the cluster to use before you finish installing OpenShift Container Platform.

7 The number of control plane machines that you add to the cluster. Because the cluster uses this values as the number of etcd endpoints in the cluster, the value must match the number of control

8 The cluster name that you specified in your DNS records.

9 A block of IP addresses from which pod IP addresses are allocated. This block must not overlap with existing physical networks. These IP addresses are used for the pod network. If you need to access the pods from an external network, you must configure load balancers and routers to manage the traffic.

10 The subnet prefix length to assign to each individual node. For example, if **hostPrefix** is set to **23**, then each node is assigned a /**23** subnet out of the given **cidr**, which allows for 510 (2^(32 - 23) - 2) pod IPs addresses. If you are required to provide access to nodes from an external network, configure load balancers and routers to manage the traffic.

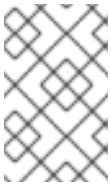
11 The IP address pool to use for service IP addresses. You can enter only one IP address pool. If you need to access the services from an external network, configure load balancers and routers to manage the traffic.

12 You must set the platform to **none**. You cannot provide additional platform configuration variables for IBM Z infrastructure.

13 Whether to enable or disable FIPS mode. By default, FIPS mode is not enabled. 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.

14 The pull secret that you obtained from the Pull Secret page on the Red Hat OpenShift Cluster Manager site. 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.

15 The public portion of the default SSH key for the **core** user in Red Hat Enterprise Linux CoreOS (RHCOS).



NOTE

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.

1.1.9. Creating the Kubernetes manifest and Ignition config files

Because you must modify some cluster definition files and manually start the cluster machines, you must generate the Kubernetes manifest and Ignition config files that the cluster needs to make its machines.

IMPORTANT

The Ignition config files that the installation program generates contain certificates that expire after 24 hours, which are then renewed at that time. If the cluster is shut down before renewing the certificates and the cluster is later restarted after the 24 hours have elapsed, the cluster automatically recovers the expired certificates. The exception is that you must manually approve the pending **node-bootstrapper** certificate signing requests (CSRs) to recover kubelet certificates. See the documentation for *Recovering from expired control plane certificates* for more information.

Prerequisites

- Obtain the OpenShift Container Platform installation program.
- Create the **install-config.yaml** installation configuration file.

Procedure

1. Generate the Kubernetes manifests for the cluster:

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

Example output

```
INFO Consuming Install Config from target directory
WARNING Making control-plane schedulable by setting MastersSchedulable to true for
Scheduler cluster settings
```

1 For **<installation_directory>**, specify the installation directory that contains the **install-config.yaml** file you created.

Because you create your own compute machines later in the installation process, you can safely ignore this warning.

2. Modify the **<installation_directory>/manifests/cluster-scheduler-02-config.yml** Kubernetes manifest file to prevent pods from being scheduled on the control plane machines:
   a. Open the **<installation_directory>/manifests/cluster-scheduler-02-config.yml** file.
   b. Locate the **mastersSchedulable** parameter and set its value to **False**.
   c. Save and exit the file.
3. Obtain the Ignition config files:

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

1 For **<installation_directory>**, specify the same installation directory.

The following files are generated in the directory:

```
.
├── auth
```

```
│   ├── kubeadmin-password
│   └── kubeconfig
├── bootstrap.ign
├── master.ign
├── metadata.json
└── worker.ign
```

1.1.10. Creating Red Hat Enterprise Linux CoreOS (RHCOS) machines

Before you install a cluster on IBM Z infrastructure that you provision, you must install RHCOS on z/VM guest virtual machines for the cluster to use. Complete the following steps to create the machines.

Prerequisites

- An FTP server running on your provisioning machine that is accessible to the machines you create.

Procedure

1. Log in to Linux on your provisioning machine.
2. Download the Red Hat Enterprise Linux CoreOS (RHCOS) installation files from the RHCOS image mirror.

IMPORTANT

The RHCOS images might not change with every release of OpenShift Container Platform. You must download images with the highest version that is less than or equal to the OpenShift Container Platform version that you install. Use the image versions that match your OpenShift Container Platform version if they are available.

Download the following files:

- The initramfs: **rhcos-<version>-installer-initramfs.img**
- The kernel: **rhcos-<version>-installer-kernel**
- The operating system image for the disk on which you want to install RHCOS. This type can differ by virtual machine:
  rhcos-<version>-s390x-dasd.s390x.raw.gz for DASD

  rhcos-<version>-s390x-metal.s390x.raw.gz for FCP

3. Create parameter files. The following parameters are specific for a particular virtual machine:
   - For **coreos.inst.install_dev=**, specify **dasda** for a DASD installation, or **sda** for FCP. Note that FCP requires **zfcp.allow_lun_scan=0**.
   - For **rd.dasd=**, specifys the DASD where RHCOS is to be installed.
   - **rd.zfcp=<adapter>,<wwpn>,<lun>** specifies the FCP disk to install RHCOS on.
   - For **ip=**, specify the following seven entries:

i. The IP address for the machine.

ii. An empty string.

iii. The gateway.

iv. The netmask.

v. The machine host and domain name in the form **hostname.domainname**. Omit this value to let RHCOS decide set it.

vi. The network interface name. Omit this value to let RHCOS decide set it.

vii. If you use static IP addresses, an empty string.

- For **coreos.inst.ignition_url=**, specify the Ignition file for the machine role. Use **bootstrap.ign**, **master.ign**, or **worker.ign**.
- All other parameters can stay as they are.
  Example parameter file, **bootstrap-0.parm**, for the bootstrap machine:

```
rd.neednet=1 coreos.inst=yes coreos.inst.install_dev=dasda coreos.inst.image_url=ftp://
cl1.provide.example.com:8080/assets/rhcos-43.80.20200430.0-s390x-dasd.390x.raw.gz
coreos.inst.ignition_url=ftp://cl1.provide.example.com:8080/ignition-bootstrap-0
ip=172.18.78.2::172.18.78.1:255.255.255.0:::none nameserver=172.18.78.1
rd.znet=qeth,0.0.bdf0,0.0.bdf1,0.0.bdf2,layer2=1,portno=0 zfcp.allow_lun_scan=0
cio_ignore=all,
!condev rd.dasd=0.0.3490
```

4. Transfer the initramfs, kernel, parameter files, and RHCOS images to z/VM, for example with FTP. For details about how to transfer the files with FTP and boot from the virtual reader, see Installing under Z/VM.

5. Punch the files to the virtual reader of the z/VM guest virtual machine that is to become your bootstrap node.
   See PUNCH in the IBM Knowledge Center.

   TIP

   You can use the CP PUNCH command or, if you use Linux, the **vmur** command to transfer files between two z/VM guest virtual machines.

6. Log in to CMS on the bootstrap machine.

7. IPL the bootstrap machine from the reader:

```
$ ipl c
```

   See IPL in the IBM Knowledge Center.

8. Repeat this procedure for the other machines in the cluster.

1.1.11. Creating the cluster

To create the OpenShift Container Platform cluster, you wait for the bootstrap process to complete on the machines that you provisioned by using the Ignition config files that you generated with the installation program.

Prerequisites

- Create the required infrastructure for the cluster.
- You obtained the installation program and generated the Ignition config files for your cluster.
- You used the Ignition config files to create RHCOS machines for your cluster.
- Your machines have direct Internet access or have an HTTP or HTTPS proxy available.

Procedure

1. Monitor the bootstrap process:

```
$ ./openshift-install --dir=<installation_directory> wait-for bootstrap-complete \ 1
    --log-level=info 2
```

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

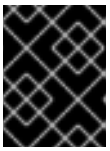
2 To view different installation details, specify **warn**, **debug**, or **error** instead of **info**.

Example output

```
INFO Waiting up to 30m0s for the Kubernetes API at https://api.test.example.com:6443...
INFO API v1.18.3 up
INFO Waiting up to 30m0s for bootstrapping to complete...
INFO It is now safe to remove the bootstrap resources
```

The command succeeds when the Kubernetes API server signals that it has been bootstrapped on the control plane machines.

2. After bootstrap process is complete, remove the bootstrap machine from the load balancer.



IMPORTANT

You must remove the bootstrap machine from the load balancer at this point. You can also remove or reformat the machine itself.

1.1.12. 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
```

1.1.13. Approving the certificate signing requests for your machines

When you add machines to a cluster, two pending certificate signing requests (CSRs) are generated for each machine that you added. You must confirm that these CSRs are approved or, if necessary, approve them yourself. The client requests must be approved first, followed by the server requests.

Prerequisites

- You added machines to your cluster.

Procedure

1. Confirm that the cluster recognizes the machines:

```
$ oc get nodes
```

Example output

```
NAME      STATUS    ROLES   AGE  VERSION
master-0  Ready     master  63m  v1.18.3
master-1  Ready     master  63m  v1.18.3
master-2  Ready     master  64m  v1.18.3
worker-0  NotReady  worker  76s  v1.18.3
worker-1  NotReady  worker  70s  v1.18.3
```

The output lists all of the machines that you created.

2. Review the pending CSRs and ensure that you see the client requests with the **Pending** or **Approved** status for each machine that you added to the cluster:

```
$ oc get csr
```

Example output

```
NAME        AGE   REQUESTOR                                 CONDITION
csr-mddf5   20m   system:node:master-01.example.com   Approved,Issued
csr-z5rln   16m   system:node:worker-21.example.com   Approved,Issued
```

3. If the CSRs were not approved, after all of the pending CSRs for the machines you added are in **Pending** status, approve the CSRs for your cluster machines:

NOTE

Because the CSRs rotate automatically, approve your CSRs within an hour of adding the machines to the cluster. If you do not approve them within an hour, the certificates will rotate, and more than two certificates will be present for each node. You must approve all of these certificates. Once the client CSR is approved, the Kubelet creates a secondary CSR for the serving certificate, which requires manual approval. Then, subsequent serving certificate renewal requests are automatically approved by the **machine-approver** if the Kubelet requests a new certificate with identical parameters.

- To approve them individually, run the following command for each valid CSR:

```
$ oc adm certificate approve <csr_name> 1
```

1 **<csr_name>** is the name of a CSR from the list of current CSRs.

- To approve all pending CSRs, run the following command:

```
$ oc get csr -o go-template='{{range .items}}{{if not .status}}{{.metadata.name}}{{"\n"}}
{{end}}{{end}}' | xargs --no-run-if-empty oc adm certificate approve
```

4. Now that your client requests are approved, you must review the server requests for each machine that you added to the cluster:

```
$ oc get csr
```

Example output

```
NAME        AGE     REQUESTOR                                                   CONDITION
csr-bfd72   5m26s   system:node:ip-10-0-50-126.us-east-2.compute.internal
Pending
csr-c57lv   5m26s   system:node:ip-10-0-95-157.us-east-2.compute.internal
Pending
...
```

5. If the remaining CSRs are not approved, and are in the **Pending** status, approve the CSRs for your cluster machines:

- To approve them individually, run the following command for each valid CSR:

```
$ oc adm certificate approve <csr_name> 1
```

1 **<csr_name>** is the name of a CSR from the list of current CSRs.

- To approve all pending CSRs, run the following command:

```
$ oc get csr -o go-template='{{range .items}}{{if not .status}}{{.metadata.name}}{{"\n"}}
{{end}}{{end}}' | xargs oc adm certificate approve
```

6. After all client and server CSRs have been approved, the machines have the **Ready** status. Verify this by running the following command:

```
$ oc get nodes
```

Example output

```
NAME      STATUS    ROLES   AGE  VERSION
master-0  Ready     master  73m  v1.20.0
master-1  Ready     master  73m  v1.20.0
master-2  Ready     master  74m  v1.20.0
worker-0  Ready     worker  11m  v1.20.0
worker-1  Ready     worker  11m  v1.20.0
```

NOTE

It can take a few minutes after approval of the server CSRs for the machines to transition to the **Ready** status.

Additional information

- For more information on CSRs, see Certificate Signing Requests.

1.1.14. Initial Operator configuration

After the control plane initializes, you must immediately configure some Operators so that they all become available.

Prerequisites

- Your control plane has initialized.

Procedure

1. Watch the cluster components come online:

```
$ watch -n5 oc get clusteroperators
```

Example output

```
NAME                       VERSION   AVAILABLE   PROGRESSING   DEGRADED
SINCE
authentication             4.5.4     True        False         False     69s
cloud-credential           4.5.4     True        False         False     12m
cluster-autoscaler         4.5.4     True        False         False     11m
```

```
console                                    4.5.4     True        False         False      46s
dns                                        4.5.4     True        False         False      11m
image-registry                             4.5.4     True        False         False      5m26s
ingress                                    4.5.4     True        False         False      5m36s
kube-apiserver                             4.5.4     True        False         False      8m53s
kube-controller-manager                    4.5.4     True        False         False      7m24s
kube-scheduler                             4.5.4     True        False         False      12m
machine-api                                4.5.4     True        False         False      12m
machine-config                             4.5.4     True        False         False      7m36s
marketplace                                4.5.4     True        False         False      7m54m
monitoring                                 4.5.4     True        False         False      7h54s
network                                    4.5.4     True        False         False      5m9s
node-tuning                                4.5.4     True        False         False      11m
openshift-apiserver                        4.5.4     True        False         False      11m
openshift-controller-manager               4.5.4     True        False         False      5m943s
openshift-samples                          4.5.4     True        False         False      3m55s
operator-lifecycle-manager                 4.5.4     True        False         False      11m
operator-lifecycle-manager-catalog         4.5.4     True        False         False      11m
service-ca                                 4.5.4     True        False         False      11m
service-catalog-apiserver                  4.5.4     True        False         False      5m26s
service-catalog-controller-manager         4.5.4     True        False         False      5m25s
storage                                    4.5.4     True        False         False      5m30s
```

2. Configure the Operators that are not available.

1.1.14.1. Image registry storage configuration

The Image Registry Operator is not initially available for platforms that do not provide default storage. After installation, you must configure your registry to use storage so that the Registry Operator is made available.

Instructions are shown for configuring a persistent volume, which is required for production clusters. Where applicable, instructions are shown for configuring an empty directory as the storage location, which is available for only non-production clusters.

Additional instructions are provided for allowing the image registry to use block storage types by using the **Recreate** rollout strategy during upgrades.

1.1.14.1.1. Configuring registry storage for bare metal

As a cluster administrator, following installation you must configure your registry to use storage.

Prerequisites

- Cluster administrator permissions.
- A cluster on bare metal.
- Persistent storage provisioned for your cluster, such as Red Hat OpenShift Container Storage.

IMPORTANT

OpenShift Container Platform supports **ReadWriteOnce** access for image registry storage when you have only one replica. To deploy an image registry that supports high availability with two or more replicas, **ReadWriteMany** access is required.

- Must have 100Gi capacity.

Procedure

1. To configure your registry to use storage, change the **spec.storage.pvc** in the **configs.imageregistry/cluster** resource.

NOTE

When using shared storage, review your security settings to prevent outside access.

2. Verify that you do not have a registry pod:

```
$ oc get pod -n openshift-image-registry
```

NOTE

If the storage type is **emptyDIR**, the replica number cannot be greater than **1**.

3. Check the registry configuration:

```
$ oc edit configs.imageregistry.operator.openshift.io
```

Example output

```
storage:
  pvc:
    claim:
```

Leave the **claim** field blank to allow the automatic creation of an **image-registry-storage** PVC.

4. Check the **clusteroperator** status:

```
$ oc get clusteroperator image-registry
```

1.1.14.1.2. Configuring storage for the image registry in non-production clusters

You must configure storage for the Image Registry Operator. For non-production clusters, you can set the image registry to an empty directory. If you do so, all images are lost if you restart the registry.

Procedure

1. To set the image registry storage to an empty directory:

```
$ oc patch configs.imageregistry.operator.openshift.io cluster --type merge --patch '{"spec":{"storage":{"emptyDir":{}}}}'
```

WARNING

Configure this option for only non-production clusters.

If you run this command before the Image Registry Operator initializes its components, the **oc patch** command fails with the following error:

```
Error from server (NotFound): configs.imageregistry.operator.openshift.io "cluster" not found
```

Wait a few minutes and run the command again.

2. Ensure that your registry is set to managed to enable building and pushing of images.

   - Run:

     ```
     $ oc edit configs.imageregistry/cluster
     ```

     Then, change the line

     ```
     managementState: Removed
     ```

     to

     ```
     managementState: Managed
     ```

1.1.15. Completing installation on user-provisioned infrastructure

After you complete the Operator configuration, you can finish installing the cluster on infrastructure that you provide.

Prerequisites

- Your control plane has initialized.
- You have completed the initial Operator configuration.

Procedure

1. Confirm that all the cluster components are online with the following command:

   ```
   $ watch -n5 oc get clusteroperators
   ```

   #### Example output

   ```
   NAME                                       VERSION   AVAILABLE   PROGRESSING   DEGRADED
   ```

```
SINCE
authentication                             4.5.4     True        False       False      7m56s
cloud-credential                           4.5.4     True        False       False      31m
cluster-autoscaler                         4.5.4     True        False       False      16m
console                                    4.5.4     True        False       False      10m
csi-snapshot-controller                    4.5.4     True        False       False      16m
dns                                        4.5.4     True        False       False      22m
etcd                                       4.5.4     False       False       False      25s
image-registry                             4.5.4     True        False       False      16m
ingress                                    4.5.4     True        False       False      16m
insights                                   4.5.4     True        False       False      17m
kube-apiserver                             4.5.4     True        False       False      19m
kube-controller-manager                    4.5.4     True        False       False      20m
kube-scheduler                             4.5.4     True        False       False      20m
kube-storage-version-migrator              4.5.4     True        False       False      16m
machine-api                                4.5.4     True        False       False      22m
machine-config                             4.5.4     True        False       False      22m
marketplace                                4.5.4     True        False       False      16m
monitoring                                 4.5.4     True        False       False      10m
network                                    4.5.4     True        False       False      23m
node-tuning                                4.5.4     True        False       False      23m
openshift-apiserver                        4.5.4     True        False       False      17m
openshift-controller-manager               4.5.4     True        False       False      15m
openshift-samples                          4.5.4     True        False       False      16m
operator-lifecycle-manager                 4.5.4     True        False       False      22m
operator-lifecycle-manager-catalog         4.5.4     True        False       False      22m
operator-lifecycle-manager-packageserver   4.5.4     True        False       False      18m
service-ca                                 4.5.4     True        False       False      23m
service-catalog-apiserver                  4.5.4     True        False       False      23m
service-catalog-controller-manager         4.5.4     True        False       False      23m
storage                                    4.5.4     True        False       False      17m
```

Alternatively, the following command notifies you when all of the clusters are available. It also retrieves and displays credentials:

```
$ ./openshift-install --dir=<installation_directory> wait-for install-complete 1
```

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

Example output

```
INFO Waiting up to 30m0s for the cluster to initialize...
```

The command succeeds when the Cluster Version Operator finishes deploying the OpenShift Container Platform cluster from Kubernetes API server.

IMPORTANT

The Ignition config files that the installation program generates contain certificates that expire after 24 hours, which are then renewed at that time. If the cluster is shut down before renewing the certificates and the cluster is later restarted after the 24 hours have elapsed, the cluster automatically recovers the expired certificates. The exception is that you must manually approve the pending **node-bootstrapper** certificate signing requests (CSRs) to recover kubelet certificates. See the documentation for *Recovering from expired control plane certificates* for more information.

2. Confirm that the Kubernetes API server is communicating with the pods.

   a. To view a list of all pods, use the following command:

   ```
   $ oc get pods --all-namespaces
   ```

   Example output

   ```
   NAMESPACE                  NAME                                        READY   STATUS
   RESTARTS   AGE
   openshift-apiserver-operator    openshift-apiserver-operator-85cb746d55-zqhs8   1/1
   Running   1          9m
   openshift-apiserver        apiserver-67b9g                             1/1     Running     0
   3m
   openshift-apiserver        apiserver-ljcmx                             1/1     Running     0
   1m
   openshift-apiserver        apiserver-z25h4                             1/1     Running     0
   2m
   openshift-authentication-operator authentication-operator-69d5d8bf84-vh2n8       1/1
   Running     0          5m
   ...
   ```

   b. View the logs for a pod that is listed in the output of the previous command by using the following command:

   ```
   $ oc logs <pod_name> -n <namespace>
   ```
   (1)

   (1) Specify the pod name and namespace, as shown in the output of the previous command.

   If the pod logs display, the Kubernetes API server can communicate with the cluster machines.

1.1.16. Collecting debugging information

You can gather debugging information that might help you to troubleshoot and debug certain issues with an OpenShift Container Platform installation on IBM Z.

Prerequisites

- The **oc** CLI tool installed.

Procedure

Procedure

1. Log in to the cluster:

```
$ oc login
```

2. On the node you want to gather hardware information about, start a debugging container:

```
$ oc debug node/<nodename>
```

3. Change to the **/host** file system and start **toolbox**:

```
$ chroot /host
$ toolbox
```

4. Collect the **dbginfo** data:

```
$ dbginfo.sh
```

5. You can then retrieve the data, for example, using **scp**.

1.1.17. Additional resources

- See also How to generate SOSREPORT within OpenShift4 nodes without SSH .

1.1.18. Next steps

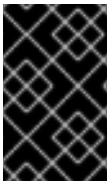
- Customize your cluster.
- If necessary, you can opt out of remote health reporting .

1.2. INSTALLING A CLUSTER ON IBM Z AND LINUXONE IN A RESTRICTED NETWORK

In OpenShift Container Platform version 4.5, you can install a cluster on IBM Z and LinuxONE infrastructure that you provision in a restricted network.

NOTE

While this document refers only to IBM Z, all information in it also applies to LinuxONE.



IMPORTANT

Additional considerations exist for non-bare metal platforms. Review the information in the guidelines for deploying OpenShift Container Platform on non-tested platforms before you install an OpenShift Container Platform cluster.

Prerequisites

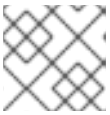
- Create a mirror registry for installation in a restricted network and obtain the **imageContentSources** data for your version of OpenShift Container Platform.

- Before you begin the installation process, you must move or remove any existing installation files. This ensures that the required installation files are created and updated during the installation process.

IMPORTANT

Ensure that installation steps are done from a machine with access to the installation media.

- Provision persistent storage using NFS for your cluster. To deploy a private image registry, your storage must provide **ReadWriteMany** access modes.
- Review details about the OpenShift Container Platform installation and update processes.
- If you use a firewall and plan to use telemetry, you must configure the firewall to allow the sites that your cluster requires access to.



NOTE

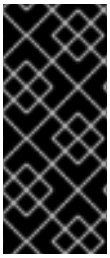
Be sure to also review this site list if you are configuring a proxy.

1.2.1. About installations in restricted networks

In OpenShift Container Platform 4.5, you can perform an installation that does not require an active connection to the Internet to obtain software components. Restricted network installations can be completed using installer-provisioned infrastructure or user-provisioned infrastructure, depending on the cloud platform to which you are installing the cluster.

If you choose to perform a restricted network installation on a cloud platform, you still require access to its cloud APIs. Some cloud functions, like Amazon Web Service's IAM service, require Internet access, so you might still require Internet access. Depending on your network, you might require less Internet access for an installation on bare metal hardware or on VMware vSphere.

To complete a restricted network installation, you must create a registry that mirrors the contents of the OpenShift Container Platform registry and contains the installation media. You can create this registry on a mirror host, which can access both the Internet and your closed network, or by using other methods that meet your restrictions.



IMPORTANT

Because of the complexity of the configuration for user-provisioned installations, consider completing a standard user-provisioned infrastructure installation before you attempt a restricted network installation using user-provisioned infrastructure. Completing this test installation might make it easier to isolate and troubleshoot any issues that might arise during your installation in a restricted network.

1.2.1.1. Additional limits

Clusters in restricted networks have the following additional limitations and restrictions:

- The **ClusterVersion** status includes an **Unable to retrieve available updates** error.
- By default, you cannot use the contents of the Developer Catalog because you cannot access the required image stream tags.

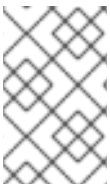
1.2.2. Machine requirements for a cluster with user-provisioned infrastructure

For a cluster that contains user-provisioned infrastructure, you must deploy all of the required machines.

1.2.2.1. Required machines

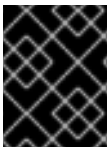
The smallest OpenShift Container Platform clusters require the following hosts:

- One temporary bootstrap machine
- Three control plane, or master, machines
- At least two compute machines, which are also known as worker machines.



NOTE

The cluster requires the bootstrap machine to deploy the OpenShift Container Platform cluster on the three control plane machines. You can remove the bootstrap machine after you install the cluster.



IMPORTANT

To improve high availability of your cluster, distribute the control plane machines over different z/VM instances on at least two physical machines.

The bootstrap and control plane machines must use Red Hat Enterprise Linux CoreOS (RHCOS) as the operating system.

Note that RHCOS is based on Red Hat Enterprise Linux (RHEL) 8 and inherits all of its hardware certifications and requirements. See Red Hat Enterprise Linux technology capabilities and limits .

1.2.2.2. Network connectivity requirements

All the Red Hat Enterprise Linux CoreOS (RHCOS) machines require network in **initramfs** during boot to fetch Ignition config files from the Machine Config Server. The machines are configured with static IP addresses. No DHCP server is required. Additionally, each OpenShift Container Platform node in the cluster must have access to a Network Time Protocol (NTP) server.

1.2.2.3. IBM Z network connectivity requirements

To install on IBM Z under z/VM, you require a single z/VM virtual NIC in layer 2 mode. You also need:

- A direct-attached OSA or RoCE network adapter
- A z/VM VSWITCH set up. For a preferred setup, use OSA link aggregation.

1.2.2.4. Minimum resource requirements

Each cluster machine must meet the following minimum requirements:

Machine	Operating System	vCPU [1]	Virtual RAM	Storage
Bootstrap	RHCOS	4	16 GB	120 GB

Machine	Operating System	vCPU [1]	Virtual RAM	Storage
Control plane	RHCOS	4	16 GB	120 GB
Compute	RHCOS	2	8 GB	120 GB

1. 1 vCPU is equivalent to 1 physical core when simultaneous multithreading (SMT), or hyperthreading, is not enabled. When enabled, use the following formula to calculate the corresponding ratio: (threads per core × cores) × sockets = vCPUs.

1.2.2.5. Minimum IBM Z system requirements

You can install OpenShift Container Platform version 4.5 on the following IBM hardware:

- IBM Z: z13, z13s, all z14 models, all z15 models
- LinuxONE: all models

Hardware requirements

- 1 LPAR with 3 IFLs that supports SMT2
- 1 OSA or RoCE network adapter

Operating system requirements

- One instance of z/VM 7.1

On your z/VM instance, set up:

- 3 guest virtual machines for OpenShift Container Platform control plane machines
- 2 guest virtual machines for OpenShift Container Platform compute machines
- 1 guest virtual machine for the temporary OpenShift Container Platform bootstrap machine

Disk storage for the z/VM guest virtual machines

- FICON attached disk storage (DASDs). These can be z/VM minidisks, fullpack minidisks, or dedicated DASDs, all of which must be formatted as CDL, which is the default. To reach the minimum required DASD size for Red Hat Enterprise Linux CoreOS (RHCOS) installations, you need extended address volumes (EAV). If available, use HyperPAV to ensure optimal performance.
- FCP attached disk storage

Storage / Main Memory

- 16 GB for OpenShift Container Platform control plane machines
- 8 GB for OpenShift Container Platform compute machines
- 16 GB for the temporary OpenShift Container Platform bootstrap machine

1.2.2.6. Preferred IBM Z system requirements

Hardware requirements

- 3 LPARs with 6 IFLs each that support SMT2
- 1 or 2 OSA or RoCE network adapters, or both
- Hipersockets, which are attached to a node either directly as a device or by bridging with one z/VM VSWITCH to be transparent to the z/VM guest. To directly connect Hipersockets to a node, you must set up a gateway to the external network via a RHEL 8 guest to bridge to the Hipersockets network.

Operating system requirements

- 2 or 3 instances of z/VM 7.1 for high availability

On your z/VM instances, set up:

- 3 guest virtual machines for OpenShift Container Platform control plane machines, one per z/VM instance
- At least 6 guest virtual machines for OpenShift Container Platform compute machines, distributed across the z/VM instances
- 1 guest virtual machine for the temporary OpenShift Container Platform bootstrap machine

Disk storage for the z/VM guest virtual machines

- FICON attached disk storage (DASDs). These can be z/VM minidisks, fullpack minidisks, or dedicated DASDs, all of which must be formatted as CDL, which is the default. To reach the minimum required DASD size for Red Hat Enterprise Linux CoreOS (RHCOS) installations, you need extended address volumes (EAV). If available, use HyperPAV and High Performance FICON (zHPF) to ensure optimal performance.
- FCP attached disk storage

Storage / Main Memory

- 16 GB for OpenShift Container Platform control plane machines
- 8 GB for OpenShift Container Platform compute machines
- 16 GB for the temporary OpenShift Container Platform bootstrap machine

1.2.2.7. Certificate signing requests management

Because your cluster has limited access to automatic machine management when you use infrastructure that you provision, you must provide a mechanism for approving cluster certificate signing requests (CSRs) after installation. The **kube-controller-manager** only approves the kubelet client CSRs. The **machine-approver** cannot guarantee the validity of a serving certificate that is requested by using kubelet credentials because it cannot confirm that the correct machine issued the request. You must determine and implement a method of verifying the validity of the kubelet serving certificate requests and approving them.

Additional resources

- See Bridging a HiperSockets LAN with a z/VM Virtual Switch in the IBM Knowledge Center.
- See Scaling HyperPAV alias devices on Linux guests on z/VM for performance optimization.

1.2.3. Creating the user-provisioned infrastructure

Before you deploy an OpenShift Container Platform cluster that uses user-provisioned infrastructure, you must create the underlying infrastructure.

Prerequisites

- Review the OpenShift Container Platform 4.x Tested Integrations page before you create the supporting infrastructure for your cluster.

Procedure

1. Configure DHCP or set static IP addresses on each node.
2. Provision the required load balancers.
3. Configure the ports for your machines.
4. Configure DNS.
5. Ensure network connectivity.

1.2.3.1. Networking requirements for user-provisioned infrastructure

All the Red Hat Enterprise Linux CoreOS (RHCOS) machines require network in **initramfs** during boot to fetch Ignition config from the machine config server.

During the initial boot, the machines require either a DHCP server or that static IP addresses be set on each host in the cluster in order to establish a network connection, which allows them to download their Ignition config files.

It is recommended to use the DHCP server to manage the machines for the cluster long-term. Ensure that the DHCP server is configured to provide persistent IP addresses and host names to the cluster machines.

The Kubernetes API server, which runs on each master node after a successful cluster installation, must be able to resolve the node names of the cluster machines. If the API servers and worker nodes are in different zones, you can configure a default DNS search zone to allow the API server to resolve the node names. Another supported approach is to always refer to hosts by their fully-qualified domain names in both the node objects and all DNS requests.

You must configure the network connectivity between machines to allow cluster components to communicate. Each machine must be able to resolve the host names of all other machines in the cluster.

Table 1.7. All machines to all machines

Protocol	Port	Description
ICMP	N/A	Network reachability tests

Protocol	Port	Description
TCP	**1936**	Metrics
	9000-**9999**	Host level services, including the node exporter on ports **9100**-**9101** and the Cluster Version Operator on port**9099**.
	10250-**10259**	The default ports that Kubernetes reserves
	10256	openshift-sdn
UDP	**4789**	VXLAN and Geneve
	6081	VXLAN and Geneve
	9000-**9999**	Host level services, including the node exporter on ports **9100**-**9101**.
TCP/UDP	**30000**-**32767**	Kubernetes node port

Table 1.8. All machines to control plane

Protocol	Port	Description
TCP	**6443**	Kubernetes API

Table 1.9. Control plane machines to control plane machines

Protocol	Port	Description
TCP	**2379**-**2380**	etcd server and peer ports

Network topology requirements
The infrastructure that you provision for your cluster must meet the following network topology requirements.

Load balancers
Before you install OpenShift Container Platform, you must provision two load balancers that meet the following requirements:

1. **API load balancer**: Provides a common endpoint for users, both human and machine, to interact with and configure the platform. Configure the following conditions:

   - Layer 4 load balancing only. This can be referred to as Raw TCP, SSL Passthrough, or SSL Bridge mode. If you use SSL Bridge mode, you must enable Server Name Indication (SNI) for the API routes.

   - A stateless load balancing algorithm. The options vary based on the load balancer implementation.

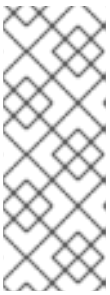
NOTE

Session persistence is not required for the API load balancer to function properly.

Configure the following ports on both the front and back of the load balancers:

Table 1.10. API load balancer

Port	Back-end machines (pool members)	Internal	External	Description
6443	Bootstrap and control plane. You remove the bootstrap machine from the load balancer after the bootstrap machine initializes the cluster control plane. You must configure the **/readyz** endpoint for the API server health check probe.	X	X	Kubernetes API server
22623	Bootstrap and control plane. You remove the bootstrap machine from the load balancer after the bootstrap machine initializes the cluster control plane.	X		Machine config server



NOTE

The load balancer must be configured to take a maximum of 30 seconds from the time the API server turns off the **/readyz** endpoint to the removal of the API server instance from the pool. Within the time frame after **/readyz** returns an error or becomes healthy, the endpoint must have been removed or added. Probing every 5 or 10 seconds, with two successful requests to become healthy and three to become unhealthy, are well-tested values.

2. **Application Ingress load balancer**: Provides an Ingress point for application traffic flowing in from outside the cluster. Configure the following conditions:

   - Layer 4 load balancing only. This can be referred to as Raw TCP, SSL Passthrough, or SSL Bridge mode. If you use SSL Bridge mode, you must enable Server Name Indication (SNI) for the Ingress routes.
   - A connection-based or session-based persistence is recommended, based on the options available and types of applications that will be hosted on the platform.

   Configure the following ports on both the front and back of the load balancers:

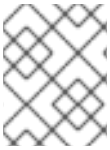
Table 1.11. Application Ingress load balancer

Port	Back-end machines (pool members)	Internal	External	Description
443	The machines that run the Ingress router pods, compute, or worker, by default.	X	X	HTTPS traffic

Port	Back-end machines (pool members)	Internal	External	Description
80	The machines that run the Ingress router pods, compute, or worker, by default.	X	X	HTTP traffic

TIP

If the true IP address of the client can be seen by the load balancer, enabling source IP-based session persistence can improve performance for applications that use end-to-end TLS encryption.



NOTE

A working configuration for the Ingress router is required for an OpenShift Container Platform cluster. You must configure the Ingress router after the control plane initializes.

NTP configuration

OpenShift Container Platform clusters are configured to use a public Network Time Protocol (NTP) server by default. If you want to use a local enterprise NTP server, or if your cluster is being deployed in a disconnected network, you can configure the cluster to use a specific time server. For more information, see the documentation for *Configuring chrony time service* .

If a DHCP server provides NTP server information, the chrony time service on the Red Hat Enterprise Linux CoreOS (RHCOS) machines read the information and can sync the clock with the NTP servers.

Additional resources

- Configuring chrony time service

1.2.3.2. User-provisioned DNS requirements

DNS is used for name resolution and reverse name resolution. DNS A/AAAA or CNAME records are used for name resolution and PTR records are used for reverse name resolution. The reverse records are important because Red Hat Enterprise Linux CoreOS (RHCOS) uses the reverse records to set the host name for all the nodes. Additionally, the reverse records are used to generate the certificate signing requests (CSR) that OpenShift Container Platform needs to operate.

The following DNS records are required for an OpenShift Container Platform cluster that uses user-provisioned infrastructure. In each record, **<cluster_name>** is the cluster name and **<base_domain>** is the cluster base domain that you specify in the **install-config.yaml** file. A complete DNS record takes the form: **<component>.<cluster_name>.<base_domain>.**.

Table 1.12. Required DNS records

Component	Record	Description

Component	Record	Description
Kubernetes API	**api.<cluster_name>.<base_domain>.**	Add a DNS A/AAAA or CNAME record, and a DNS PTR record, to identify the load balancer for the control plane machines. These records must be resolvable by both clients external to the cluster and from all the nodes within the cluster.
	api-int.<cluster_name>.<base_domain>.	Add a DNS A/AAAA or CNAME record, and a DNS PTR record, to identify the load balancer for the control plane machines. These records must be resolvable from all the nodes within the cluster.  **IMPORTANT** The API server must be able to resolve the worker nodes by the host names that are recorded in Kubernetes. If the API server cannot resolve the node names, then proxied API calls can fail, and you cannot retrieve logs from pods.
Routes	***.apps.<cluster_name>.<base_domain>.**	Add a wildcard DNS A/AAAA or CNAME record that refers to the load balancer that targets the machines that run the Ingress router pods, which are the worker nodes by default. These records must be resolvable by both clients external to the cluster and from all the nodes within the cluster.
Bootstrap	**bootstrap.<cluster_name>.<base_domain>.**	Add a DNS A/AAAA or CNAME record, and a DNS PTR record, to identify the bootstrap machine. These records must be resolvable by the nodes within the cluster.
Master hosts	**<master><n>.<cluster_name>.<base_domain>.**	Add DNS A/AAAA or CNAME records and DNS PTR records to identify each machine for the master nodes. These records must be resolvable by the nodes within the cluster.
Worker hosts	**<worker><n>.<cluster_name>.<base_domain>.**	Add DNS A/AAAA or CNAME records and DNS PTR records to identify each machine for the worker nodes. These records must be resolvable by the nodes within the cluster.

TIP

You can use the **nslookup <hostname>** command to verify name resolution. You can use the **dig -x <ip_address>** command to verify reverse name resolution for the PTR records.

The following example of a BIND zone file shows sample A records for name resolution. The purpose of the example is to show the records that are needed. The example is not meant to provide advice for choosing one name resolution service over another.

Example 1.3. Sample DNS zone database

```
$TTL 1W
@ IN SOA ns1.example.com. root (
   2019070700 ; serial
   3H  ; refresh (3 hours)
   30M  ; retry (30 minutes)
   2W  ; expiry (2 weeks)
   1W )  ; minimum (1 week)
 IN NS ns1.example.com.
 IN MX 10 smtp.example.com.
;
;
ns1 IN A 192.168.1.5
smtp IN A 192.168.1.5
;
helper IN A 192.168.1.5
helper.ocp4 IN A 192.168.1.5
;
; The api identifies the IP of your load balancer.
api.ocp4  IN A 192.168.1.5
api-int.ocp4  IN A 192.168.1.5
;
; The wildcard also identifies the load balancer.
*.apps.ocp4  IN A 192.168.1.5
;
; Create an entry for the bootstrap host.
bootstrap.ocp4 IN A 192.168.1.96
;
; Create entries for the master hosts.
master0.ocp4  IN A 192.168.1.97
master1.ocp4  IN A 192.168.1.98
master2.ocp4  IN A 192.168.1.99
;
; Create entries for the worker hosts.
worker0.ocp4  IN A 192.168.1.11
worker1.ocp4  IN A 192.168.1.7
;
;EOF
```

The following example BIND zone file shows sample PTR records for reverse name resolution.

Example 1.4. Sample DNS zone database for reverse records

```
$TTL 1W
@ IN SOA ns1.example.com. root (
   2019070700 ; serial
   3H  ; refresh (3 hours)
   30M  ; retry (30 minutes)
   2W  ; expiry (2 weeks)
   1W )  ; minimum (1 week)
 IN NS ns1.example.com.
;
; The syntax is "last octet" and the host must have an FQDN
; with a trailing dot.
97 IN PTR master0.ocp4.example.com.
```

```
98 IN PTR master1.ocp4.example.com.
99 IN PTR master2.ocp4.example.com.
;
96 IN PTR bootstrap.ocp4.example.com.
;
5 IN PTR api.ocp4.example.com.
5 IN PTR api-int.ocp4.example.com.
;
11 IN PTR worker0.ocp4.example.com.
7 IN PTR worker1.ocp4.example.com.
;
;EOF
```

1.2.4. 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 the installation program. You can use this key to access the bootstrap machine in a public cluster to troubleshoot installation issues.

NOTE

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

IMPORTANT

Do not skip this procedure in production environments where disaster recovery and debugging is required.

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.

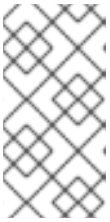
Procedure

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 ed25519 -N '' \
  -f <path>/<file_name> 1
```

1 Specify the path and file name, such as **~/.ssh/id_rsa**, of the new SSH key. If you have an existing key pair, ensure your public key is in the your **~/.ssh** directory.

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



NOTE

If you plan to install an OpenShift Container Platform cluster that uses FIPS Validated / Modules in Process cryptographic libraries on the **x86_64** architecture, do not create a key that uses the **ed25519** algorithm. Instead, create a key that uses the **rsa** or **ecdsa** algorithm.

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

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

Example output

```
Agent pid 31874
```

If your cluster is in FIPS mode, only use FIPS-compliant algorithms to generate the SSH key. The key must be either RSA or ECDSA.

1. 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.

1.2.5. Manually creating the installation configuration file

For installations of OpenShift Container Platform that use user-provisioned infrastructure, you manually generate your installation configuration file.

Prerequisites

- Obtain the OpenShift Container Platform installation program and the access token for your cluster.

Procedure

1. Create an installation directory to store your required installation assets in:

```
$ mkdir <installation_directory>
```

IMPORTANT

You must create a 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.

2. Customize the following **install-config.yaml** file template and save it in the **<installation_directory>**.

NOTE

You must name this configuration file **install-config.yaml**.

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 next step of the installation process. You must back it up now.

1.2.5.1. Sample install-config.yaml file for IBM Z

You can customize the **install-config.yaml** file to specify more details about your OpenShift Container Platform cluster's platform or modify the values of the required parameters.

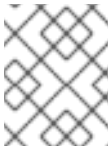
```
apiVersion: v1
baseDomain: example.com (1)
compute: (2)
- hyperthreading: Enabled (3)
  name: worker
  replicas: 0 (4)
controlPlane: (5)
  hyperthreading: Enabled (6)
  name: master
  replicas: 3 (7)
metadata:
  name: test (8)
networking:
  clusterNetwork:
  - cidr: 10.128.0.0/14 (9)
    hostPrefix: 23 (10)
  networkType: OpenShiftSDN
  serviceNetwork: (11)
  - 172.30.0.0/16
platform:
  none: {} (12)
fips: false (13)
pullSecret: '{"auths":{"<local_registry>": {"auth": "<credentials>","email": "you@example.com"}}}' (14)
sshKey: 'ssh-ed25519 AAAA...' (15)
```

```
additionalTrustBundle: | 16
  -----BEGIN CERTIFICATE-----
  ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
  -----END CERTIFICATE-----
imageContentSources: 17
- mirrors:
  - <local_repository>/ocp4/openshift4
  source: quay.io/openshift-release-dev/ocp-release
- mirrors:
  - <local_repository>/ocp4/openshift4
  source: quay.io/openshift-release-dev/ocp-v4.0-art-dev
```

1 The base domain of the cluster. All DNS records must be sub-domains of this base and include the cluster name.

2 5 The **controlPlane** section is a single mapping, but the **compute** section is a sequence of mappings. To meet the requirements of the different data structures, the first line of the **compute** section must begin with a hyphen, **-**, and the first line of the **controlPlane** section must not. Although both sections currently define a single machine pool, it is possible that future versions of OpenShift Container Platform will support defining multiple compute pools during installation. Only one control plane pool is used.

3 6 Whether to enable or disable simultaneous multithreading (SMT), or **hyperthreading**. By default, SMT is enabled to increase the performance of your machines' cores. You can disable it by setting the parameter value to **Disabled**. If you disable SMT, you must disable it in all cluster machines; this includes both control plane and compute machines.



NOTE

Simultaneous multithreading (SMT) is enabled by default. If SMT is not enabled in your BIOS settings, the **hyperthreading** parameter has no effect.

IMPORTANT

If you disable **hyperthreading**, whether in the BIOS or in the **install-config.yaml**, ensure that your capacity planning accounts for the dramatically decreased machine performance.

4 You must set the value of the **replicas** parameter to **0**. This parameter controls the number of workers that the cluster creates and manages for you, which are functions that the cluster does not perform when you use user-provisioned infrastructure. You must manually deploy worker machines for the cluster to use before you finish installing OpenShift Container Platform.

7 The number of control plane machines that you add to the cluster. Because the cluster uses this values as the number of etcd endpoints in the cluster, the value must match the number of control plane machines that you deploy.

8 The cluster name that you specified in your DNS records.

9 A block of IP addresses from which pod IP addresses are allocated. This block must not overlap with existing physical networks. These IP addresses are used for the pod network. If you need to access the pods from an external network, you must configure load balancers and routers to manage the traffic.

10 The subnet prefix length to assign to each individual node. For example, if **hostPrefix** is set to **23**, then each node is assigned a /**23** subnet out of the given **cidr**, which allows for 510 (2^(32 - 23) - 2)

then each node is assigned a **/23** subnet out of the given **cidr**, which allows for 510 ($2^{(32 - 23)} - 2$) pod IPs addresses. If you are required to provide access to nodes from an external network, configure load balancers and routers to manage the traffic.

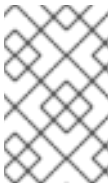
11 The IP address pool to use for service IP addresses. You can enter only one IP address pool. If you need to access the services from an external network, configure load balancers and routers to manage the traffic.

12 You must set the platform to **none**. You cannot provide additional platform configuration variables for IBM Z infrastructure.

13 Whether to enable or disable FIPS mode. By default, FIPS mode is not enabled. 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.

14 For **<local_registry>**, specify the registry domain name, and optionally the port, that your mirror registry uses to serve content. For example **registry.example.com** or **registry.example.com:5000**. For **<credentials>**, specify the base64-encoded user name and password for your mirror registry.

15 The public portion of the default SSH key for the **core** user in Red Hat Enterprise Linux CoreOS (RHCOS).



NOTE

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.

16 Add the **additionalTrustBundle** parameter and value. The value must be the contents of the certificate file that you used for your mirror registry, which can be an exiting, trusted certificate authority or the self-signed certificate that you generated for the mirror registry.

17 Provide the **imageContentSources** section from the output of the command to mirror the repository.

1.2.5.2. Configuring the cluster-wide proxy during installation

Production environments can deny direct access to the Internet and instead have an HTTP or HTTPS proxy available. You can configure a new OpenShift Container Platform cluster to use a proxy by configuring the proxy settings in the **install-config.yaml** file.

Prerequisites

- An existing **install-config.yaml** file.
- Review the sites that your cluster requires access to and determine whether any need to bypass the proxy. By default, all cluster egress traffic is proxied, including calls to hosting cloud provider APIs. Add sites to the **Proxy** object's **spec.noProxy** field to bypass the proxy if necessary.

NOTE

The **Proxy** object **status.noProxy** field is populated with the values of the **networking.machineNetwork[].cidr**, **networking.clusterNetwork[].cidr**, and **networking.serviceNetwork[]** fields from your installation configuration.

For installations on Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure, and Red Hat OpenStack Platform (RHOSP), the **Proxy** object **status.noProxy** field is also populated with the instance metadata endpoint (**169.254.169.254**).

Procedure

1. Edit your **install-config.yaml** file and add the proxy settings. For example:

```
apiVersion: v1
baseDomain: my.domain.com
proxy:
  httpProxy: http://<username>:<pswd>@<ip>:<port> 1
  httpsProxy: http://<username>:<pswd>@<ip>:<port> 2
  noProxy: example.com 3
additionalTrustBundle: | 4
    -----BEGIN CERTIFICATE-----
    <MY_TRUSTED_CA_CERT>
    -----END CERTIFICATE-----
...
```

1. A proxy URL to use for creating HTTP connections outside the cluster. The URL scheme must be **http**. If you use an MITM transparent proxy network that does not require additional proxy configuration but requires additional CAs, you must not specify an **httpProxy** value.

2. A proxy URL to use for creating HTTPS connections outside the cluster. If this field is not specified, then **httpProxy** is used for both HTTP and HTTPS connections. If you use an MITM transparent proxy network that does not require additional proxy configuration but requires additional CAs, you must not specify an **httpsProxy** value.

3. A comma-separated list of destination domain names, domains, IP addresses, or other network CIDRs to exclude proxying. Preface a domain with **.** to match subdomains only. For example, **.y.com** matches **x.y.com**, but not **y.com**. Use ***** to bypass proxy for all destinations.

4. If provided, the installation program generates a config map that is named **user-ca-bundle** in the **openshift-config** namespace that contains one or more additional CA certificates that are required for proxying HTTPS connections. The Cluster Network Operator then creates a **trusted-ca-bundle** config map that merges these contents with the Red Hat Enterprise Linux CoreOS (RHCOS) trust bundle, and this config map is referenced in the **Proxy** object's **trustedCA** field. The **additionalTrustBundle** field is required unless the proxy's identity certificate is signed by an authority from the RHCOS trust bundle. If you use an MITM transparent proxy network that does not require additional proxy configuration but requires additional CAs, you must provide the MITM CA certificate.

NOTE

The installation program does not support the proxy **readinessEndpoints** field.

2. Save the file and reference it when installing OpenShift Container Platform.

The installation program creates a cluster-wide proxy that is named **cluster** that uses the proxy settings in the provided **install-config.yaml** file. If no proxy settings are provided, a **cluster Proxy** object is still created, but it will have a nil **spec**.

NOTE

Only the **Proxy** object named **cluster** is supported, and no additional proxies can be created.

1.2.6. Creating the Kubernetes manifest and Ignition config files

Because you must modify some cluster definition files and manually start the cluster machines, you must generate the Kubernetes manifest and Ignition config files that the cluster needs to make its machines.

IMPORTANT

The Ignition config files that the installation program generates contain certificates that expire after 24 hours, which are then renewed at that time. If the cluster is shut down before renewing the certificates and the cluster is later restarted after the 24 hours have elapsed, the cluster automatically recovers the expired certificates. The exception is that you must manually approve the pending **node-bootstrapper** certificate signing requests (CSRs) to recover kubelet certificates. See the documentation for *Recovering from expired control plane certificates* for more information.

Prerequisites

- Obtain the OpenShift Container Platform installation program.
- Create the **install-config.yaml** installation configuration file.

Procedure

1. Generate the Kubernetes manifests for the cluster:

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

Example output

```
INFO Consuming Install Config from target directory
WARNING Making control-plane schedulable by setting MastersSchedulable to true for
Scheduler cluster settings
```

1 For **<installation_directory>**, specify the installation directory that contains the **install-config.yaml** file you created.

Because you create your own compute machines later in the installation process, you can safely ignore this warning.

2. Modify the **<installation_directory>/manifests/cluster-scheduler-02-config.yml** Kubernetes manifest file to prevent pods from being scheduled on the control plane machines:

   a. Open the **<installation_directory>/manifests/cluster-scheduler-02-config.yml** file.

   b. Locate the **mastersSchedulable** parameter and set its value to **False**.

   c. Save and exit the file.

3. Obtain the Ignition config files:

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

1 For **<installation_directory>**, specify the same installation directory.

The following files are generated in the directory:

```
.
├── auth
│   ├── kubeadmin-password
│   └── kubeconfig
├── bootstrap.ign
├── master.ign
├── metadata.json
└── worker.ign
```

1.2.7. Creating Red Hat Enterprise Linux CoreOS (RHCOS) machines

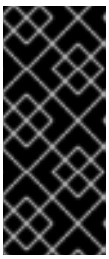
Before you install a cluster on IBM Z infrastructure that you provision, you must install RHCOS on z/VM guest virtual machines for the cluster to use. Complete the following steps to create the machines.

Prerequisites

- An FTP server running on your provisioning machine that is accessible to the machines you create.

Procedure

1. Log in to Linux on your provisioning machine.
2. Download the Red Hat Enterprise Linux CoreOS (RHCOS) installation files from the RHCOS image mirror.



IMPORTANT

The RHCOS images might not change with every release of OpenShift Container Platform. You must download images with the highest version that is less than or equal to the OpenShift Container Platform version that you install. Use the image versions that match your OpenShift Container Platform version if they are available.

Download the following files:

- The initramfs: **rhcos-<version>-installer-initramfs.img**
- The kernel: **rhcos-<version>-installer-kernel**
- The operating system image for the disk on which you want to install RHCOS. This type can differ by virtual machine:
  rhcos-<version>-s390x-dasd.s390x.raw.gz for DASD

  rhcos-<version>-s390x-metal.s390x.raw.gz for FCP

3. Create parameter files. The following parameters are specific for a particular virtual machine:
   - For **coreos.inst.install_dev=**, specify **dasda** for a DASD installation, or **sda** for FCP. Note that FCP requires **zfcp.allow_lun_scan=0**.
   - For **rd.dasd=**, specifys the DASD where RHCOS is to be installed.
   - **rd.zfcp=<adapter>,<wwpn>,<lun>** specifies the FCP disk to install RHCOS on.
   - For **ip=**, specify the following seven entries:
     i. The IP address for the machine.
     ii. An empty string.
     iii. The gateway.
     iv. The netmask.
     v. The machine host and domain name in the form **hostname.domainname**. Omit this value to let RHCOS decide set it.
     vi. The network interface name. Omit this value to let RHCOS decide set it.
     vii. If you use static IP addresses, an empty string.
   - For **coreos.inst.ignition_url=**, specify the Ignition file for the machine role. Use **bootstrap.ign**, **master.ign**, or **worker.ign**.
   - All other parameters can stay as they are.
     Example parameter file, **bootstrap-0.parm**, for the bootstrap machine:

     ```
     rd.neednet=1 coreos.inst=yes coreos.inst.install_dev=dasda coreos.inst.image_url=ftp://
     cl1.provide.example.com:8080/assets/rhcos-43.80.20200430.0-s390x-dasd.390x.raw.gz
     coreos.inst.ignition_url=ftp://cl1.provide.example.com:8080/ignition-bootstrap-0
     ip=172.18.78.2::172.18.78.1:255.255.255.0:::none nameserver=172.18.78.1
     rd.znet=qeth,0.0.bdf0,0.0.bdf1,0.0.bdf2,layer2=1,portno=0 zfcp.allow_lun_scan=0
     cio_ignore=all,
     !condev rd.dasd=0.0.3490
     ```

4. Transfer the initramfs, kernel, parameter files, and RHCOS images to z/VM, for example with FTP. For details about how to transfer the files with FTP and boot from the virtual reader, see Installing under Z/VM.

5. Punch the files to the virtual reader of the z/VM guest virtual machine that is to become your bootstrap node.
   See PUNCH in the IBM Knowledge Center.

TIP

You can use the CP PUNCH command or, if you use Linux, the **vmur** command to transfer files between two z/VM guest virtual machines.

6. Log in to CMS on the bootstrap machine.
7. IPL the bootstrap machine from the reader:

```
$ ipl c
```

See IPL in the IBM Knowledge Center.

8. Repeat this procedure for the other machines in the cluster.

1.2.8. Creating the cluster

To create the OpenShift Container Platform cluster, you wait for the bootstrap process to complete on the machines that you provisioned by using the Ignition config files that you generated with the installation program.

Prerequisites

- Create the required infrastructure for the cluster.
- You obtained the installation program and generated the Ignition config files for your cluster.
- You used the Ignition config files to create RHCOS machines for your cluster.

Procedure

1. Monitor the bootstrap process:

```
$ ./openshift-install --dir=<installation_directory> wait-for bootstrap-complete \ 1
    --log-level=info 2
```

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

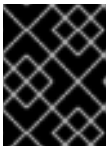
2 To view different installation details, specify **warn**, **debug**, or **error** instead of **info**.

Example output

```
INFO Waiting up to 30m0s for the Kubernetes API at https://api.test.example.com:6443...
INFO API v1.18.3 up
INFO Waiting up to 30m0s for bootstrapping to complete...
INFO It is now safe to remove the bootstrap resources
```

The command succeeds when the Kubernetes API server signals that it has been bootstrapped on the control plane machines.

2. After bootstrap process is complete, remove the bootstrap machine from the load balancer.



IMPORTANT

You must remove the bootstrap machine from the load balancer at this point. You can also remove or reformat the machine itself.

1.2.9. 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
```

1.2.10. Approving the certificate signing requests for your machines

When you add machines to a cluster, two pending certificate signing requests (CSRs) are generated for each machine that you added. You must confirm that these CSRs are approved or, if necessary, approve them yourself. The client requests must be approved first, followed by the server requests.

Prerequisites

- You added machines to your cluster.

Procedure

1. Confirm that the cluster recognizes the machines:

```
$ oc get nodes
```

Example output

```
NAME     STATUS    ROLES   AGE  VERSION
master-0  Ready     master  63m  v1.18.3
master-1  Ready     master  63m  v1.18.3
master-2  Ready     master  64m  v1.18.3
worker-0  NotReady  worker  76s  v1.18.3
worker-1  NotReady  worker  70s  v1.18.3
```

The output lists all of the machines that you created.

2. Review the pending CSRs and ensure that you see the client requests with the **Pending** or **Approved** status for each machine that you added to the cluster:

```
$ oc get csr
```

Example output

```
NAME        AGE     REQUESTOR                                                   CONDITION
csr-8b2br   15m     system:serviceaccount:openshift-machine-config-operator:node-
bootstrapper   Pending
csr-8vnps   15m     system:serviceaccount:openshift-machine-config-operator:node-
bootstrapper   Pending
...
```

In this example, two machines are joining the cluster. You might see more approved CSRs in the list.

3. If the CSRs were not approved, after all of the pending CSRs for the machines you added are in **Pending** status, approve the CSRs for your cluster machines:

NOTE

Because the CSRs rotate automatically, approve your CSRs within an hour of adding the machines to the cluster. If you do not approve them within an hour, the certificates will rotate, and more than two certificates will be present for each node. You must approve all of these certificates. Once the client CSR is approved, the Kubelet creates a secondary CSR for the serving certificate, which requires manual approval. Then, subsequent serving certificate renewal requests are automatically approved by the **machine-approver** if the Kubelet requests a new certificate with identical parameters.

- To approve them individually, run the following command for each valid CSR:

```
$ oc adm certificate approve <csr_name> 1
```

1 **<csr_name>** is the name of a CSR from the list of current CSRs.

- To approve all pending CSRs, run the following command:

```
$ oc get csr -o go-template='{{range .items}}{{if not .status}}{{.metadata.name}}{{"\n"}}
{{end}}{{end}}' | xargs --no-run-if-empty oc adm certificate approve
```

4. Now that your client requests are approved, you must review the server requests for each machine that you added to the cluster:

```
$ oc get csr
```

Example output

```
NAME        AGE     REQUESTOR                                                   CONDITION
csr-bfd72   5m26s   system:node:ip-10-0-50-126.us-east-2.compute.internal
Pending
csr-c57lv   5m26s   system:node:ip-10-0-95-157.us-east-2.compute.internal
Pending
...
```

5. If the remaining CSRs are not approved, and are in the **Pending** status, approve the CSRs for your cluster machines:

- To approve them individually, run the following command for each valid CSR:

```
$ oc adm certificate approve <csr_name> 1
```

1 **<csr_name>** is the name of a CSR from the list of current CSRs.

- To approve all pending CSRs, run the following command:

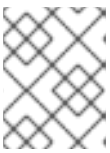
```
$ oc get csr -o go-template='{{range .items}}{{if not .status}}{{.metadata.name}}{{"\n"}}
{{end}}{{end}}' | xargs oc adm certificate approve
```

6. After all client and server CSRs have been approved, the machines have the **Ready** status. Verify this by running the following command:

```
$ oc get nodes
```

Example output

```
NAME      STATUS    ROLES   AGE  VERSION
master-0  Ready     master  73m  v1.20.0
master-1  Ready     master  73m  v1.20.0
master-2  Ready     master  74m  v1.20.0
worker-0  Ready     worker  11m  v1.20.0
worker-1  Ready     worker  11m  v1.20.0
```



NOTE

It can take a few minutes after approval of the server CSRs for the machines to transition to the **Ready** status.

Additional information

- For more information on CSRs, see Certificate Signing Requests.

1.2.11. Initial Operator configuration

After the control plane initializes, you must immediately configure some Operators so that they all become available.

Prerequisites

- Your control plane has initialized.

Procedure

1. Watch the cluster components come online:

```
$ watch -n5 oc get clusteroperators
```

Example output

```
NAME                                       VERSION   AVAILABLE   PROGRESSING   DEGRADED
SINCE
authentication                             4.5.4     True        False         False      69s
cloud-credential                           4.5.4     True        False         False      12m
cluster-autoscaler                         4.5.4     True        False         False      11m
console                                    4.5.4     True        False         False      46s
dns                                        4.5.4     True        False         False      11m
image-registry                             4.5.4     True        False         False      5m26s
ingress                                    4.5.4     True        False         False      5m36s
kube-apiserver                             4.5.4     True        False         False      8m53s
kube-controller-manager                    4.5.4     True        False         False      7m24s
kube-scheduler                             4.5.4     True        False         False      12m
machine-api                                4.5.4     True        False         False      12m
machine-config                             4.5.4     True        False         False      7m36s
marketplace                                4.5.4     True        False         False      7m54m
monitoring                                 4.5.4     True        False         False      7h54s
network                                    4.5.4     True        False         False      5m9s
node-tuning                                4.5.4     True        False         False      11m
openshift-apiserver                        4.5.4     True        False         False      11m
openshift-controller-manager               4.5.4     True        False         False      5m943s
openshift-samples                          4.5.4     True        False         False      3m55s
operator-lifecycle-manager                 4.5.4     True        False         False      11m
operator-lifecycle-manager-catalog         4.5.4     True        False         False      11m
service-ca                                 4.5.4     True        False         False      11m
service-catalog-apiserver                  4.5.4     True        False         False      5m26s
service-catalog-controller-manager         4.5.4     True        False         False      5m25s
storage                                    4.5.4     True        False         False      5m30s
```

2. Configure the Operators that are not available.

1.2.11.1. Image registry storage configuration

The Image Registry Operator is not initially available for platforms that do not provide default storage. After installation, you must configure your registry to use storage so that the Registry Operator is made available.

Instructions are shown for configuring a persistent volume, which is required for production clusters. Where applicable, instructions are shown for configuring an empty directory as the storage location, which is available for only non-production clusters.

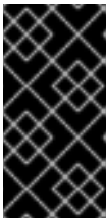
Additional instructions are provided for allowing the image registry to use block storage types by using the **Recreate** rollout strategy during upgrades.

1.2.11.1.1. Configuring registry storage for bare metal

As a cluster administrator, following installation you must configure your registry to use storage.

Prerequisites

- Cluster administrator permissions.
- A cluster on bare metal.
- Persistent storage provisioned for your cluster, such as Red Hat OpenShift Container Storage.



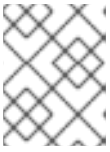
IMPORTANT

OpenShift Container Platform supports **ReadWriteOnce** access for image registry storage when you have only one replica. To deploy an image registry that supports high availability with two or more replicas, **ReadWriteMany** access is required.

- Must have 100Gi capacity.

Procedure

1. To configure your registry to use storage, change the **spec.storage.pvc** in the **configs.imageregistry/cluster** resource.



NOTE

When using shared storage, review your security settings to prevent outside access.

2. Verify that you do not have a registry pod:

```
$ oc get pod -n openshift-image-registry
```

NOTE

If the storage type is **emptyDIR**, the replica number cannot be greater than **1**.

3. Check the registry configuration:

```
$ oc edit configs.imageregistry.operator.openshift.io
```

Example output

```
storage:
  pvc:
    claim:
```

Leave the **claim** field blank to allow the automatic creation of an **image-registry-storage** PVC.

4. Check the **clusteroperator** status:

```
$ oc get clusteroperator image-registry
```

1.2.11.1.2. Configuring storage for the image registry in non-production clusters

You must configure storage for the Image Registry Operator. For non-production clusters, you can set the image registry to an empty directory. If you do so, all images are lost if you restart the registry.

Procedure

1. To set the image registry storage to an empty directory:

```
$ oc patch configs.imageregistry.operator.openshift.io cluster --type merge --patch '{"spec":{"storage":{"emptyDir":{}}}}'
```

WARNING

Configure this option for only non-production clusters.

If you run this command before the Image Registry Operator initializes its components, the **oc patch** command fails with the following error:

```
Error from server (NotFound): configs.imageregistry.operator.openshift.io "cluster" not found
```

Wait a few minutes and run the command again.

2. Ensure that your registry is set to managed to enable building and pushing of images.

- Run:

```
$ oc edit configs.imageregistry/cluster
```

Then, change the line

```
managementState: Removed
```

to

```
managementState: Managed
```

1.2.12. Completing installation on user-provisioned infrastructure

After you complete the Operator configuration, you can finish installing the cluster on infrastructure that you provide.

Prerequisites

- Your control plane has initialized.
- You have completed the initial Operator configuration.

Procedure

1. Confirm that all the cluster components are online with the following command:

```
$ watch -n5 oc get clusteroperators
```

Example output

```
NAME                                       VERSION   AVAILABLE   PROGRESSING   DEGRADED
SINCE
authentication                             4.5.4     True        False         False      7m56s
cloud-credential                           4.5.4     True        False         False      31m
cluster-autoscaler                         4.5.4     True        False         False      16m
console                                    4.5.4     True        False         False      10m
csi-snapshot-controller                    4.5.4     True        False         False      16m
dns                                        4.5.4     True        False         False      22m
etcd                                       4.5.4     False       False         False      25s
image-registry                             4.5.4     True        False         False      16m
ingress                                    4.5.4     True        False         False      16m
insights                                   4.5.4     True        False         False      17m
kube-apiserver                             4.5.4     True        False         False      19m
kube-controller-manager                    4.5.4     True        False         False      20m
kube-scheduler                             4.5.4     True        False         False      20m
kube-storage-version-migrator              4.5.4     True        False         False      16m
machine-api                                4.5.4     True        False         False      22m
machine-config                             4.5.4     True        False         False      22m
marketplace                                4.5.4     True        False         False      16m
monitoring                                 4.5.4     True        False         False      10m
network                                    4.5.4     True        False         False      23m
node-tuning                                4.5.4     True        False         False      23m
openshift-apiserver                        4.5.4     True        False         False      17m
openshift-controller-manager               4.5.4     True        False         False      15m
openshift-samples                          4.5.4     True        False         False      16m
operator-lifecycle-manager                 4.5.4     True        False         False      22m
operator-lifecycle-manager-catalog         4.5.4     True        False         False      22m
operator-lifecycle-manager-packageserver   4.5.4     True        False         False      18m
service-ca                                 4.5.4     True        False         False      23m
service-catalog-apiserver                  4.5.4     True        False         False      23m
service-catalog-controller-manager         4.5.4     True        False         False      23m
storage                                    4.5.4     True        False         False      17m
```

Alternatively, the following command notifies you when all of the clusters are available. It also retrieves and displays credentials:

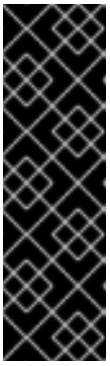
```
$ ./openshift-install --dir=<installation_directory> wait-for install-complete 1
```

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

Example output

```
INFO Waiting up to 30m0s for the cluster to initialize...
```

The command succeeds when the Cluster Version Operator finishes deploying the OpenShift Container Platform cluster from Kubernetes API server.



IMPORTANT

The Ignition config files that the installation program generates contain certificates that expire after 24 hours, which are then renewed at that time. If the cluster is shut down before renewing the certificates and the cluster is later restarted after the 24 hours have elapsed, the cluster automatically recovers the expired certificates. The exception is that you must manually approve the pending **node-bootstrapper** certificate signing requests (CSRs) to recover kubelet certificates. See the documentation for *Recovering from expired control plane certificates* for more information.

2. Confirm that the Kubernetes API server is communicating with the pods.

   a. To view a list of all pods, use the following command:

   ```
   $ oc get pods --all-namespaces
   ```

   Example output

   ```
   NAMESPACE                  NAME                                        READY   STATUS
   RESTARTS   AGE
   openshift-apiserver-operator    openshift-apiserver-operator-85cb746d55-zqhs8   1/1
   Running    1          9m
   openshift-apiserver        apiserver-67b9g                             1/1     Running    0
   3m
   openshift-apiserver        apiserver-ljcmx                             1/1     Running    0
   1m
   openshift-apiserver        apiserver-z25h4                             1/1     Running    0
   2m
   openshift-authentication-operator authentication-operator-69d5d8bf84-vh2n8       1/1
   Running    0          5m
   ...
   ```

   b. View the logs for a pod that is listed in the output of the previous command by using the following command:

   ```
   $ oc logs <pod_name> -n <namespace>
   ```
   (1)

   (1) Specify the pod name and namespace, as shown in the output of the previous command.

   If the pod logs display, the Kubernetes API server can communicate with the cluster machines.

3. Register your cluster on the Cluster registration page.

1.2.13. Collecting debugging information

You can gather debugging information that might help you to troubleshoot and debug certain issues with an OpenShift Container Platform installation on IBM Z.

Prerequisites

- The **oc** CLI tool installed.

Procedure

1. Log in to the cluster:

```
$ oc login
```

2. On the node you want to gather hardware information about, start a debugging container:

```
$ oc debug node/<nodename>
```

3. Change to the **/host** file system and start **toolbox**:

```
$ chroot /host
$ toolbox
```

4. Collect the **dbginfo** data:

```
$ dbginfo.sh
```

5. You can then retrieve the data, for example, using **scp**.

Additional resources

- See also How to generate SOSREPORT within OpenShift Container Platform version 4 nodes without SSH.

Next steps

- Customize your cluster.
- If the mirror registry that you used to install your cluster has a trusted CA, add it to the cluster by configuring additional trust stores.