OpenShift Container Platform 4.19

Configuring network settings

General networking configuration processes in OpenShift Container Platform

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Legal Notice

Abstract

This document covers configuring networking aspects such as node port services, IP address ranges, IP failover, and cluster-wide proxies in OpenShift Container Platform.

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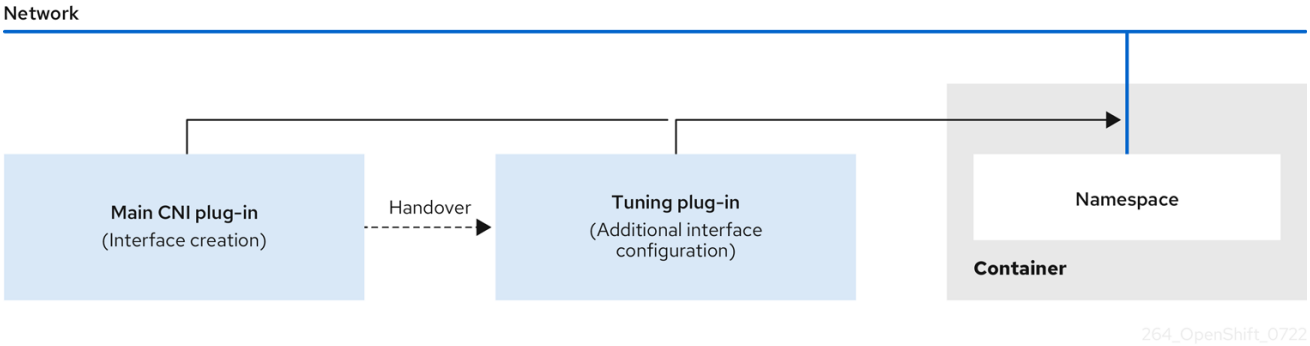
CHAPTER 1. CONFIGURING SYSTEM CONTROLS AND INTERFACE ATTRIBUTES USING THE TUNING PLUGIN

To modify kernel parameters and interface attributes at runtime in OpenShift Container Platform, you can use the tuning Container Network Interface (CNI) meta plugin. The plugin operates in a chain with a main CNI plugin and allows you to change sysctls and interface attributes such as promiscuous mode, all-multicast mode, MTU, and MAC address.



1.1. CONFIGURING SYSTEM CONTROLS BY USING THE TUNING CNI

To configure interface-level network sysctls in OpenShift Container Platform, you can use the tuning CNI meta plugin in a network attachment definition. Configure the **net.ipv4.conf.IFNAME.accept_redirects** sysctl to enable accepting and sending ICMP-redirected packets.

Procedure

1. Create a network attachment definition, such as **tuning-example.yaml**, with the following content:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: <name>
  namespace: default
spec:
  config: '{
    "cniVersion": "0.4.0",
    "name": "<name>",
    "plugins": [{
       "type": "<main_CNI_plugin>"
      },
      {
       "type": "tuning",
       "sysctl": {
            "net.ipv4.conf.IFNAME.accept_redirects": "1"
        }
      }
     ]
}
```

where:

metadata.name

Specifies the name for the additional network attachment to create. The name must be unique within the specified namespace.

metadata.namespace

Specifies the namespace that the object is associated with.

spec.config.cniVersion

Specifies the CNI specification version.

spec.config.name

Specifies the name for the configuration. It is recommended to match the configuration name to the name value of the network attachment definition.

spec.config.plugins.type

Specifies the name of the main CNI plugin to configure.

spec.config.plugins.tuning.sysctl

Specifies the sysctl to set. The interface name is represented by the **IFNAME** token and is replaced with the actual name of the interface at runtime.

Example network attachment definition

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: tuningnad
  namespace: default
spec:
  config: '{
    "cniVersion": "0.4.0",
    "name": "tuningnad",
    "plugins": [{
      "type": "bridge"
      },
      {
      "type": "tuning",
      "sysctl": {
        "net.ipv4.conf.IFNAME.accept_redirects": "1"
       }
    }
  ]
}'
```

2. Apply the YAML by running the following command:

```
$ oc apply -f tuning-example.yaml
```

Example output

```
networkattachmentdefinition.k8.cni.cncf.io/tuningnad created
```

3. Create a pod such as **examplepod.yaml** with the network attachment definition similar to the following:

```
apiVersion: v1
kind: Pod
metadata:
  name: tunepod
  namespace: default
  annotations:
    k8s.v1.cni.cncf.io/networks: tuningnad
spec:
  containers:
  - name: podexample
    image: centos
    command: ["/bin/bash", "-c", "sleep INF"]
    securityContext:
      runAsUser: 2000
      runAsGroup: 3000
      allowPrivilegeEscalation: false
      capabilities:
        drop: ["ALL"]
  securityContext:
    runAsNonRoot: true
    seccompProfile:
      type: RuntimeDefault
```

where:

metadata.annotations.k8s.v1.cni.cncf.io/networks

Specifies the name of the configured **NetworkAttachmentDefinition**.

spec.containers.securityContext.runAsUser

Specifies which user ID the container is run with.

spec.containers.securityContext.runAsGroup

Specifies which primary group ID the containers is run with.

spec.containers.securityContext.allowPrivilegeEscalation

Specifies if a pod can request to allow privilege escalation. If unspecified, it defaults to true. This boolean directly controls whether the **no_new_privs** flag gets set on the container process.

spec.containers.securityContext.capabilities

Specifies privileged actions without giving full root access. This policy ensures all capabilities are dropped from the pod.

spec.securityContext.runAsNonRoot: true

Specifies that the container will run with a user with any UID other than 0.

spec.securityContext.seccompProfile

Specifies the default seccomp profile for a pod or container workload.

4. Apply the yaml by running the following command:

```
$ oc apply -f examplepod.yaml
```

5. Verify that the pod is created by running the following command:

```
$ oc get pod
```

Example output

```
NAME     READY   STATUS    RESTARTS   AGE
tunepod  1/1     Running   0          47s
```

6. Log in to the pod by running the following command:

```
$ oc rsh tunepod
```

7. Verify the values of the configured sysctl flags. For example, find the value **net.ipv4.conf.net1.accept_redirects** by running the following command:

```
sh-4.4# sysctl net.ipv4.conf.net1.accept_redirects
```

Expected output

```
net.ipv4.conf.net1.accept_redirects = 1
```

1.2. ENABLING ALL-MULTICAST MODE BY USING THE TUNING CNI

To enable all-multicast mode on network interfaces in OpenShift Container Platform, you can use the tuning Container Network Interface (CNI) meta plugin in a network attachment definition. When enabled, the interface receives all multicast packets on the network.

Procedure

1. Create a network attachment definition, such as **tuning-example.yaml**, with the following content:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: <name>
  namespace: default
spec:
  config: '{
    "cniVersion": "0.4.0",
    "name": "<name>",
    "plugins": [{
      "type": "<main_CNI_plugin>"
     },
     {
      "type": "tuning",
      "allmulti": true
     }
    ]
}
```

where:

<name>

Specifies the name for the additional network attachment to create. The name must be unique within the specified namespace.

default

Specifies the namespace that the object is associated with.

"0.4.0"

Specifies the CNI specification version.

"<name>"

Specifies the name for the configuration. Match the configuration name to the name value of the network attachment definition.

"<main_CNI_plugin>"

Specifies the name of the main CNI plugin to configure.

"tuning"

Specifies the name of the CNI meta plugin.

"true"

Specifies the all-multicast mode of interface. If enabled, all multicast packets on the network will be received by the interface.

Example network attachment definition

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: setallmulti
  namespace: default
spec:
  config: '{
    "cniVersion": "0.4.0",
    "name": "setallmulti",
    "plugins": [
      {
        "type": "bridge"
      },
      {
        "type": "tuning",
        "allmulti": true
      }
    ]
  }'
```

2. Apply the settings specified in the YAML file by running the following command:

```
$ oc apply -f tuning-allmulti.yaml
```

Example output

```
networkattachmentdefinition.k8s.cni.cncf.io/setallmulti created
```

3. Create a pod with a network attachment definition similar to that specified in the following **examplepod.yaml** sample file:

```
apiVersion: v1
kind: Pod
metadata:
  name: allmultipod
  namespace: default
  annotations:
    k8s.v1.cni.cncf.io/networks: setallmulti
spec:
  containers:
  - name: podexample
    image: centos
    command: ["/bin/bash", "-c", "sleep INF"]
    securityContext:
      runAsUser: 2000
      runAsGroup: 3000
      allowPrivilegeEscalation: false
      capabilities:
        drop: ["ALL"]
  securityContext:
    runAsNonRoot: true
    seccompProfile:
      type: RuntimeDefault
```

where:

metadata.annotations.k8s.v1.cni.cncf.io/networks

Specifies the name of the configured **NetworkAttachmentDefinition**.

spec.containers.securityContext.runAsUser

Specifies which user ID the container is run with.

spec.containers.securityContext.runAsGroup

Specifies which primary group ID the containers is run with.

spec.containers.securityContext.allowPrivilegeEscalation

Specifies if a pod can request to allow privilege escalation. If unspecified, it defaults to true. This boolean directly controls whether the **no_new_privs** flag gets set on the container process.

spec.containers.securityContext.capabilities

Specifies privileged actions without giving full root access. This policy ensures all capabilities are dropped from the pod.

spec.containers.securityContext.runAsNonRoot: true

Specifies that the container will run with a user with any UID other than 0.

spec.containers.securityContext.seccompProfile

Specifies the default seccomp profile for a pod or container workload.

4. Apply the settings specified in the YAML file by running the following command:

```
$ oc apply -f examplepod.yaml
```

5. Verify that the pod is created by running the following command:

```
$ oc get pod
```

Example output

```
NAME         READY   STATUS    RESTARTS   AGE
allmultipod  1/1     Running   0          23s
```

6. Log in to the pod by running the following command:

```
$ oc rsh allmultipod
```

7. List all the interfaces associated with the pod by running the following command:

```
sh-4.4# ip link
```

Example output

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode
DEFAULT group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: eth0@if22: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 8901 qdisc noqueue state
UP mode DEFAULT group default
    link/ether 0a:58:0a:83:00:10 brd ff:ff:ff:ff:ff:ff link-netnsid 0
3: net1@if24: <BROADCAST,MULTICAST,ALLMULTI,UP,LOWER_UP> mtu 1500 qdisc
noqueue state UP mode DEFAULT group default
    link/ether ee:9b:66:a4:ec:1d brd ff:ff:ff:ff:ff:ff link-netnsid 0
```

where:

eth0@if22

Specifies the primary interface.

net1@if24

Specifies the secondary interface configured with the network-attachment-definition that supports the all-multicast mode (ALLMULTI flag).

1.3. ADDITIONAL RESOURCES

- Using sysctls in containers
- SR-IOV network node configuration object
- Configuring interface-level network sysctl settings and all-multicast mode for SR-IOV networks

CHAPTER 2. CONFIGURING THE NODE PORT SERVICE RANGE

To meet your cluster node port requirements in OpenShift Container Platform, you can configure the node port service range during installation or expand it after installation. You can expand the default range of **30000-32768** on either side while preserving this default range within your new configuration.

IMPORTANT

Red Hat has not performed testing outside the default port range of **30000-32768**. For ranges outside the default port range, ensure that you test to verify the expanding node port range does not impact your cluster. In particular, ensure that there is:

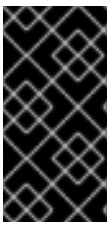
- No overlap with any ports already in use by host processes
- No overlap with any ports already in use by pods that are configured with host networking

If you expanded the range and a port allocation issue occurs, create a new cluster and set the required range for it.

If you expand the node port range and OpenShift CLI (**oc**) stops working because of a port conflict with the OpenShift Container Platform API server, you must create a new cluster.

2.1. EXPANDING THE NODE PORT RANGE

To expand the node port range for your OpenShift Container Platform cluster after installation, you can use the **oc patch** command to update the **serviceNodePortRange** parameter. You can expand the range on either side, but you cannot shrink it after installation.



IMPORTANT

Red Hat has not performed testing outside the default port range of **30000-32768**. For ranges outside the default port range, ensure that you test to verify that expanding your node port range does not impact your cluster. If you expanded the range and a port allocation issue occurs, create a new cluster and set the required range for it.

Prerequisites

- Installed the OpenShift CLI (**oc**).
- Logged in to the cluster as a user with **cluster-admin** privileges.
- You ensured that your cluster infrastructure allows access to the ports that exist in the extended range. For example, if you expand the node port range to **30000-32900**, your firewall or packet filtering configuration must allow the inclusive port range of **30000-32900**.

Procedure

- To expand the range for the **serviceNodePortRange** parameter in the **network.config.openshift.io** object that your cluster uses to manage traffic for pods, enter the following command:

```
$ oc patch network.config.openshift.io cluster --type=merge -p \
  '{
    "spec":
      { "serviceNodePortRange": "<port_range>" }
  }'
```

where:

<port_range>

Specifies the expanded range, such as **30000-32900**.

TIP

You can also apply the following YAML to update the node port range:

```
apiVersion: config.openshift.io/v1
kind: Network
metadata:
  name: cluster
spec:
  serviceNodePortRange: "<port_range>"
# ...
```

Example output

```
network.config.openshift.io/cluster patched
```

Verification

- To confirm that the updated configuration is active, enter the following command. The update can take several minutes to apply.

```
$ oc get configmaps -n openshift-kube-apiserver config \
  -o jsonpath="{.data['config\.yaml']}" | \
  grep -Eo '"service-node-port-range":["[[:digit:]]+-[[:digit:]]+"]'
```

Example output

```
"service-node-port-range":["30000-32900"]
```

2.2. ADDITIONAL RESOURCES

- Configuring ingress cluster traffic using a NodePort
- Network [config.openshift.io/v1]
- Service [core/v1]

CHAPTER 3. CONFIGURING THE CLUSTER NETWORK RANGE

To expand the cluster network range in OpenShift Container Platform to support more nodes and IP addresses, you can modify the cluster network CIDR mask after cluster installation. This procedure requires the OVN-Kubernetes network plugin and provides more IP space for additional nodes.

For example, if you deployed a cluster and specified **10.128.0.0/19** as the cluster network range and a host prefix of **23**, you are limited to 16 nodes. You can expand that to 510 nodes by changing the CIDR mask on a cluster to /**14**.

The following limitations apply when modifying the cluster network IP address range:

- The CIDR mask size specified must always be smaller than the currently configured CIDR mask size, because you can only increase IP space by adding more nodes to an installed cluster
- The host prefix cannot be modified
- Pods that are configured with an overridden default gateway must be recreated after the cluster network expands

3.1. EXPANDING THE CLUSTER NETWORK IP ADDRESS RANGE

To expand the cluster network IP address range in OpenShift Container Platform to support more nodes, you can modify the cluster network CIDR mask using the **oc patch** command.

NOTE

This change requires rolling out a new Operator configuration across the cluster, and can take up to 30 minutes to take effect.

Prerequisites

- You have installed the OpenShift CLI (**oc**).
- You have logged in to the cluster with a user with **cluster-admin** privileges.
- You have ensured that the cluster uses the OVN-Kubernetes network plugin.

Procedure

1. To obtain the cluster network range and host prefix for your cluster, enter the following command:

```
$ oc get network.operator.openshift.io \
  -o jsonpath="{.items[0].spec.clusterNetwork}"
```

Example output

```
[{"cidr":"10.217.0.0/22","hostPrefix":23}]
```

2. To expand the cluster network IP address range, enter the following command. Use the CIDR IP address range and host prefix returned from the output of the previous command.

```
$ oc patch Network.config.openshift.io cluster --type='merge' --patch \
  '{
    "spec":{
      "clusterNetwork": [ {"cidr":"<network>/<cidr>","hostPrefix":<prefix>} ],
      "networkType": "OVNKubernetes"
    }
  }'
```

where:

<network>

Specifies the network part of the **cidr** field that you obtained from the previous step. You cannot change this value.

<cidr>

Specifies the network prefix length. For example, **14**. Change this value to a smaller number than the value from the output in the previous step to expand the cluster network range.

<prefix>

Specifies the current host prefix for your cluster. This value must be the same value for the **hostPrefix** field that you obtained from the previous step.

Example command

```
$ oc patch Network.config.openshift.io cluster --type='merge' --patch \
  '{
    "spec":{
      "clusterNetwork": [ {"cidr":"10.217.0.0/14","hostPrefix": 23} ],
      "networkType": "OVNKubernetes"
    }
  }'
```

Example output

```
network.config.openshift.io/cluster patched
```

3. To confirm that the configuration is active, enter the following command. It can take up to 30 minutes for this change to take effect.

```
$ oc get network.operator.openshift.io \
  -o jsonpath="{.items[0].spec.clusterNetwork}"
```

Example output

```
[{"cidr":"10.217.0.0/14","hostPrefix":23}]
```

3.2. ADDITIONAL RESOURCES

- OVN-Kubernetes network plugin
- Red Hat OpenShift Network Calculator
- About the OVN-Kubernetes network plugin

CHAPTER 4. CONFIGURING IP FAILOVER

To provide high availability for Virtual IP addresses and ensure services remain accessible when nodes fail in OpenShift Container Platform, you can configure IP failover using Keepalived.

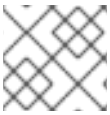
IP failover uses Keepalived to host a set of externally accessible Virtual IP (VIP) addresses on a set of hosts. Each VIP address is only serviced by a single host at a time. Keepalived uses the Virtual Router Redundancy Protocol (VRRP) to determine which host, from the set of hosts, services which VIP. If a host becomes unavailable, or if the service that Keepalived is watching does not respond, the VIP is switched to another host from the set. This means a VIP is always serviced as long as a host is available.

Every VIP in the set is serviced by a node selected from the set. If a single node is available, the VIPs are served. There is no way to explicitly distribute the VIPs over the nodes, so there can be nodes with no VIPs and other nodes with many VIPs. If there is only one node, all VIPs are on it.

The administrator must ensure that all of the VIP addresses meet the following requirements:

- Accessible on the configured hosts from outside the cluster.
- Not used for any other purpose within the cluster.

Keepalived on each node determines whether the needed service is running. If it is, VIPs are supported and Keepalived participates in the negotiation to determine which node serves the VIP. For a node to participate, the service must be listening on the watch port on a VIP or the check must be disabled.



NOTE

Each VIP in the set might be served by a different node.

IP failover monitors a port on each VIP to determine whether the port is reachable on the node. If the port is not reachable, the VIP is not assigned to the node. If the port is set to **0**, this check is suppressed. The check script does the needed testing.

When a node running Keepalived passes the check script, the VIP on that node can enter the **master** state based on its priority and the priority of the current master and as determined by the preemption strategy.

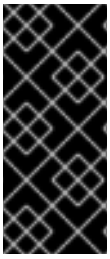
A cluster administrator can provide a script through the **OPENSHIFT_HA_NOTIFY_SCRIPT** variable, and this script is called whenever the state of the VIP on the node changes. Keepalived uses the **master** state when it is servicing the VIP, the **backup** state when another node is servicing the VIP, or in the **fault** state when the check script fails. The notify script is called with the new state whenever the state changes.

You can create an IP failover deployment configuration on OpenShift Container Platform. The IP failover deployment configuration specifies the set of VIP addresses, and the set of nodes on which to service them. A cluster can have multiple IP failover deployment configurations, with each managing its own set of unique VIP addresses. Each node in the IP failover configuration runs an IP failover pod, and this pod runs Keepalived.

When using VIPs to access a pod with host networking, the application pod runs on all nodes that are running the IP failover pods. This enables any of the IP failover nodes to become the master and service the VIPs when needed. If application pods are not running on all nodes with IP failover, either some IP failover nodes never service the VIPs or some application pods never receive any traffic. Use the same selector and replication count, for both IP failover and the application pods, to avoid this mismatch.

While using VIPs to access a service, any of the nodes can be in the IP failover set of nodes, since the service is reachable on all nodes, no matter where the application pod is running. Any of the IP failover nodes can become master at any time. The service can either use external IPs and a service port or it can use a **NodePort**. Setting up a **NodePort** is a privileged operation.

When using external IPs in the service definition, the VIPs are set to the external IPs, and the IP failover monitoring port is set to the service port. When using a node port, the port is open on every node in the cluster, and the service load-balances traffic from whatever node currently services the VIP. In this case, the IP failover monitoring port is set to the **NodePort** in the service definition.



IMPORTANT

Even though a service VIP is highly available, performance can still be affected. Keepalived makes sure that each of the VIPs is serviced by some node in the configuration, and several VIPs can end up on the same node even when other nodes have none. Strategies that externally load-balance across a set of VIPs can be thwarted when IP failover puts multiple VIPs on the same node.

When you use **ExternalIP**, you can set up IP failover to have the same VIP range as the **ExternalIP** range. You can also disable the monitoring port. In this case, all of the VIPs appear on same node in the cluster. Any user can set up a service with an **ExternalIP** and make it highly available.

IMPORTANT

There are a maximum of 254 VIPs in the cluster.

4.1. IP FAILOVER ENVIRONMENT VARIABLES

The IP failover environment variables reference lists all variables you can use to configure IP failover in OpenShift Container Platform, including VIP addresses, monitoring ports, and network interfaces.

Table 4.1. IP failover environment variables

Variable Name	Default	Description
OPENSHIFT_HA_MONITOR_PORT	**80**	The IP failover pod tries to open a TCP connection to this port on each Virtual IP (VIP). If connection is established, the service is considered to be running. If this port is set to **0**, the test always passes.
OPENSHIFT_HA_NETWORK_INTERFACE		The interface name that IP failover uses to send Virtual Router Redundancy Protocol (VRRP) traffic. The default value is **eth0**. If your cluster uses the OVN-Kubernetes network plugin, set this value to **br-ex** to avoid packet loss. For a cluster that uses the OVN-Kubernetes network plugin, all listening interfaces do not serve VRRP but instead expect inbound traffic over a **br-ex** bridge.

Variable Name	Default	Description
OPENSHIFT_HA_REPLICA_COUNT	**2**	The number of replicas to create. This must match **spec.replicas** value in IP failover deployment configuration.
OPENSHIFT_HA_VIRTUAL_IPS		The list of IP address ranges to replicate. This must be provided. For example, **1.2.3.4-6,1.2.3.9**.
OPENSHIFT_HA_VRRP_ID_OFFSET	**10**	The offset value used to set the virtual router IDs. Using different offset values allows multiple IP failover configurations to exist within the same cluster. The default offset is **10**, and the allowed range is **0** through **255**.
OPENSHIFT_HA_VIP_GROUPS		The number of groups to create for VRRP. If not set, a group is created for each virtual IP range specified with the **OPENSHIFT_HA_VIP_GROUPS** variable.
OPENSHIFT_HA_IPTABLES_CHAIN	INPUT	The name of the iptables chain, to automatically add an **iptables** rule to allow the VRRP traffic on. If the value is not set, an **iptables** rule is not added. If the chain does not exist, it is not created.
OPENSHIFT_HA_CHECK_SCRIPT		The full path name in the pod file system of a script that is periodically run to verify the application is operating.
OPENSHIFT_HA_CHECK_INTERVAL	**2**	The period, in seconds, that the check script is run.
OPENSHIFT_HA_NOTIFY_SCRIPT		The full path name in the pod file system of a script that is run whenever the state changes.
OPENSHIFT_HA_PREEMPTION	**preempt_nodelay 300**	The strategy for handling a new higher priority host. The **nopreempt** strategy does not move master from the lower priority host to the higher priority host.

4.2. CONFIGURING IP FAILOVER IN YOUR CLUSTER

To configure IP failover in your OpenShift Container Platform cluster and provide high availability for Virtual IP addresses, you can create a deployment that runs Keepalived on selected nodes to monitor services and fail over VIPs when nodes become unavailable.

The IP failover deployment ensures that a failover pod runs on each of the nodes matching the constraints or the label used. The pod, which runs Keepalived, can monitor an endpoint and use Virtual Router Redundancy Protocol (VRRP) to fail over the virtual IP (VIP) from one node to another if the first node cannot reach the service or endpoint.

For production use, set a **selector** that selects at least two nodes, and set **replicas** equal to the number of selected nodes.

Prerequisites

- You have logged in to the cluster as a user with **cluster-admin** privileges.
- You have created a pull secret.
- Red Hat OpenStack Platform (RHOSP) only:
  - You have installed an RHOSP client (RHCOS documentation) on the target environment.
  - You have downloaded the RHOSP **openrc.sh** rc file (RHCOS documentation).

Procedure

1. Create an IP failover service account:

```
$ oc create sa ipfailover
```

2. Update security context constraints (SCC) for **hostNetwork**:

```
$ oc adm policy add-scc-to-user privileged -z ipfailover
```

```
$ oc adm policy add-scc-to-user hostnetwork -z ipfailover
```

3. Red Hat OpenStack Platform (RHOSP) only: Complete the following steps to make a failover VIP address reachable on RHOSP ports.

   a. Use the RHOSP CLI to show the default RHOSP API and VIP addresses in the **allowed_address_pairs** parameter of your RHOSP cluster:

```
$ openstack port show <cluster_name> -c allowed_address_pairs
```

   Output example

```
*Field*                 *Value*
allowed_address_pairs    ip_address='192.168.0.5', mac_address='fa:16:3e:31:f9:cb'
                         ip_address='192.168.0.7', mac_address='fa:16:3e:31:f9:cb'
```

   b. Set a different VIP address for the IP failover deployment and make the address reachable on RHOSP ports by entering the following command in the RHOSP CLI. Do not set any default RHOSP API and VIP addresses as the failover VIP address for the IP failover deployment.

   Example of adding the 1.1.1.1 failover IP address as an allowed address on RHOSP ports.

```
$ openstack port set <cluster_name> --allowed-address ip-address=1.1.1.1,mac-
address=fa:fa:16:3e:31:f9:cb
```

c. Create a deployment YAML file to configure IP failover for your deployment. See "Example deployment YAML for IP failover configuration" in a later step.

d. Specify the following specification in the IP failover deployment so that you pass the failover VIP address to the **OPENSHIFT_HA_VIRTUAL_IPS** environment variable:

Example of adding the 1.1.1.1 VIP address to OPENSHIFT_HA_VIRTUAL_IPS

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ipfailover-keepalived
# ...
      spec:
         env:
         - name: OPENSHIFT_HA_VIRTUAL_IPS
         value: "1.1.1.1"
# ...
```

4. Create a deployment YAML file to configure IP failover.

NOTE

For Red Hat OpenStack Platform (RHOSP), you do not need to re-create the deployment YAML file. You already created this file as part of the earlier instructions.

Example deployment YAML for IP failover configuration

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ipfailover-keepalived
  labels:
    ipfailover: hello-openshift
spec:
  strategy:
    type: Recreate
  replicas: 2
  selector:
    matchLabels:
      ipfailover: hello-openshift
  template:
    metadata:
      labels:
        ipfailover: hello-openshift
    spec:
      serviceAccountName: ipfailover
      privileged: true
      hostNetwork: true
      nodeSelector:
        node-role.kubernetes.io/worker: ""
      containers:
      - name: openshift-ipfailover
        image: registry.redhat.io/openshift4/ose-keepalived-ipfailover-rhel9:v4.19
```

```
      ports:
      - containerPort: 63000
        hostPort: 63000
      imagePullPolicy: IfNotPresent
      securityContext:
        privileged: true
      volumeMounts:
      - name: lib-modules
        mountPath: /lib/modules
        readOnly: true
      - name: host-slash
        mountPath: /host
        readOnly: true
        mountPropagation: HostToContainer
      - name: etc-sysconfig
        mountPath: /etc/sysconfig
        readOnly: true
      - name: config-volume
        mountPath: /etc/keepalive
      env:
      - name: OPENSHIFT_HA_CONFIG_NAME
        value: "ipfailover"
      - name: OPENSHIFT_HA_VIRTUAL_IPS
        value: "1.1.1.1-2"
      - name: OPENSHIFT_HA_VIP_GROUPS
        value: "10"
      - name: OPENSHIFT_HA_NETWORK_INTERFACE
        value: "ens3" #The host interface to assign the VIPs
      - name: OPENSHIFT_HA_MONITOR_PORT
        value: "30060"
      - name: OPENSHIFT_HA_VRRP_ID_OFFSET
        value: "10"
      - name: OPENSHIFT_HA_REPLICA_COUNT
        value: "2" #Must match the number of replicas in the deployment
      - name: OPENSHIFT_HA_USE_UNICAST
        value: "false"
      #- name: OPENSHIFT_HA_UNICAST_PEERS
        #value: "10.0.148.40,10.0.160.234,10.0.199.110"
      - name: OPENSHIFT_HA_IPTABLES_CHAIN
        value: "INPUT"
      #- name: OPENSHIFT_HA_NOTIFY_SCRIPT
      #  value: /etc/keepalive/mynotifyscript.sh
      - name: OPENSHIFT_HA_CHECK_SCRIPT
        value: "/etc/keepalive/mycheckscript.sh"
      - name: OPENSHIFT_HA_PREEMPTION
        value: "preempt_delay 300"
      - name: OPENSHIFT_HA_CHECK_INTERVAL
        value: "2"
      livenessProbe:
        initialDelaySeconds: 10
        exec:
          command:
          - pgrep
          - keepalived
    volumes:
    - name: lib-modules
```

```
      hostPath:
        path: /lib/modules
    - name: host-slash
      hostPath:
        path: /
    - name: etc-sysconfig
      hostPath:
        path: /etc/sysconfig
    # config-volume contains the check script
    # created with `oc create configmap keepalived-checkscript --from-file=mycheckscript.sh`
    - configMap:
        defaultMode: 0755
        name: keepalived-checkscript
      name: config-volume
    imagePullSecrets:
      - name: openshift-pull-secret
```

where:

ipfailover-keepalived

Specifies the name of the IP failover deployment.

OPENSHIFT_HA_VIRTUAL_IPS

Specifies the lis t of IP address ranges to replicate. This must be provided. For example, **1.2.3.4-6,1.2.3.9**.

OPENSHIFT_HA_VIP_GROUPS

Specifies the number of groups to create for VRRP. If not set, a group is created for each virtual IP range specified with the **OPENSHIFT_HA_VIP_GROUPS** variable.

OPENSHIFT_HA_NETWORK_INTERFACE

Specifies the interface name that IP failover uses to send VRRP traffic. By default, **eth0** is used.

OPENSHIFT_HA_MONITOR_PORT

Specifies the IP failover pod tries to open a TCP connection to this port on each VIP. If connection is established, the service is considered to be running. If this port is set to **0**, the test always passes. The default value is **80**.

OPENSHIFT_HA_VRRP_ID_OFFSET

Specifies the offset value used to set the virtual router IDs. Using different offset values allows multiple IP failover configurations to exist within the same cluster. The default offset is **10**, and the allowed range is **0** through **255**.

OPENSHIFT_HA_REPLICA_COUNT

Specifies the number of replicas to create. This must match **spec.replicas** value in IP failover configuration. The default value is **2**.

OPENSHIFT_HA_USE_UNICAST

Specifies whether to use unicast mode for VRRP. The default value is **false**.

OPENSHIFT_HA_UNICAST_PEERS

Specifies the list of IP addresses of the unicast peers. This must be provided if **OPENSHIFT_HA_USE_UNICAST** is set to **true**.

OPENSHIFT_HA_IPTABLES_CHAIN

Specifies the name of the **iptables** chain to automatically add an **iptables** rule to allow the VRRP traffic on. If the value is not set, an **iptables** rule is not added. If the chain does not exist, it is not created, and Keepalived operates in unicast mode. The default is **INPUT**.

OPENSHIFT_HA_NOTIFY_SCRIPT

Specifies the full path name in the pod file system of a script that is run whenever the state changes.

OPENSHIFT_HA_CHECK_SCRIPT

Specifies the full path name in the pod file system of a script that is periodically run to verify the application is operating.

OPENSHIFT_HA_PREEMPTION

Specifies the strategy for handling a new higher priority host. The default value is **preempt_delay 300**, which causes a Keepalived instance to take over a VIP after 5 minutes if a lower-priority master is holding the VIP.

OPENSHIFT_HA_CHECK_INTERVAL

Specifies the period, in seconds, that the check script is run. The default value is **2**.

openshift-pull-secret

Specifies the name of the pull secret to use for the IP failover deployment. Create the pull secret before creating the deployment, otherwise you will get an error when creating the deployment.

4.3. CONFIGURING CHECK AND NOTIFY SCRIPTS

To customize health monitoring for IP failover and receive notifications when VIP state changes in OpenShift Container Platform, you can configure check and notify scripts by using **ConfigMap** objects.

The check and notify scripts run inside the IP failover pod and use the pod file system rather than the host file system. The host file system is available to the pod under the **/hosts** mount path. When configuring a check or notify script, you must provide the full path to the script.

Each IP failover pod manages a Keepalived daemon that controls one or more virtual IP (VIP) addresses on the node where the pod is running. Keepalived tracks the state of each VIP on the node, which can be **master**, **backup**, or **fault**.

The full path names of the check and notify scripts are added to the Keepalived configuration file, **/etc/keepalived/keepalived.conf**, which is loaded each time Keepalived starts. You add the scripts to the pod by using a **ConfigMap** object, as described in the following sections.

Check script

Keepalived monitors application health by periodically running an optional, user-supplied check script. For example, the script can test a web server by issuing a request and verifying the response. If you do not provide a check script, Keepalived runs a default script that tests the TCP connection. This default test is suppressed when the monitor port is set to **0**.

If the check script returns a non-zero value, the node enters the **backup** state and any VIPs that it holds are reassigned.

Notify script

As a cluster administrator, you can provide an optional notify script that Keepalived calls whenever the VIP state changes. Keepalived passes the following parameters to the notify script:

- **$1** – **group** or **instance**

- **$2** – Name of the **group** or **instance**
- **$3** – New state: **master**, **backup**, or **fault**

Prerequisites

- You installed the OpenShift CLI (**oc**).
- You are logged in to the cluster with a user with **cluster-admin** privileges.

Procedure

1. Create the desired script and create a **ConfigMap** object to hold it. The script has no input arguments and must return **0** for **OK** and **1** for **fail**.
   The check script, ***mycheckscript.sh***:

```
#!/bin/bash
   # Whatever tests are needed
   # E.g., send request and verify response
exit 0
```

2. Create the **ConfigMap** object by running the following command:

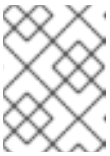
```
$ oc create configmap mycustomcheck --from-file=mycheckscript.sh
```

3. Add the script to the pod. The **defaultMode** for the mounted **ConfigMap** object files must able to run by using **oc** commands or by editing the IP failover configuration.

   a. Add the script to the pod by running the following command. A value of **0755**, **493** decimal, is typical. For example:

```
$ oc set env deploy/ipfailover-keepalived \
   OPENSHIFT_HA_CHECK_SCRIPT=/etc/keepalive/mycheckscript.sh
```

```
$ oc set volume deploy/ipfailover-keepalived --add --overwrite \
   --name=config-volume \
   --mount-path=/etc/keepalive \
   --source='{"configMap": { "name": "mycustomcheck", "defaultMode": 493}}'
```



NOTE

The **oc set env** command is whitespace sensitive. There must be no whitespace on either side of the **=** sign.

   b. Alternatively, edit the **ipfailover-keepalived** configuration by running the following command:

```
$ oc edit deploy ipfailover-keepalived
```

Example ipfailover-keepalived configuration

```
    spec:
      containers:
      - env:
        - name: OPENSHIFT_HA_CHECK_SCRIPT
          value: /etc/keepalive/mycheckscript.sh
...
        volumeMounts:
        - mountPath: /etc/keepalive
          name: config-volume
      dnsPolicy: ClusterFirst
...
      volumes:
      - configMap:
          defaultMode: 0755
          name: customrouter
        name: config-volume
...
```

where:

spec.container.env.name

Specifies the **OPENSHIFT_HA_CHECK_SCRIPT** environment variable to point to the mounted script file.

spec.container.volumeMounts

Specifies the **spec.container.volumeMounts** field to create the mount point.

spec.volumes

Specifies a new **spec.volumes** field to mention the config map.

spec.volumes.configMap.defaultMode

Specifies run permission on the files. When read back, it is displayed in decimal, **493**.

c. Save the changes and exit the editor. This restarts the **ipfailover-keepalived** configuration.

4.4. CONFIGURING VRRP PREEMPTION

To control VIP preemption behavior when nodes recover in OpenShift Container Platform, you can configure the **OPENSHIFT_HA_PREEMPTION** variable to set a delay before higher priority VIPs take over or disable preemption entirely.

When a virtual IP (VIP) on a node recovers from the **fault** state, it enters the **backup** state if it has a lower priority than the VIP currently in the **master** state.

There are two options for the **OPENSHIFT_HA_PREEMPTION** variable:

- **nopreempt**: When set, the **master** role does not move from a lower-priority VIP to a higher-priority VIP.
- **preempt_delay 300**: When set, Keepalived waits 300 seconds before moving the **master** role to the higher-priority VIP.

In the following example, the **OPENSHIFT_HA_PREEMPTION** value is set to **preempt_delay 300**.

Procedure

- To specify preemption enter **oc edit deploy ipfailover-keepalived** to edit the router deployment configuration:

```
$ oc edit deploy ipfailover-keepalived
```

```
# ...
   spec:
     containers:
     - env:
       - name: OPENSHIFT_HA_PREEMPTION
         value: preempt_delay 300
#...
```

4.5. DEPLOYING MULTIPLE IP FAILOVER INSTANCES

When deploying multiple IP failover instances in OpenShift Container Platform, each Keepalived daemon assigns unique VRRP IDs to virtual IP addresses. Configure the **OPENSHIFT_HA_VRRP_ID_OFFSET** variable to prevent VRRP ID range overlaps between different IP failover configurations.

Each IP failover pod created by an IP failover configuration (one pod per node or replica) runs a Keepalived daemon. When multiple IP failover configurations are present, additional pods are created, and their Keepalived daemons participate together in Virtual Router Redundancy Protocol (VRRP) negotiation. This negotiation determines which node services each virtual IP (VIP).

For each VIP, Keepalived assigns a unique internal **vrrp-id**. During VRRP negotiation, these **vrrp-id** values are used to select the node that services the corresponding VIP.

The IP failover pod assigns **vrrp-id** values sequentially to the VIPs defined in the IP failover configuration, starting from the value specified by **OPENSHIFT_HA_VRRP_ID_OFFSET**. Valid **vrrp-id** values are in the range 1..255.

When you deploy multiple IP failover configurations, ensure that the configured offset leaves sufficient space for additional VIPs and prevents **vrrp-id** ranges from overlapping across configurations.

4.6. CONFIGURING IP FAILOVER FOR MORE THAN 254 ADDRESSES

To configure IP failover for more than 254 Virtual IP addresses in OpenShift Container Platform, you can use the **OPENSHIFT_HA_VIP_GROUPS** variable to group multiple addresses together. By using the **OPENSHIFT_HA_VIP_GROUPS** variable, you can change the number of VIPs per VRRP instance and define the number of VIP groups available for each VRRP instance when configuring IP failover.

Grouping VIPs creates a wider range of allocation of VIPs per VRRP in the case of VRRP failover events, and is useful when all hosts in the cluster have access to a service locally. For example, when a service is being exposed with an **ExternalIP**.

NOTE

As a rule for failover, do not limit services, such as the router, to one specific host. Instead, services should be replicated to each host so that in the case of IP failover, the services do not have to be recreated on the new host.

NOTE

If you are using OpenShift Container Platform health checks, the nature of IP failover and groups means that all instances in the group are not checked. For that reason, the Kubernetes health checks must be used to ensure that services are live.

Prerequisites

- You are logged in to the cluster with a user with **cluster-admin** privileges.

Procedure

- To change the number of IP addresses assigned to each group, change the value for the **OPENSHIFT_HA_VIP_GROUPS** variable, for example:

  Example Deployment YAML for IP failover configuration

```
...
  spec:
    env:
    - name: OPENSHIFT_HA_VIP_GROUPS
      value: "3"
...
```

  In this example, the **OPENSHIFT_HA_VIP_GROUPS** variable is set to **3**. In an environment with seven VIPs, it creates three groups, assigning three VIPs to the first group, and two VIPs to the two remaining groups.

NOTE

If the number of groups set by **OPENSHIFT_HA_VIP_GROUPS** is fewer than the number of IP addresses set to fail over, the group contains more than one IP address, and all of the addresses move as a single unit.

4.7. HIGH AVAILABILITY FOR EXTERNALIP

High availability for **ExternalIP** in non-cloud clusters of OpenShift Container Platform combines IP failover with **ExternalIP** auto-assignment to ensure services remain accessible when nodes fail. You can configure this by using the same CIDR range for both **ExternalIP** auto-assignment and IP failover.

To configure high availability for **ExternalIP**, you can specify a **spec.ExternalIP.autoAssignCIDRs** range of the cluster network configuration, and then use the same range in creating the IP failover configuration.

Because IP failover can support up to a maximum of 255 VIPs for the entire cluster, the **spec.ExternalIP.autoAssignCIDRs** must be **/24** or smaller.

Additional resources

- Configuration for ExternalIP
- Kubernetes documentation on ExternalIP

4.8. REMOVING IP FAILOVER

To remove IP failover from your OpenShift Container Platform cluster and clean up iptables rules and virtual IP addresses, you can delete the deployment and service account, then run a cleanup job on each configured node.

When IP failover is initially configured, the worker nodes in the cluster are modified with an **iptables** rule that explicitly allows multicast packets on **224.0.0.18** for Keepalived. Because of the change to the nodes, removing IP failover requires running a job to remove the **iptables** rule and removing the virtual IP addresses used by Keepalived.

Procedure

1. Optional: Identify and delete any check and notify scripts that are stored as config maps:

   a. Identify whether any pods for IP failover use a config map as a volume:

   ```
   $ oc get pod -l ipfailover \
     -o jsonpath="\
   {range .items[?(@.spec.volumes[*].configMap)]}
   {'Namespace: '}{.metadata.namespace}
   {'Pod:       '}{.metadata.name}
   {'Volumes that use config maps:'}
   {range .spec.volumes[?(@.configMap)]}  {'volume:    '}{.name}
     {'configMap: '}{.configMap.name}{'\n'}{end}
   {end}"
   ```

   Example output

   ```
   Namespace: default
   Pod:       keepalived-worker-59df45db9c-2x9mn
   Volumes that use config maps:
     volume:    config-volume
     configMap: mycustomcheck
   ```

   b. If the preceding step provided the names of config maps that are used as volumes, delete the config maps:

   ```
   $ oc delete configmap <configmap_name>
   ```

2. Identify an existing deployment for IP failover:

   ```
   $ oc get deployment -l ipfailover
   ```

   Example output

   ```
   NAMESPACE   NAME        READY   UP-TO-DATE   AVAILABLE   AGE
   default     ipfailover   2/2     2            2           105d
   ```

3. Delete the deployment:

   ```
   $ oc delete deployment <ipfailover_deployment_name>
   ```

4. Remove the **ipfailover** service account:

```
$ oc delete sa ipfailover
```

5. Run a job that removes the IP tables rule that was added when IP failover was initially configured:

   a. Create a file such as **remove-ipfailover-job.yaml** with contents that are similar to the following example:

```
apiVersion: batch/v1
kind: Job
metadata:
  generateName: remove-ipfailover-
  labels:
    app: remove-ipfailover
spec:
  template:
    metadata:
      name: remove-ipfailover
    spec:
      containers:
      - name: remove-ipfailover
        image: registry.redhat.io/openshift4/ose-keepalived-ipfailover-rhel9:v4.19
        command: ["/var/lib/ipfailover/keepalived/remove-failover.sh"]
      nodeSelector:
        kubernetes.io/hostname: <host_name>
      restartPolicy: Never
```

   - The **nodeSelector** is likely the same as the selector used in the old IP failover deployment.
   - Run the job for each node in your cluster that was configured for IP failover and replace the hostname each time.

   b. Run the job:

```
$ oc create -f remove-ipfailover-job.yaml
```

Example output

```
job.batch/remove-ipfailover-2h8dm created
```

Verification

- Confirm that the job removed the initial configuration for IP failover.

```
$ oc logs job/remove-ipfailover-2h8dm
```

Example output

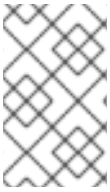
```
remove-failover.sh: OpenShift IP Failover service terminating.
  - Removing ip_vs module ...
  - Cleaning up ...
```

```
- Releasing VIPs  (interface eth0) ...
```

CHAPTER 5. CONFIGURING THE CLUSTER-WIDE PROXY

To enable your OpenShift Container Platform cluster to use an HTTP or HTTPS proxy when direct internet access is denied, you can configure cluster-wide proxy settings by modifying the **Proxy** object for existing clusters or by configuring proxy settings in the **install-config.yaml** file for new clusters.

After you enable a cluster-wide egress proxy for your cluster on a supported platform, Red Hat Enterprise Linux CoreOS (RHCOS) populates the **status.noProxy** parameter with the values of the **networking.machineNetwork[].cidr**, **networking.clusterNetwork[].cidr**, and **networking.serviceNetwork[]** fields from your **install-config.yaml** file that exists on the supported platform.



NOTE

As a postinstallation task, you can change the **networking.clusterNetwork[].cidr** value, but not the **networking.machineNetwork[].cidr** and the **networking.serviceNetwork[]** values. For more information, see "Configuring the cluster network range".

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

Example of values added to the status: segment of a Proxy object by RHCOS

```
apiVersion: config.openshift.io/v1
kind: Proxy
metadata:
  name: cluster
# ...
networking:
  clusterNetwork:
  - cidr: <ip_address_from_cidr>
    hostPrefix: 23
  network type: OVNKubernetes
  machineNetwork:
  - cidr: <ip_address_from_cidr>
  serviceNetwork:
  - 172.30.0.0/16
# ...
status:
  noProxy:
  - localhost
  - .cluster.local
  - .svc
  - 127.0.0.1
  - <api_server_internal_url>
# ...
```

where:

<ip_address_from_cidr>

Specifies IP address blocks from which pod IP addresses are allocated. The default value is **10.128.0.0/14** with a host prefix of **/23**.

<ip_address_from_cidr>

Specifies IP address blocks for machines. The default value is **10.0.0.0/16**.

<ip_address_from_cidr>

Specifies IP address block for services. The default value is **172.30.0.0/16**.

<api_server_internal_url>

You can find the URL of the internal API server by running the **oc get infrastructures.config.openshift.io cluster -o jsonpath='{.status.etcdDiscoveryDomain}'** command.

IMPORTANT

If your installation type does not include setting the **networking.machineNetwork[].cidr** field, you must include the machine IP addresses manually in the **.status.noProxy** field to make sure that the traffic between nodes can bypass the proxy.

5.1. PREREQUISITES

Review the sites that your cluster requires access to and determine whether any of them must bypass the proxy. By default, all cluster system egress traffic is proxied, including calls to the cloud provider API for the cloud that hosts your cluster. The system-wide proxy affects system components only, not user workloads. If necessary, add sites to the **spec.noProxy** parameter of the **Proxy** object to bypass the proxy.

5.2. ENABLING THE CLUSTER-WIDE PROXY

To enable the cluster-wide egress proxy for your OpenShift Container Platform cluster, you can modify the **Proxy** object to configure HTTP and HTTPS proxy settings and specify domains that bypass the proxy.

When a cluster is installed or upgraded without the proxy configured, a **Proxy** object is still generated but it has a nil **spec**. For example:

```
apiVersion: config.openshift.io/v1
kind: Proxy
metadata:
  name: cluster
spec:
  trustedCA:
    name: ""
status:
```

NOTE

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

A cluster administrator can configure the proxy for OpenShift Container Platform by modifying the **cluster Proxy** object.

WARNING

After you enable the cluster-wide proxy capability for your cluster and you save the **Proxy** object file, the Machine Config Operator (MCO) reboots all nodes in your cluster so that each node can access connections that exist outside of the cluster. You do not need to manually reboot these nodes.

Prerequisites

- You have cluster administrator permissions.
- You installed the OpenShift Container Platform **oc** CLI tool.

Procedure

1. Create a config map that contains any additional CA certificates required for proxying HTTPS connections.

NOTE

You can skip this step if the identity certificate of the proxy is signed by an authority from the Red Hat Enterprise Linux CoreOS (RHCOS) trust bundle.

   a. Create a file called **user-ca-bundle.yaml**, and provide the values of your PEM-encoded certificates:

```
apiVersion: v1
data:
  ca-bundle.crt: | 1
    <MY_PEM_ENCODED_CERTS> 2
kind: ConfigMap
metadata:
  name: user-ca-bundle 3
  namespace: openshift-config 4
```

   where:

   data.ca-bundle.crt

   Specifies the data key that must be named **ca-bundle.crt**.

   <MY_PEM_ENCODED_CERTS>

   Specifies one or more PEM-encoded X.509 certificates used to sign the proxy's identity certificate.

   user-ca-bundle

   Specifies the config map name that is referenced from the **Proxy** object.

   openshift-config

   Specifies the namespace that the config map must exist in.

b. Create the config map from the **user-ca-bundle.yaml** file by entering the following command:

```
$ oc create -f user-ca-bundle.yaml
```

2. Use the **oc edit** command to modify the **Proxy** object:

```
$ oc edit proxy/cluster
```

3. Configure the necessary fields for the proxy:

```
apiVersion: config.openshift.io/v1
kind: Proxy
metadata:
  name: cluster
spec:
  httpProxy: http://<username>:<pswd>@<ip>:<port> 1
  httpsProxy: https://<username>:<pswd>@<ip>:<port> 2
  noProxy: example.com 3
  readinessEndpoints:
  - http://www.google.com 4
  - https://www.google.com
  trustedCA:
    name: user-ca-bundle 5
```

where:

httpProxy

Specifies the proxy URL to use for creating HTTP connections outside the cluster. The URL scheme must be **http**.

httpsProxy

Specifies the proxy URL to use for creating HTTPS connections outside the cluster. The URL scheme must be either **http** or **https**. Specify a URL for the proxy that supports the URL scheme. For example, most proxies report an error if they are configured to use **https** but they only support **http**. This failure message may not propagate to the logs and can appear to be a network connection failure instead. If using a proxy that listens for **https** connections from the cluster, you might need to configure the cluster to accept the CAs and certificates that the proxy uses.

noProxy

Specifies a comma-separated list of destination domain names, domains, IP addresses (or other network CIDRs), and port numbers to exclude proxying. Note that Port numbers are only supported when configuring IPv6 addresses. Port numbers are not supported when configuring IPv4 addresses.
Preface a domain with **.** to match subdomains only. For example, **.y.com** matches **x.y.com**, but not **y.com**. Use * to bypass proxy for all destinations.

If your **noproxy** field needs to include a domain address, you must explicitly specify that FQDN, or prefix-matched subdomain, in the **noproxy** field. You cannot use the IP address or CIDR range that encapsulates the domain. This is because the cluster does not wait for DNS to return the IP address before assigning the route connection, and checks explicitly against the request being made. For example, if you have a CIDR block value, such as **10.0.0.0/24**, for

the **noproxy** field and the field attempts to access **https://10.0.0.11**, the addresses successfully match. However, attempting to access **https://exampleserver.externaldomain.com**, whose A record entry is **10.0.0.11**, fails. An additional value of **.externaldomain.com** for your **noproxy** field is necessary.

If you scale up compute nodes that are not included in the network defined by the **networking.machineNetwork[].cidr** field from the installation configuration, you must add them to this list to prevent connection issues.

This field is ignored if neither the **httpProxy** or **httpsProxy** fields are set.

readinessEndpoints

Specifies one or more URLs external to the cluster to use to perform a readiness check before writing the **httpProxy** and **httpsProxy** values to status.

trustedCA

Specifies a reference to the config map in the **openshift-config** namespace that contains additional CA certificates required for proxying HTTPS connections. Note that the config map must already exist before referencing it here. This field is required unless the proxy's identity certificate is signed by an authority from the RHCOS trust bundle.

4. Save the file to apply the changes.

5.3. REMOVING THE CLUSTER-WIDE PROXY

The **cluster** Proxy object cannot be deleted. To remove the cluster-wide proxy configuration from your OpenShift Container Platform cluster, you can remove all spec fields from the **Proxy** object by using the **oc edit** command.

Prerequisites

- Cluster administrator permissions
- OpenShift Container Platform **oc** CLI tool installed

Procedure

1. Use the **oc edit** command to modify the proxy:

```
$ oc edit proxy/cluster
```

2. Remove all **spec** fields from the Proxy object. For example:

```
apiVersion: config.openshift.io/v1
kind: Proxy
metadata:
  name: cluster
spec: {}
```

3. Save the file to apply the changes.

5.4. VERIFYING THE CLUSTER-WIDE PROXY CONFIGURATION

To verify that your cluster-wide proxy configuration is working correctly in OpenShift Container Platform, you can check the **Proxy** object status, review Machine Config Operator logs, and confirm that system components are routing external requests through the proxy.

Prerequisites

- You have cluster administrator permissions.
- You have the OpenShift Container Platform **oc** CLI tool installed.

Procedure

1. Check the proxy configuration status using the **oc** command:

```
$ oc get proxy/cluster -o yaml
```

2. Verify the proxy fields in the output to ensure they match your configuration. Specifically, check the **spec.httpProxy**, **spec.httpsProxy**, **spec.noProxy**, and **spec.trustedCA** fields.

3. Inspect the status of the **Proxy** object:

```
$ oc get proxy/cluster -o jsonpath='{.status}'
```

Example output

```
{
status:
    httpProxy: http://user:xxx@xxxx:3128
    httpsProxy: http://user:xxx@xxxx:3128
    noProxy:
.cluster.local,.svc,10.0.0.0/16,10.128.0.0/14,127.0.0.1,169.254.169.254,172.30.0.0/16,localhost,
test.no-proxy.com
}
```

4. Check the logs of the Machine Config Operator (MCO) to ensure that the configuration changes were applied successfully:

```
$ oc logs -n openshift-machine-config-operator $(oc get pods -n openshift-machine-config-operator -l k8s-app=machine-config-operator -o name)
```

5. Look for messages that indicate the proxy settings were applied and the nodes were rebooted if necessary.

6. Verify that system components are using the proxy by checking the logs of a component that makes external requests, such as the Cluster Version Operator (CVO):

```
$ oc logs -n openshift-cluster-version $(oc get pods -n openshift-cluster-version -l k8s-app=machine-config-operator -o name)
```

7. Look for log entries that show that external requests have been routed through the proxy.

5.5. ADDITIONAL RESOURCES

- Configuring the cluster network range
- Understanding the CA Bundle certificate
- Proxy certificates
- How is the cluster-wide proxy setting applied to OpenShift Container Platform nodes?

CHAPTER 6. CONFIGURING A CUSTOM PKI

To ensure secure communication between internal components in your OpenShift Container Platform cluster, you can add your organization's custom Certificate Authority (CA) certificates to the cluster-wide truststore.

You can leverage the Proxy API to add cluster-wide trusted CA certificates. You must do this either during installation or at runtime.

- During *installation*, configure the cluster-wide proxy. You must define your privately signed CA certificates in the **install-config.yaml** file's **additionalTrustBundle** setting.
  The installation program generates a ConfigMap that is named **user-ca-bundle** that contains the additional CA certificates you defined. The Cluster Network Operator then creates a **trusted-ca-bundle** ConfigMap that merges these CA certificates with the Red Hat Enterprise Linux CoreOS (RHCOS) trust bundle; this ConfigMap is referenced in the Proxy object's **trustedCA** field.

- At *runtime*, modify the default Proxy object to include your privately signed CA certificates (part of cluster's proxy enablement workflow). This involves creating a ConfigMap that contains the privately signed CA certificates that should be trusted by the cluster, and then modifying the proxy resource with the **trustedCA** referencing the privately signed certificates' ConfigMap.

NOTE

The installer configuration's **additionalTrustBundle** field and the proxy resource's **trustedCA** field are used to manage the cluster-wide trust bundle; **additionalTrustBundle** is used at install time and the proxy's **trustedCA** is used at runtime.

The **trustedCA** field is a reference to a **ConfigMap** containing the custom certificate and key pair used by the cluster component.

6.1. CONFIGURING THE CLUSTER-WIDE PROXY DURING INSTALLATION

To enable internet access in environments that deny direct connections, configure a cluster-wide proxy in the **install-config.yaml** file. This configuration ensures that the new OpenShift Container Platform cluster routes traffic through the specified HTTP or HTTPS proxy.

Prerequisites

- You have an existing **install-config.yaml** file.

- You have reviewed the sites that your cluster requires access to and determined whether any of them need to bypass the proxy. By default, all cluster egress traffic is proxied, including calls to hosting cloud provider APIs. You added 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, 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>
  httpsProxy: https://<username>:<pswd>@<ip>:<port>
  noProxy: example.com
additionalTrustBundle: |
    -----BEGIN CERTIFICATE-----
    <MY_TRUSTED_CA_CERT>
    -----END CERTIFICATE-----
additionalTrustBundlePolicy: <policy_to_add_additionalTrustBundle>
# ...
```

where:

proxy.httpProxy

Specifies a proxy URL to use for creating HTTP connections outside the cluster. The URL scheme must be **http**.

proxy.httpsProxy

Specifies a proxy URL to use for creating HTTPS connections outside the cluster.

proxy.noProxy

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

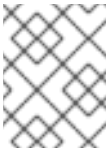
additionalTrustBundle

If provided, the installation program generates a config map that is named **user-ca-bundle** in the **openshift-config** namespace to hold the additional CA certificates. If you provide **additionalTrustBundle** and at least one proxy setting, the **Proxy** object is configured to reference the **user-ca-bundle** config map in the **trustedCA** field. The Cluster Network Operator then creates a **trusted-ca-bundle** config map that merges the contents specified for the **trustedCA** parameter with the RHCOS trust bundle. The **additionalTrustBundle** field is required unless the proxy's identity certificate is signed by an authority from the RHCOS trust bundle.

additionalTrustBundlePolicy

Specifies the policy that determines the configuration of the **Proxy** object to reference the

user-ca-bundle config map in the **trustedCA** field. The allowed values are **Proxyonly** and **Always**. Use **Proxyonly** to reference the **user-ca-bundle** config map only when **http/https** proxy is configured. Use **Always** to always reference the **user-ca-bundle** config map. The default value is **Proxyonly**. Optional parameter.



NOTE

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

NOTE

If the installer times out, restart and then complete the deployment by using the **wait-for** command of the installer. For example:

+

```
$ ./openshift-install wait-for install-complete --log-level debug
```

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

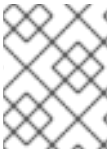
Only the **Proxy** object named **cluster** is supported, and no additional proxies can be created.

6.2. ENABLING THE CLUSTER-WIDE PROXY

To enable the cluster-wide egress proxy for your OpenShift Container Platform cluster, you can modify the **Proxy** object to configure HTTP and HTTPS proxy settings and specify domains that bypass the proxy.

When a cluster is installed or upgraded without the proxy configured, a **Proxy** object is still generated but it has a nil **spec**. For example:

```
apiVersion: config.openshift.io/v1
kind: Proxy
metadata:
  name: cluster
spec:
  trustedCA:
    name: ""
status:
```



NOTE

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

A cluster administrator can configure the proxy for OpenShift Container Platform by modifying the **cluster Proxy** object.

WARNING

After you enable the cluster-wide proxy capability for your cluster and you save the **Proxy** object file, the Machine Config Operator (MCO) reboots all nodes in your cluster so that each node can access connections that exist outside of the cluster. You do not need to manually reboot these nodes.

Prerequisites

- You have cluster administrator permissions.
- You installed the OpenShift Container Platform **oc** CLI tool.

Procedure

1. Create a config map that contains any additional CA certificates required for proxying HTTPS connections.

NOTE

You can skip this step if the identity certificate of the proxy is signed by an authority from the Red Hat Enterprise Linux CoreOS (RHCOS) trust bundle.

   a. Create a file called **user-ca-bundle.yaml**, and provide the values of your PEM-encoded certificates:

```
apiVersion: v1
data:
  ca-bundle.crt: | 1
    <MY_PEM_ENCODED_CERTS> 2
kind: ConfigMap
metadata:
  name: user-ca-bundle 3
  namespace: openshift-config 4
```

   where:

   data.ca-bundle.crt

   Specifies the data key that must be named **ca-bundle.crt**.

   <MY_PEM_ENCODED_CERTS>

Specifies one or more PEM-encoded X.509 certificates used to sign the proxy's identity certificate.

user-ca-bundle

Specifies the config map name that is referenced from the **Proxy** object.

openshift-config

Specifies the namespace that the config map must exist in.

b. Create the config map from the **user-ca-bundle.yaml** file by entering the following command:

```
$ oc create -f user-ca-bundle.yaml
```

2. Use the **oc edit** command to modify the **Proxy** object:

```
$ oc edit proxy/cluster
```

3. Configure the necessary fields for the proxy:

```
apiVersion: config.openshift.io/v1
kind: Proxy
metadata:
  name: cluster
spec:
  httpProxy: http://<username>:<pswd>@<ip>:<port> 1
  httpsProxy: https://<username>:<pswd>@<ip>:<port> 2
  noProxy: example.com 3
  readinessEndpoints:
  - http://www.google.com 4
  - https://www.google.com
  trustedCA:
    name: user-ca-bundle 5
```

where:

httpProxy

Specifies the proxy URL to use for creating HTTP connections outside the cluster. The URL scheme must be **http**.

httpsProxy

Specifies the proxy URL to use for creating HTTPS connections outside the cluster. The URL scheme must be either **http** or **https**. Specify a URL for the proxy that supports the URL scheme. For example, most proxies report an error if they are configured to use **https** but they only support **http**. This failure message may not propagate to the logs and can appear to be a network connection failure instead. If using a proxy that listens for **https** connections from the cluster, you might need to configure the cluster to accept the CAs and certificates that the proxy uses.

noProxy

Specifies a comma-separated list of destination domain names, domains, IP addresses (or other network CIDRs), and port numbers to exclude proxying. Note that Port numbers are only supported when configuring IPv6 addresses. Port numbers are not supported when configuring IPv4 addresses.

Preface a domain with **.** to match subdomains only. For example, **.y.com** matches **x.y.com**, but not **y.com**. Use ***** to bypass proxy for all destinations.

If your **noproxy** field needs to include a domain address, you must explicitly specify that FQDN, or prefix-matched subdomain, in the **noproxy** field. You cannot use the IP address or CIDR range that encapsulates the domain. This is because the cluster does not wait for DNS to return the IP address before assigning the route connection, and checks explicitly against the request being made. For example, if you have a CIDR block value, such as **10.0.0.0/24**, for the **noproxy** field and the field attempts to access **https://10.0.0.11**, the addresses successfully match. However, attempting to access **https://exampleserver.externaldomain.com**, whose A record entry is **10.0.0.11**, fails. An additional value of **.externaldomain.com** for your **noproxy** field is necessary.

If you scale up compute nodes that are not included in the network defined by the **networking.machineNetwork[].cidr** field from the installation configuration, you must add them to this list to prevent connection issues.

This field is ignored if neither the **httpProxy** or **httpsProxy** fields are set.

readinessEndpoints

Specifies one or more URLs external to the cluster to use to perform a readiness check before writing the **httpProxy** and **httpsProxy** values to status.

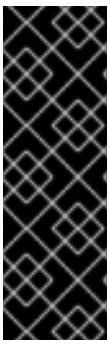
trustedCA

Specifies a reference to the config map in the **openshift-config** namespace that contains additional CA certificates required for proxying HTTPS connections. Note that the config map must already exist before referencing it here. This field is required unless the proxy's identity certificate is signed by an authority from the RHCOS trust bundle.

4. Save the file to apply the changes.

6.3. CERTIFICATE INJECTION USING OPERATORS

In OpenShift Container Platform, certificate injection using Operators merges your custom Certificate Authorities (CAs) with system certificates and injects the merged bundle into Operators that request it. You can use this feature so your Operators trust custom certificates without requiring manual certificate bundle management.



IMPORTANT

After adding a **config.openshift.io/inject-trusted-cabundle="true"** label to the config map, existing data in it is deleted. The Cluster Network Operator takes ownership of a config map and only accepts **ca-bundle** as data. You must use a separate config map to store **service-ca.crt** by using the **service.beta.openshift.io/inject-cabundle=true** annotation or a similar configuration. Adding a **config.openshift.io/inject-trusted-cabundle="true"** label and **service.beta.openshift.io/inject-cabundle=true** annotation on the same config map can cause issues.

Operators request this injection by creating an empty ConfigMap with the following label:

```
config.openshift.io/inject-trusted-cabundle="true"
```

An example of the empty ConfigMap:

```
apiVersion: v1
data: {}
kind: ConfigMap
metadata:
  labels:
    config.openshift.io/inject-trusted-cabundle: "true"
  name: ca-inject
  namespace: apache
```

where:

metadata.name

Specifies the empty ConfigMap name.

The Operator mounts this ConfigMap into the container's local trust store.

NOTE

Adding a trusted CA certificate is only needed if the certificate is not included in the Red Hat Enterprise Linux CoreOS (RHCOS) trust bundle.

Certificate injection is not limited to Operators. The Cluster Network Operator injects certificates across any namespace when an empty ConfigMap is created with the **config.openshift.io/inject-trusted-cabundle=true** label.

The ConfigMap can reside in any namespace, but the ConfigMap must be mounted as a volume to each container within a pod that requires a custom CA. For example:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-example-custom-ca-deployment
  namespace: my-example-custom-ca-ns
spec:
  ...
    spec:
      ...
      containers:
        - name: my-container-that-needs-custom-ca
          volumeMounts:
          - name: trusted-ca
            mountPath: /etc/pki/ca-trust/extracted/pem
            readOnly: true
      volumes:
      - name: trusted-ca
        configMap:
          name: ca-inject
          items:
            - key: ca-bundle.crt
              path: tls-ca-bundle.pem
```

where:

volumes.items.key

Specifies the ConfigMap key.

volumes.items.path

Specifies the ConfigMap path.