Abstract

Read more to learn about networking requirements for the hub cluster and managed cluster.
# Table of Contents

## CHAPTER 1. NETWORKING

1.1. HUB CLUSTER NETWORK CONFIGURATION .................................................. 3
   1.1.1. Hub cluster network configuration table ............................................. 3

1.2. MANAGED CLUSTER NETWORK CONFIGURATION ..................................... 5
   1.2.1. Managed cluster network configuration table .................................... 5

1.3. ADVANCED NETWORK CONFIGURATION .................................................. 7
   1.3.1. Additional networking requirements for infrastructure operator table .......... 7
   1.3.2. Submariner networking requirements table .......................................... 7
   1.3.3. Additional networking requirements for Hive ....................................... 8
   1.3.4. Hosted control planes networking requirements table (Technology Preview) ... 8
   1.3.5. Application deployment network requirements table ............................. 9
   1.3.6. Namespace connection network requirements table ............................ 9

1.4. SUBMARINER MULTICLUSTER NETWORKING AND SERVICE DISCOVERY ......... 10
   1.4.1. Deploying Submariner on disconnected clusters ................................. 10
      1.4.1.1. Configuring Submariner on disconnected clusters .......................... 10
      1.4.1.1.1. Mirroring images in the local registry ...................................... 11
      1.4.1.1.2. Customizing catalogSource names ......................................... 11
      1.4.1.1.3. Enabling airGappedDeployment in SubmarinerConfig .................. 11
   1.4.2. Configuring Submariner ................................................................. 11
      1.4.2.1. Prerequisites ............................................................................. 12
      1.4.2.2. Submariner ports table ............................................................. 12
      1.4.2.3. Globalnet .................................................................................. 12
      1.4.2.3.1. Enabling Globalnet by creating the submariner-broker object ......... 12
      1.4.2.3.2. Configuring the number of global IPs ..................................... 13
      1.4.2.3.3. Additional resources ............................................................. 13
   1.4.3. Installing the subctl command utility ................................................. 14
      1.4.3.1. Using the subctl commands ......................................................... 14
   1.4.4. Deploying Submariner by using the console ....................................... 15
   1.4.5. Deploying Submariner manually ....................................................... 17
      1.4.5.1. Preparing bare metal for Submariner ........................................... 18
      1.4.5.2. Preparing Microsoft Azure Red Hat OpenShift for Submariner by using the command line interface ................................................................. 18
      1.4.5.2.1. Preparing Microsoft Azure Red Hat OpenShift for Submariner by using the API ................................................................. 19
      1.4.5.3. Preparing Red Hat OpenShift Service on AWS for Submariner by using the command line interface ................................................................. 20
      1.4.5.3.1. Preparing Red Hat OpenShift Service on AWS for Submariner by using the API ................................................................. 20
      1.4.5.4. Deploy Submariner with the ManagedClusterAddOn API ................. 20
   1.4.6. Customizing Submariner deployments ............................................. 23
      1.4.6.1. NATT port ............................................................................... 23
      1.4.6.2. Number of gateway nodes ......................................................... 23
      1.4.6.3. Instance types of gateway nodes ............................................... 24
      1.4.6.4. Cable driver ............................................................................. 25
      1.4.6.5. Using a customized Submariner subscription .................................. 25
   1.4.7. Managing service discovery for Submariner .................................... 26
      1.4.7.1. Enabling service discovery for Submariner .................................. 26
      1.4.7.2. Disabling service discovery for Submariner .................................. 27
   1.4.8. Uninstalling Submariner ................................................................. 27
      1.4.8.1. Uninstalling Submariner by using the console ............................ 27
      1.4.8.2. Uninstalling Submariner by using the CLI .................................... 27
      1.4.8.3. Uninstalling Submariner manually ............................................ 28
      1.4.8.4. Verifying Submariner resource removal ...................................... 28
CHAPTER 1. NETWORKING

Learn about network requirements for both the hub cluster and the managed cluster.

- Hub cluster network configuration
- Managed cluster network configuration
- Advanced network configuration
- Submariner multicluster networking and service discovery

1.1. HUB CLUSTER NETWORK CONFIGURATION

**Important:** The trusted CA bundle is available in the Red Hat Advanced Cluster Management namespace, but that enhancement requires changes to your network. The trusted CA bundle ConfigMap uses the default name of `trusted-ca-bundle`. You can change this name by providing it to the operator in an environment variable named `TRUSTED_CA_BUNDLE`. See Configuring the cluster-wide proxy in the Networking section of Red Hat OpenShift Container Platform for more information.

You can refer to the configuration for your hub cluster network.

1.1.1. Hub cluster network configuration table

See the hub cluster network requirements in the following table:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Protocol</th>
<th>Connection</th>
<th>Port (if specified)</th>
<th>Source address</th>
<th>Destination address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbound to the managed cluster</td>
<td>HTTPS</td>
<td>Retrieval of logs dynamically from Search console for the pods of the managed cluster, uses the klusterlet-addon-workmgr service that is running on the managed cluster</td>
<td>443</td>
<td>None</td>
<td>IP address to access managed cluster route</td>
</tr>
<tr>
<td>Direction</td>
<td>Protocol</td>
<td>Connection</td>
<td>Port (if specified)</td>
<td>Source address</td>
<td>Destination address</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
<td>----------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>----------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Outbound to the managed cluster</td>
<td>HTTPS</td>
<td>Kubernetes API server of the managed cluster that is provisioned during installation to install the klusterlet</td>
<td>6443</td>
<td>None</td>
<td>IP of Kubernetes managed cluster API server</td>
</tr>
<tr>
<td>Outbound to the channel source</td>
<td>HTTPS</td>
<td>The channel source, including GitHub, Object Store, and Helm repository, which is only required when you are using Application lifecycle, OpenShift GitOps, or Argo CD to connect</td>
<td>443</td>
<td>None</td>
<td>IP of the channel source</td>
</tr>
<tr>
<td>Inbound from the managed cluster</td>
<td>HTTPS</td>
<td>Managed cluster to push metrics and alerts that are gathered only for managed clusters that are running OpenShift Container Platform version 4.13 or later</td>
<td>443</td>
<td>None</td>
<td>IP address to hub cluster access route</td>
</tr>
<tr>
<td>Inbound from the managed cluster</td>
<td>HTTPS</td>
<td>Kubernetes API Server of hub cluster that is watched for changes from the managed cluster</td>
<td>6443</td>
<td>None</td>
<td>IP address of hub cluster Kubernetes API Server</td>
</tr>
</tbody>
</table>
### 1.2. MANAGED CLUSTER NETWORK CONFIGURATION

You can refer to the configuration for your managed cluster network.

#### 1.2.1. Managed cluster network configuration table

See the managed cluster network requirements in the following table:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Protocol</th>
<th>Connection</th>
<th>Port (if specified)</th>
<th>Source address</th>
<th>Destination address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbound to the ObjectStore</td>
<td>HTTPS</td>
<td>Sends Observability metric data for long term storage when the Cluster Backup Operator is running</td>
<td>443</td>
<td>None</td>
<td>IP address of ObjectStore</td>
</tr>
<tr>
<td>Outbound to the image repository</td>
<td>HTTPS</td>
<td>Access images for OpenShift Container Platform and Red Hat Advanced Cluster Management</td>
<td>443</td>
<td>None</td>
<td>IP address of image repository</td>
</tr>
<tr>
<td>Inbound from the hub cluster</td>
<td>HTTPS</td>
<td>Sending of logs dynamically from Search console for the pods of the managed cluster, uses the klusterlet-addon-workmgr service that is running on the managed cluster</td>
<td>443</td>
<td>None</td>
<td>IP address to access managed cluster route</td>
</tr>
<tr>
<td>Direction</td>
<td>Protocol</td>
<td>Connection</td>
<td>Port (if specified)</td>
<td>Source address</td>
<td>Destination address</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>----------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Inbound from the hub cluster</td>
<td>HTTPS</td>
<td>Kubernetes API server of the managed cluster that is provisioned during installation to install the klusterlet</td>
<td>6443</td>
<td>None</td>
<td>IP of Kubernetes managed cluster API server</td>
</tr>
<tr>
<td>Outbound to the image repository</td>
<td>HTTPS</td>
<td>Access images for OpenShift Container Platform and Red Hat Advanced Cluster Management</td>
<td>443</td>
<td>None</td>
<td>IP address of image repository</td>
</tr>
<tr>
<td>Outbound to the hub cluster</td>
<td>HTTPS</td>
<td>Managed cluster to push metrics and alerts that are gathered only for managed clusters that are running OpenShift Container Platform version 4.13 or later</td>
<td>443</td>
<td>None</td>
<td>IP address to hub cluster access route</td>
</tr>
<tr>
<td>Outbound to the hub cluster</td>
<td>HTTPS</td>
<td>Watches the Kubernetes API server of the hub cluster for changes</td>
<td>6443</td>
<td>None</td>
<td>IP address of hub cluster Kubernetes API Server</td>
</tr>
</tbody>
</table>
### 1.3. ADVANCED NETWORK CONFIGURATION

- Additional networking requirements for infrastructure operator table
- Submariner networking requirements table
- Additional networking requirements for Hive table
- Hosted control planes networking requirements table (Technology Preview)
- Application deployment network requirements table
- Namespace connection network requirements table

#### 1.3.1. Additional networking requirements for infrastructure operator table

When you are installing bare metal managed clusters with the Infrastructure Operator, see Network configuration in the multicluster engine for Kubernetes operator documentation for additional networking requirements.

#### 1.3.2. Submariner networking requirements table

Clusters that are using Submariner require three open ports. The following table shows which ports you might use:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Protocol</th>
<th>Connection</th>
<th>Port (if specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbound and inbound</td>
<td>UDP</td>
<td>Each of the managed clusters</td>
<td>4800</td>
</tr>
</tbody>
</table>
1.3.3. Additional networking requirements for Hive table

When you are installing bare metal managed clusters with the Hive Operator, which includes using central infrastructure management, you must configure a layer 2 or layer 3 port connection between the hub cluster and the libvirt provisioning host. This connection to the provisioning host is required during the creation of a base metal cluster with Hive. See the following table for more information:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Protocol</th>
<th>Connection</th>
<th>Port (if specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hub cluster outbound and inbound to the libvirt provisioning host</td>
<td>IP</td>
<td>Connects the hub cluster, where the Hive operator is installed, to the libvirt provisioning host that serves as a bootstrap when creating the bare metal cluster</td>
<td></td>
</tr>
</tbody>
</table>

Note: These requirements only apply when installing, and are not required when upgrading clusters that were installed with Infrastructure Operator.

1.3.4. Hosted control planes networking requirements table (Technology Preview)

When you use hosted control planes, the HypershiftDeployment resource must have connectivity to the endpoints listed in the following table:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Connection</th>
<th>Port (if specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbound</td>
<td>OpenShift Container Platform control-plane and worker nodes</td>
<td></td>
</tr>
<tr>
<td>Outbound</td>
<td>For hosted clusters on Amazon Web Services only: Outbound connection to AWS API and S3 API</td>
<td></td>
</tr>
<tr>
<td>Outbound</td>
<td>For hosted clusters on Microsoft Azure cloud services only: Outbound connection to Azure API</td>
<td></td>
</tr>
</tbody>
</table>
Outbound

OpenShift Container Platform image repositories that store the ISO images of the coreOS and the image registry for OpenShift Container Platform pods

Outbound

Local API client of the klusterlet on the hosting cluster communicates with the API of the HyperShift hosted cluster

### 1.3.5. Application deployment network requirements table

In general, the application deployment communication is one way from a managed cluster to the hub cluster. The connection uses `kubeconfig`, which is configured by the agent on the managed cluster. The application deployment on the managed cluster needs to access the following namespaces on the hub cluster:

- The namespace of the channel resource
- The namespace of the managed cluster

### 1.3.6. Namespace connection network requirements table

- Application lifecycle connections:
  - The namespace `open-cluster-management` needs to access the console API on port 4000.
  - The namespace `open-cluster-management` needs to expose the Application UI on port 3001.

- Application lifecycle backend components (pods):
  On the hub cluster, all of the application lifecycle pods are installed in the `open-cluster-management` namespace, including the following pods:
    - multicluster-operators-hub-subscription
    - multicluster-operators-standalone-subscription
    - multicluster-operators-channel
    - multicluster-operators-application
    - multicluster-integrations
      As a result of these pods being in the `open-cluster-management` namespace:
        - The namespace `open-cluster-management` needs to access the Kube API on port 6443.

On the managed cluster, only the `klusterlet-addon-appmgr` application lifecycle pod is installed in the `open-cluster-management-agent-addon` namespace:
The namespace `open-cluster-management-agent-addon` needs to access the Kube API on port 6443.

Governance and risk:
On the hub cluster, the following access is required:
- The namespace `open-cluster-management` needs to access the Kube API on port 6443.
- The namespace `open-cluster-management` needs to access the OpenShift DNS on port 5353.

On the managed cluster, the following access is required:
- The namespace `open-cluster-management-addon` needs to access the Kube API on port 6443.

### 1.4. SUBMARINER MULTICLUSTER NETWORKING AND SERVICE DISCOVERY

Submariner is an open source tool that you can use with Red Hat Advanced Cluster Management for Kubernetes to provide direct networking and service discovery between two or more managed clusters in your environment, either on-premises or in the cloud. Submariner is compatible with Multi-Cluster Services API ([Kubernetes Enhancements Proposal #1645](https://gitlab.com/kubernetes/community/proposals/-/wikis/files/)). For more information about Submariner, see the [Submariner site](https://submariner.io/).

See the [Red Hat Advanced Cluster Management support matrix](https://redhat.com) for more details about the support levels of infrastructure providers, including which providers support automated console deployments or require manual deployment.

See the following topics to learn more about how to use Submariner:

- Deploying Submariner on disconnected clusters
- Configuring Submariner
- Installing the subctl command utility
- Deploying Submariner by using the console
- Deploying Submariner manually
- Customizing Submariner deployments
- Managing service discovery for Submariner
- Uninstalling Submariner

#### 1.4.1. Deploying Submariner on disconnected clusters

Deploying Submariner on disconnected clusters can help with security concerns by reducing the risk of external attacks on clusters. To deploy Submariner with Red Hat Advanced Cluster Management for Kubernetes on disconnected clusters, you must first complete the steps outlined in [Install in disconnected network environments](https://redhat.com).
After following the steps outlined in Install in disconnected network environments, you must configure Submariner during the installation to support deployment on disconnected clusters. See the following topics:

1.4.1.1. Mirroring images in the local registry

Make sure to mirror the Submariner Operator bundle image in the local registry before deploying Submariner on disconnected clusters.

1.4.1.1.2. Customizing catalogSource names

By default, submariner-addon searches for a catalogSource with the name redhat-operators. When using a catalogSource with a different name, you must update the value of the SubmarinerConfig.Spec.subscriptionConfig.Source parameter in the SubmarinerConfig associated with your managed cluster with the custom name of the catalogSource. 

1.4.1.1.3. Enabling airGappedDeployment in SubmarinerConfig

When installing submariner-addon on a managed cluster from the Red Hat Advanced Cluster Management for Kubernetes console, you can select the Disconnected cluster option so that Submariner does not make API queries to external servers.

If you are installing Submariner by using the APIs, you must set the airGappedDeployment parameter to true in the SubmarinerConfig associated with your managed cluster.

1.4.2. Configuring Submariner

Red Hat Advanced Cluster Management for Kubernetes provides Submariner as an add-on for your hub cluster. To learn how to configure Submariner, read the following topics:

- Prerequisites
- Submariner ports table
- Globalnet

1.4.2.1. Prerequisites

Ensure that you have the following prerequisites before using Submariner:

- A credential to access the hub cluster with cluster-admin permissions.
- IP connectivity must be configured between the gateway nodes. When connecting two clusters, at least one of the clusters must be accessible to the gateway node by using its public or private IP address designated to the gateway node. See Submariner NAT Traversal for more information.
- If you are using OVN Kubernetes, clusters must be at Red Hat OpenShift Container Platform version 4.13 or later.
- If your Red Hat OpenShift Container Platform clusters use OpenShift SDN CNI, the firewall configuration across all nodes in each of the managed clusters must allow 4800/UDP in both directions.
- The firewall configuration must allow 4500/UDP and 4490/UDP on the gateway nodes for establishing tunnels between the managed clusters.
- If the gateway nodes are directly reachable over their private IPs without any NAT in between, make sure that the firewall configuration allows the ESP protocol on the gateway nodes. **Note:** This is configured automatically when your clusters are deployed in an Amazon Web Services, Google Cloud Platform, Microsoft Azure, or Red Hat OpenStack environment, but must be configured manually for clusters on other environments and for the firewalls that protect private clouds.

- The `managedcluster` name must follow the DNS label standard as defined in RFC 1123 and meet the following requirements:
  - Contain 63 characters or fewer
  - Contain only lowercase alphanumeric characters or `-`
  - Start with an alphanumeric character
  - End with an alphanumeric character

### 1.4.2.2. Submariner ports table

View the following table to see the Submariner ports that you must enable:

<table>
<thead>
<tr>
<th>Name</th>
<th>Default value</th>
<th>Customizable</th>
<th>Optional or required</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPsec NATT</td>
<td>4500/UDP</td>
<td>Yes</td>
<td>Required</td>
</tr>
<tr>
<td>VXLAN</td>
<td>4800/UDP</td>
<td>No</td>
<td>Required</td>
</tr>
<tr>
<td>NAT discovery port</td>
<td>4490/UDP</td>
<td>No</td>
<td>Required</td>
</tr>
</tbody>
</table>

### 1.4.2.3. Globalnet

Globalnet is a Submariner add-on feature that allows you to connect clusters with overlapping Classless Inter-Domain Routings (CIDRs), without changing the CIDRs on existing clusters. Globalnet is a cluster set-wide configuration that you can select when you add the first managed cluster to a cluster set.

If you enable Globalnet, every managed cluster receives a global CIDR from the virtual Global Private Network, which is used to facilitate inter-cluster communication.

**Important:** You must enable Globalnet when clusters in a cluster set might have overlapping CIDRs.

The **ClusterAdmin** can enable Globalnet in the console by selecting the option **Enable Globalnet** when enabling the Submariner add-on for clusters in the cluster set. If you want to disable Globalnet after enabling it, you must first remove all managed clusters from your cluster set.

#### 1.4.2.3.1. Enabling Globalnet by creating the `submariner-broker` object

When using the Red Hat Advanced Cluster Management APIs, the **ClusterAdmin** can enable Globalnet by creating a `submariner-broker` object in the `<ManagedClusterSet>-broker` namespace.

The **ClusterAdmin** role has the required permissions to create the `submariner-broker` object in the broker namespace. The **ManagedClusterSetAdmin** role, which is sometimes created to act as a proxy administrator for the cluster set, does not have the required permissions.
To provide the required permissions, the ClusterAdmin must associate the role permissions for the access-to-brokers-submariner-crd to the ManagedClusterSetAdmin user.

Complete the following steps to enable Globalnet by creating the submariner-broker object:

1. Retrieve the <broker-namespace> by running the following command:
   ```
   oc get ManagedClusterSet <cluster-set-name> -o jsonpath="
   {.metadata.annotations["cluster\.open-cluster-management\.io/submariner-broker-ns"]}
   ```

2. Create a submariner-broker object that specifies the Globalnet configuration by creating a YAML file named submariner-broker. Add content that resembles the following lines to the YAML file:
   ```
   apiVersion: submariner.io/v1alpha1
   kind: Broker
   metadata:
     name: submariner-broker
     namespace: broker-namespace
   spec:
     globalnetEnabled: true-or-false
   ```
   
   1. The name must be submariner-broker.
   2. Replace broker-namespace with the name of your broker namespace.
   3. Replace true-or-false with true to enable Globalnet.

3. Apply the file by running the following command:
   ```
   oc apply -f submariner-broker.yaml
   ```

1.4.2.3.2. Configuring the number of global IPs

You can assign a configurable number of global IPs by changing the value of the numberOfIPs field in the ClusterGlobalEgressIP resource. The default value is 8. See the following example:

```
apiVersion: submariner.io/v1
kind: ClusterGlobalEgressIP
metadata:
  name: cluster-egress.submariner.io
spec:
  numberOfIPs: 8
```

1.4.2.3.3. Additional resources

- See the Submariner documentation to learn more about Submariner
- See Submariner NAT Traversal for more information about IP connectivity between gateway nodes.
- See the Submariner prerequisites documentation for more detailed information about the prerequisites.
1.4.3. Installing the subctl command utility

The subctl utility ships in a container image. To install the subctl utility locally, complete the following steps:

1. Log in to the registry by running the following command and entering your credentials when prompted:
   
   oc registry login --registry registry.redhat.io

2. Download the subctl container and extract a compressed version of the subctl binary to /tmp by entering the following command:

   oc image extract registry.redhat.io/rhacm2/subctl-rhel8:v0.16 --path="/dist/subctl-*-linux-amd64.tar.xz":/tmp/ --confirm

3. Decompress the subctl utility by entering the following command:

   tar -C /tmp/ -xf /tmp/subctl-v0.16*-Linux-amd64.tar.xz

4. Install the subctl utility by entering the following command:

   install -m744 /tmp/subctl-v0.16*/subctl-v0.16*-linux-amd64 /$HOME/.local/bin/subctl

Notes:

- Make sure that the subctl and Submariner versions match.
- For disconnected environments only, make sure to mirror the submariner-nettest image.

1.4.3.1. Using the subctl commands

After adding the utility to your path, view the following table for a brief description of the available commands:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>export service</td>
<td>Creates a ServiceExport resource for the specified service, which enables other clusters in the Submariner deployment to discover the corresponding service.</td>
</tr>
<tr>
<td>unexport service</td>
<td>Removes the ServiceExport resource for the specified service, which prevents other clusters in the Submariner deployment from discovering the corresponding service.</td>
</tr>
<tr>
<td>show</td>
<td>Provides information about Submariner resources.</td>
</tr>
</tbody>
</table>
**verify**  
Verifies connectivity, service discovery, and other Submariner features when Submariner is configured across a pair of clusters.

**benchmark**  
Benchmarks throughput and latency across a pair of clusters that are enabled with Submariner or within a single cluster.

**diagnose**  
Runs checks to identify issues that prevent the Submariner deployment from working correctly.

**gather**  
Collects information from the clusters to help troubleshoot a Submariner deployment.

**version**  
Displays the version details of the subctl binary tool.

**Note:** The Red Hat build of subctl only includes the commands that are relevant to Red Hat Advanced Cluster Management for Kubernetes. For more information about the subctl utility and its commands, see subctl in the Submariner documentation.

### 1.4.4. Deploying Submariner by using the console

Before you deploy Submariner with Red Hat Advanced Cluster Management for Kubernetes, you must prepare the clusters on the hosting environment. You can use the SubmarinerConfig API or the Red Hat Advanced Cluster Management for Kubernetes console to automatically prepare Red Hat OpenShift Container Platform clusters on the following providers:

- Amazon Web Services
- Google Cloud Platform
- IBM Power Systems Virtual Server
- Red Hat OpenShift on IBM Cloud (Technology Preview)
- Red Hat OpenStack Platform
- Microsoft Azure
- VMware vSphere

**Notes:**

- Only non-NSX deployments are supported on VMware vSphere.
- You must install the Calico API server on your cluster if you are using Red Hat OpenShift on IBM Cloud. Alternatively, you can manually create the IP pools required for cross-cluster communication by following the CALICO CNI topic in the Submariner upstream documentation.

To deploy Submariner on other providers, follow the instructions in Deploying Submariner manually.

Complete the following steps to deploy Submariner with the Red Hat Advanced Cluster Management for Kubernetes console:
Required access: Cluster administrator

1. From the console, select Infrastructure > Clusters.

2. On the Clusters page, select the Cluster sets tab. The clusters that you want enable with Submariner must be in the same cluster set.

3. If the clusters on which you want to deploy Submariner are already in the same cluster set, skip to step 5.

4. If the clusters on which you want to deploy Submariner are not in the same cluster set, create a cluster set for them by completing the following steps:
   a. Select Create cluster set
   b. Name the cluster set, and select Create.
   c. Select Manage resource assignments to assign clusters to the cluster set.
   d. Select the managed clusters that you want to connect with Submariner to add them to the cluster set.
   e. Select Review to view and confirm the clusters that you selected.
   f. Select Save to save the cluster set, and view the resulting cluster set page.

5. On the cluster set page, select the Submariner add-ons tab.


7. Select the clusters on which you want to deploy Submariner.

8. See the fields in the following table and enter the required information in the Install Submariner add-ons editor:

<table>
<thead>
<tr>
<th>Field</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS Access Key ID</td>
<td>Only visible when you import an AWS cluster.</td>
</tr>
<tr>
<td>AWS Secret Access Key</td>
<td>Only visible when you import an AWS cluster.</td>
</tr>
<tr>
<td>Base domain resource group name</td>
<td>Only visible when you import an Azure cluster.</td>
</tr>
<tr>
<td>Client ID</td>
<td>Only visible when you import an Azure cluster.</td>
</tr>
<tr>
<td>Client secret</td>
<td>Only visible when you import an Azure cluster.</td>
</tr>
<tr>
<td>Subscription ID</td>
<td>Only visible when you import an Azure cluster.</td>
</tr>
<tr>
<td>Tenant ID</td>
<td>Only visible when you import an Azure cluster.</td>
</tr>
<tr>
<td>Google Cloud Platform service account JSON key</td>
<td>Only visible when you import a Google Cloud Platform cluster.</td>
</tr>
<tr>
<td>Field</td>
<td>Notes</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Instance type</td>
<td>The instance type of the gateway node that is created on the managed cluster.</td>
</tr>
<tr>
<td>IPsec NAT-T port</td>
<td>The default value for the IPsec NAT traversal port is port 4500. If your managed cluster environment is VMware vSphere, ensure that this port is opened on your firewall.</td>
</tr>
<tr>
<td>Gateway count</td>
<td>The number of gateway nodes to be deployed on the managed cluster. For AWS, GCP, Azure, and OpenStack clusters, dedicated Gateway nodes are deployed. For VVware clusters, existing worker nodes are tagged as gateway nodes. The default value is 1. If the value is greater than 1, the Submariner gateway High Availability (HA) is automatically enabled.</td>
</tr>
<tr>
<td>Cable driver</td>
<td>The Submariner gateway cable engine component that maintains the cross-cluster tunnels. The default value is Libreswan IPsec.</td>
</tr>
<tr>
<td>Disconnected cluster</td>
<td>If enabled, tells Submariner to not access any external servers for public IP resolution.</td>
</tr>
<tr>
<td>Globalnet CIDR</td>
<td>Only visible when the Globalnet configuration is selected on the cluster set. The Globalnet CIDR to be used for the managed cluster. If left blank, a CIDR is allocated from the cluster set pool.</td>
</tr>
</tbody>
</table>

9. Select **Next** at the end of the editor to move to the editor for the next cluster, and complete the editor for each of the remaining clusters that you selected.

10. Verify your configuration for each managed cluster.

11. Click **Install** to deploy Submariner on the selected managed clusters.

   It might take several minutes for the installation and configuration to complete. You can check the Submariner status in the list on the **Submariner add-ons** tab:

   - **Connection status** indicates how many Submariner connections are established on the managed cluster.
   - **Agent status** indicates whether Submariner is successfully deployed on the managed cluster. The console might report a status of **Degraded** until it is installed and configured.
   - **Gateway nodes labeled** indicates the number of gateway nodes on the managed cluster.

Submariner is now deployed on the selected clusters.

### 1.4.5. Deploying Submariner manually
Before you deploy Submariner with Red Hat Advanced Cluster Management for Kubernetes, you must prepare the clusters on the hosting environment for the connection. See Deploying Submariner by using the console to learn how to automatically deploy Submariner on supported clusters by using the console.

If your cluster is hosted on a provider that does not support automatic Submariner deployment, see the following sections to prepare the infrastructure manually. Each provider has unique steps for preparation, so make sure to select the correct provider.

1.4.5.1. Preparing bare metal for Submariner

To prepare bare metal clusters for deploying Submariner, complete the following steps:

1. Ensure that the firewall allows inbound/outbound traffic for external clients on the 4500/UDP and 4490/UDP ports for the Gateway nodes. Also, if the cluster is deployed with OpenShiftSDN CNI, allow inbound/outbound UDP/4800 traffic within the local cluster nodes.

2. Customize and apply YAML content that is similar to the following example:

```
apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
kind: SubmarinerConfig
metadata:
  name: submariner
  namespace: <managed-cluster-namespace>
spec:
  gatewayConfig:
    gateways: 1
```

Replace `managed-cluster-namespace` with the name of your managed cluster. The name of the `SubmarinerConfig` must be `submariner`, as shown in the example.

This configuration labels one of the worker nodes as the Submariner gateway on your bare metal cluster.

By default, Submariner uses IP security (IPsec) to establish the secure tunnels between the clusters on the gateway nodes. You can either use the default IPsec NATT port, or you can specify a different port that you configured. When you run this procedure without specifying an IPsec NATT port, 4500/UDP is used for the connections.

3. Identify the Gateway node configured by Submariner and enable firewall configurations to allow the IPsec NATT (UDP/4500) and NatDiscovery (UDP/4490) ports for external traffic.

See Customizing Submariner deployments for information about the customization options.

1.4.5.2. Preparing Microsoft Azure Red Hat OpenShift for Submariner by using the command line interface

The Microsoft Azure Red Hat OpenShift service combines various tools and resources that you can use to simplify the process of building container-based applications. To prepare Azure Red Hat OpenShift clusters for deploying Submariner by using the command line interface, complete the following steps:

1. Install the Azure CLI.

2. From the Azure CLI, run the following command to install the extension:

```
az extension add --upgrade -s <path-to-extension>
```
Replace `path-to-extension` with the path to where you downloaded the .whl extension file.

3. Run the following command to verify that the CLI extension is being used:

```bash
az extension list
```

If the extension is being used, the output might resemble the following example:

```
"experimental": false,
"extensionType": "whl",
"name": "aro",
"path": "<path-to-extension>",
"preview": true,
"version": "1.0.x"
```

4. From the Azure CLI, register the preview feature by running the following command:

```bash
az feature registration create --namespace Microsoft.RedHatOpenShift --name AdminKubeconfig
```

5. Retrieve the administrator `kubeconfig` by running the following command:

```bash
az aro get-admin-kubeconfig -g <resource group> -n <cluster resource name>
```

**Note:** The `az aro` command saves the `kubeconfig` to the local directory and uses the name `kubeconfig`. To use it, set the environment variable `KUBECONFIG` to match the path of the file. See the following example:

```bash
export KUBECONFIG=<path-to-kubeconfig>
oc get nodes
```

6. Import your Azure Red Hat OpenShift cluster. See Cluster import introduction to learn more about how to import a cluster.

### 1.4.5.2.1 Preparing Microsoft Azure Red Hat OpenShift for Submariner by using the API

To prepare Azure Red Hat OpenShift clusters for deploying Submariner by using the API, customize and apply YAML content that is similar to the following example:

```yaml
apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
kind: SubmarinerConfig
metadata:
  name: submariner
  namespace: <managed-cluster-namespace>
spec:
  loadBalancerEnable: true
```

Replace `managed-cluster-namespace` with the name of your managed cluster.

The name of the `SubmarinerConfig` must be `submariner`, as shown in the example.

This configuration labels one of the worker nodes as the Submariner gateway on your Azure Red Hat OpenShift cluster.
By default, Submariner uses IP security (IPsec) to establish the secure tunnels between the clusters on the gateway nodes. You can either use the default IPsec NATT port, or you can specify a different port that you configured. When you run this procedure without specifying an IPsec NATT port, port 4500/UDP is used for the connections.

See Customizing Submariner deployments for information about the customization options.

1.4.5.3. Preparing Red Hat OpenShift Service on AWS for Submariner by using the command line interface

Red Hat OpenShift Service on AWS provides a stable and flexible platform for application development and modernization. To prepare OpenShift Service on AWS clusters for deploying Submariner, complete the following steps:

1. Log in to OpenShift Service on AWS by running the following commands:

   `rosa login`  
   `oc login <rosa-cluster-url>:6443 --username cluster-admin --password <password>`

2. Create a kubeconfig for your OpenShift Service on AWS cluster by running the following command:

   `oc config view --flatten=true > rosa_kube/kubeconfig`

3. Import your OpenShift Service on AWS cluster. See Cluster import introduction to learn more about how to import a cluster.

1.4.5.3.1. Preparing Red Hat OpenShift Service on AWS for Submariner by using the API

To prepare OpenShift Service on AWS clusters for deploying Submariner by using the API, customize and apply YAML content that is similar to the following example:

```yaml
apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
kind: SubmarinerConfig
metadata:
  name: submariner
  namespace: <managed-cluster-namespace>
spec:
  loadBalancerEnable: true
```

Replace managed-cluster-namespace with the name of your managed cluster.

The name of the SubmarinerConfig must be submariner, as shown in the example.

By default, Submariner uses IP security (IPsec) to establish the secure tunnels between the clusters on the gateway nodes. You can either use the default IPsec NATT port, or you can specify a different port that you configured. When you run this procedure without specifying an IPsec NATT port, port 4500/UDP is used for the connections.

See Customizing Submariner deployments for information about the customization options.

1.4.5.4. Deploy Submariner with the ManagedClusterAddOn API
After manually preparing your selected hosting environment, you can deploy Submariner with the ManagedClusterAddOn API by completing the following steps:

1. Create a ManagedClusterSet resource on the hub cluster by using the instructions provided in the Creating a ManagedClusterSet documentation. Make sure your entry for the ManagedClusterSet resembles the following content:

   ```yaml
   apiVersion: cluster.open-cluster-management.io/v1beta2
   kind: ManagedClusterSet
   metadata:
     name: <managed-cluster-set-name>
   ```

   Replace managed-cluster-set-name with a name for the ManagedClusterSet that you are creating.

   **Important:** The maximum character length of a Kubernetes namespace is 63 characters. The maximum character length you can use for the `<managed-cluster-set-name>` is 56 characters. If the character length of `<managed-cluster-set-name>` exceeds 56 characters, the `<managed-cluster-set-name>` is cut off from the head.

   After the ManagedClusterSet is created, the submariner-addon creates a namespace called `<managed-cluster-set-name>-broker` and deploys the Submariner broker to it.

2. Create the Broker configuration on the hub cluster in the `<managed-cluster-set-name>-broker` namespace by customizing and applying YAML content that is similar to the following example:

   ```yaml
   apiVersion: submariner.io/v1alpha1
   kind: Broker
   metadata:
     name: submariner-broker
     namespace: <managed-cluster-set-name>-broker
     labels:
       cluster.open-cluster-management.io/backup: submariner
   spec:
     globalnetEnabled: <true-or-false>
   ```

   Replace managed-cluster-set-name with the name of the managed cluster.

   Set the value of globalnetEnabled to true if you want to enable Submariner Globalnet in the ManagedClusterSet.

3. Add one managed cluster to the ManagedClusterSet by running the following command:

   ```bash
   oc label managedclusters <managed-cluster-name> "cluster.open-cluster-management.io/clusterset=<managed-cluster-set-name>" --overwrite
   ```

   Replace <managed-cluster-name> with the name of the managed cluster that you want to add to the ManagedClusterSet.

   Replace <managed-cluster-set-name> with the name of the ManagedClusterSet to which you want to add the managed cluster.

4. Customize and apply YAML content that is similar to the following example:

   ```yaml
   apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
   ```
Replace `managed-cluster-namespace` with the namespace of your managed cluster.

**Note:** The name of the `SubmarinerConfig` must be `submariner`, as shown in the example.

5. Deploy Submariner on the managed cluster by customizing and applying YAML content that is similar to the following example:

```yaml
apiVersion: addon.open-cluster-management.io/v1alpha1
kind: ManagedClusterAddOn
metadata:
  name: submariner
  namespace: <managed-cluster-name>
spec:
  installNamespace: submariner-operator
```

Replace `managed-cluster-name` with the name of the managed cluster that you want to use with Submariner.

The `installNamespace` field in the spec of the `ManagedClusterAddOn` is the namespace on the managed cluster where it installs Submariner. Currently, Submariner must be installed in the `submariner-operator` namespace.

After the `ManagedClusterAddOn` is created, the `submariner-addon` deploys Submariner to the `submariner-operator` namespace on the managed cluster. You can view the deployment status of Submariner from the status of this `ManagedClusterAddOn`.

**Note:** The name of `ManagedClusterAddOn` must be `submariner`.

6. Repeat steps three, four, and five for all of the managed clusters that you want to enable Submariner on.

7. After Submariner is deployed on the managed cluster, you can verify the Submariner deployment status by checking the status of submariner `ManagedClusterAddOn` by running the following command:

```bash
oc -n <managed-cluster-name> get managedclusteraddons submariner -oyaml
```

Replace `managed-cluster-name` with the name of the managed cluster.

In the status of the Submariner `ManagedClusterAddOn`, three conditions indicate the deployment status of Submariner:

- **SubmarinerGatewayNodesLabeled** condition indicates whether there are labeled Submariner gateway nodes on the managed cluster.

- **SubmarinerAgentDegraded** condition indicates whether the Submariner is successfully deployed on the managed cluster.

- **SubmarinerConnectionDegraded** condition indicates how many connections are established on the managed cluster with Submariner.
1.4.6. Customizing Submariner deployments

You can customize some of the settings of your Submariner deployments, including your Network Address Translation-Traversal (NATT) port, number of gateway nodes, and instance type of your gateway nodes. These customizations are consistent across all of the providers.

1.4.6.1. NATT port

If you want to customize your NATT port, customize and apply the following YAML content for your provider environment:

```yaml
apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
kind: SubmarinerConfig
metadata:
  name: submariner
  namespace: <managed-cluster-namespace>
spec:
  credentialsSecret:
    name: <managed-cluster-name>-<provider>-creds
  IPSecNATTPort: <NATTPort>

- Replace **managed-cluster-namespace** with the namespace of your managed cluster.
- Replace **managed-cluster-name** with the name of your managed cluster.
  - AWS: Replace **provider** with **aws**. The value of **<managed-cluster-name>-aws-creds** is your AWS credential secret name, which you can find in the cluster namespace of your hub cluster.
  - GCP: Replace **provider** with **gcp**. The value of **<managed-cluster-name>-gcp-creds** is your Google Cloud Platform credential secret name, which you can find in the cluster namespace of your hub cluster.
  - OpenStack: Replace **provider** with **osp**. The value of **<managed-cluster-name>-osp-creds** is your Red Hat OpenStack Platform credential secret name, which you can find in the cluster namespace of your hub cluster.
  - Azure: Replace **provider** with **azure**. The value of **<managed-cluster-name>-azure-creds** is your Microsoft Azure credential secret name, which you can find in the cluster namespace of your hub cluster.
- Replace **managed-cluster-namespace** with the namespace of your managed cluster.
- Replace **managed-cluster-name** with the name of your managed cluster. The value of **managed-cluster-name-gcp-creds** is your Google Cloud Platform credential secret name, which you can find in the cluster namespace of your hub cluster.
- Replace **NATTPort** with the NATT port that you want to use.

*Note:* The name of the **SubmarinerConfig** must be **submariner**, as shown in the example.

1.4.6.2. Number of gateway nodes

If you want to customize the number of your gateway nodes, customize and apply YAML content that is similar to the following example:
Replace `managed-cluster-namespace` with the namespace of your managed cluster.

Replace `managed-cluster-name` with the name of your managed cluster.

- AWS: Replace `provider` with `aws`. The value of `<managed-cluster-name>-aws-creds` is your AWS credential secret name, which you can find in the cluster namespace of your hub cluster.

- GCP: Replace `provider` with `gcp`. The value of `<managed-cluster-name>-gcp-creds` is your Google Cloud Platform credential secret name, which you can find in the cluster namespace of your hub cluster.

- OpenStack: Replace `provider` with `osp`. The value of `<managed-cluster-name>-osp-creds` is your Red Hat OpenStack Platform credential secret name, which you can find in the cluster namespace of your hub cluster.

- Azure: Replace `provider` with `azure`. The value of `<managed-cluster-name>-azure-creds` is your Microsoft Azure credential secret name, which you can find in the cluster namespace of your hub cluster.

- Replace `gateways` with the number of gateways that you want to use. If the value is greater than 1, the Submariner gateway automatically enables high availability.

**Note:** The name of the `SubmarinerConfig` must be `submariner`, as shown in the example.

### 1.4.6.3. Instance types of gateway nodes

If you want to customize the instance type of your gateway node, customize and apply YAML content that is similar to the following example:

```yaml
apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
class: SubmarinerConfig
metadata:
  name: submariner
  namespace: <managed-cluster-namespace>
spec:
  credentialsSecret:
    name: <managed-cluster-name>-<provider>-creds
  gatewayConfig:
    gateways: <gateways>
    instanceType: <instance-type>
```
AWS: Replace `provider` with `aws`. The value of `<managed-cluster-name>-aws-creds` is your AWS credential secret name, which you can find in the cluster namespace of your hub cluster.

GCP: Replace `provider` with `gcp`. The value of `<managed-cluster-name>-gcp-creds` is your Google Cloud Platform credential secret name, which you can find in the cluster namespace of your hub cluster.

OpenStack: Replace `provider` with `osp`. The value of `<managed-cluster-name>-osp-creds` is your Red Hat OpenStack Platform credential secret name, which you can find in the cluster namespace of your hub cluster.

Azure: Replace `provider` with `azure`. The value of `<managed-cluster-name>-azure-creds` is your Microsoft Azure credential secret name, which you can find in the cluster namespace of your hub cluster.

- Replace `instance-type` with the AWS instance type that you want to use.

**Note:** The name of the `SubmarinerConfig` must be `submariner`, as shown in the example.

### 1.4.6.4. Cable driver

The Submariner Gateway Engine component creates secure tunnels to other clusters. The cable driver component maintains the tunnels by using a pluggable architecture in the Gateway Engine component. You can use the Libreswan or VXLAN implementations for the `cableDriver` configuration of the cable engine component. See the following example:

```yaml
apiVersion: submarineraddon.open-cluster-management.io/v1alpha1
kind: SubmarinerConfig
metadata:
  name: submariner
  namespace: <managed-cluster-namespace>
spec:
cableDriver: vxlan
credentialsSecret:
  name: <managed-cluster-name>-<provider>-creds
```

**Best practice:** Do not use the VXLAN cable driver on public networks. The VXLAN cable driver is unencrypted. Only use VXLAN to avoid unnecessary double encryption on private networks. For example, some on-premise environments might handle the tunnel's encryption with a dedicated line-level hardware device.

### 1.4.6.5. Using a customized Submariner subscription

The Submariner add-on automatically configures a subscription for Submariner; this ensures that the version of Submariner appropriate for the installed version of Red Hat Advanced Cluster Management is installed and kept up-to-date. If you want to change this behavior, or if you want to manually control Submariner upgrades, you can customize the Submariner subscription.

When you use a customized Submariner subscription, you must complete the following fields:

- **Source:** The catalog source to use for the Submariner subscription. For example, `redhat-operators`.
- **source Namespace:** The namespace of the catalog source. For example, `openshift-marketplace`. 
• **Channel:** The channel to follow for the subscription. For example, for Red Hat Advanced Cluster Management 2.9, **stable-0.16**.

• **Starting CSV (Optional):** The initial **ClusterServiceVersion**.

• **Install Plan Approval:** The decision to manually or automatically approve install plans.

**Note:** If you want to manually approve the install plan, you must use a customized Submariner subscription.

### 1.4.7. Managing service discovery for Submariner

After Submariner is deployed into the same environment as your managed clusters, the routes are configured for secure IP routing between the pod and services across the clusters in the managed cluster set.

#### 1.4.7.1. Enabling service discovery for Submariner

To make a service from a cluster visible and discoverable to other clusters in the managed cluster set, you must create a **ServiceExport** object. After a service is exported with a **ServiceExport** object, you can access the service by the following format: `<service>.<namespace>.svc.clusterset.local`. If multiple clusters export a service with the same name, and from the same namespace, they are recognized by other clusters as a single logical service.

This example uses the **nginx** service in the **default** namespace, but you can discover any Kubernetes **ClusterIP** service or headless service:

1. Apply an instance of the **nginx** service on a managed cluster that is in the **ManagedClusterSet** by entering the following commands:

   ```bash
   oc -n default create deployment nginx --image=nginxinc/nginx-unprivileged:stable-alpine
   oc -n default expose deployment nginx --port=8080
   ```

2. Export the service by creating a **ServiceExport** entry by entering a command with the **subctl** tool that is similar to the following command:

   ```bash
   subctl export service --namespace <service-namespace> <service-name>
   ```

   Replace **service-namespace** with the name of the namespace where the service is located. In this example, it is **default**.

   Replace **service-name** with the name of the service that you are exporting. In this example, it is **nginx**.

   See **export** in the Submariner documentation for more information about other available flags.

3. Run the following command from a different managed cluster to confirm that it can access the **nginx** service:

   ```bash
   oc -n default run --generator=run-pod/v1 tmp-shell --rm -i --tty --image quay.io/submariner/nettest -- /bin/bash curl nginx.default.svc.clusterset.local:8080
   ```

   The **nginx** service discovery is now configured for Submariner.
1.4.7.2. Disabling service discovery for Submariner

To disable a service from being exported to other clusters, enter a command similar to the following example for nginx:

```
subctl unexport service --namespace <service-namespace> <service-name>
```

Replace `service-namespace` with the name of the namespace where the service is located.

Replace `service-name` with the name of the service that you are exporting.

See `unexport` in the Submariner documentation for more information about other available flags.

The service is no longer available for discovery by clusters.

1.4.8. Uninstalling Submariner

You can uninstall the Submariner components from your clusters using the Red Hat Advanced Cluster Management for Kubernetes console or the command-line. For Submariner versions earlier than 0.12, additional steps are needed to completely remove all data plane components. The Submariner uninstall is idempotent, so you can repeat steps without any issues.

1.4.8.1. Uninstalling Submariner by using the console

To uninstall Submariner from a cluster by using the console, complete the following steps:

1. From the console navigation, select Infrastructure > Clusters, and select the Cluster sets tab.

2. Select the cluster set that contains the clusters from which you want to remove the Submariner components.

3. Select the Submariner Add-ons tab to view the clusters in the cluster set that have Submariner deployed.

4. In the Actions menu for the cluster that you want to uninstall Submariner, select Uninstall Add-on.

5. In the Actions menu for the cluster that you want to uninstall Submariner, select Delete cluster sets.

6. Repeat those steps for other clusters from which you are removing Submariner.

   **Tip:** You can remove the Submariner add-on from multiple clusters in the same cluster set by selecting multiple clusters and clicking Actions. Select Uninstall Submariner add-ons.

If the version of Submariner that you are removing is earlier than version 0.12, continue with Uninstalling Submariner manually. If the Submariner version is 0.12 or later, Submariner is removed.

**Important:** Verify that all of the cloud resources are removed from the cloud provider to avoid additional charges by your cloud provider. See Verifying Submariner resource removal for more information.

1.4.8.2. Uninstalling Submariner by using the CLI

To uninstall Submariner by using the command line, complete the following steps:

1. Remove the Submariner deployment for the cluster by running the following command:
1. Remove the managed cluster addon by running the following command:

   ```bash
   oc -n <managed-cluster-namespace> delete managedclusteraddon submariner
   ```

   Replace `<managed-cluster-namespace>` with the namespace of your managed cluster.

2. Remove the cloud resources of the cluster by running the following command:

   ```bash
   oc -n <managed-cluster-namespace> delete submarinerconfig submariner
   ```

   Replace `<managed-cluster-namespace>` with the namespace of your managed cluster.

3. Delete the cluster set to remove the broker details by running the following command:

   ```bash
   oc delete managedclusterset <managedclusterset>
   ```

   Replace `<managedclusterset>` with the name of your managed cluster set.

If the version of Submariner that you are removing is earlier than version 0.12, continue with Uninstalling Submariner manually. If the Submariner version is 0.12 or later, Submariner is removed.

**Important:** Verify that all of the cloud resources are removed from the cloud provider to avoid additional charges by your cloud provider. See Verifying Submariner resource removal for more information.

### 1.4.8.3. Uninstalling Submariner manually

When uninstalling versions of Submariner that are earlier than version 0.12, complete steps 5-8 in the Manual Uninstall section in the Submariner documentation.

After completing those steps, your Submariner components are removed from the cluster.

**Important:** Verify that all of the cloud resources are removed from the cloud provider to avoid additional charges by your cloud provider. See Verifying Submariner resource removal for more information.

### 1.4.8.4. Verifying Submariner resource removal

After uninstalling Submariner, verify that all of the Submariner resources are removed from your clusters. If they remain on your clusters, some resources continue to accrue charges from infrastructure providers. Ensure that you have no additional Submariner resources on your cluster by completing the following steps:

1. Run the following command to list any Submariner resources that remain on the cluster:

   ```bash
   oc get cluster <CLUSTER_NAME> grep submariner
   ```

   Replace `<CLUSTER_NAME>` with the name of your cluster.

2. Remove any resources on the list by entering the following command:

   ```bash
   oc delete resource <RESOURCE_NAME> cluster <CLUSTER_NAME>
   ```

   Replace `<RESOURCE_NAME>` with the name of the Submariner resource that you want to remove.

3. Repeat steps 1-2 for each of the clusters until your search does not identify any resources.

The Submariner resources are removed from your cluster.