Red Hat Enterprise Linux 9

Deploying RHEL 9 on Google Cloud Platform

Obtaining RHEL system images and creating RHEL instances on GCP
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Abstract

To use Red Hat Enterprise Linux (RHEL) in a public cloud environment, you can create and deploy RHEL system images on various cloud platforms, including Google Cloud Platform (GCP). You can also create and configure a Red Hat High Availability (HA) cluster on GCP. The following chapters provide instructions for creating cloud RHEL instances and HA clusters on GCP. These processes include installing the required packages and agents, configuring fencing, and installing network resource agents.
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MAKING OPEN SOURCE MORE INCLUSIVE

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

We appreciate your feedback on our documentation. Let us know how we can improve it.

Submitting feedback through Jira (account required)

1. Log in to the Jira website.

2. Click Create in the top navigation bar

3. Enter a descriptive title in the Summary field.

4. Enter your suggestion for improvement in the Description field. Include links to the relevant parts of the documentation.

5. Click Create at the bottom of the dialogue.
CHAPTER 1. INTRODUCING RHEL ON PUBLIC CLOUD PLATFORMS

Public cloud platforms provide computing resources as a service. Instead of using on-premises hardware, you can run your IT workloads, including Red Hat Enterprise Linux (RHEL) systems, as public cloud instances.

1.1. BENEFITS OF USING RHEL IN A PUBLIC CLOUD

RHEL as a cloud instance located on a public cloud platform has the following benefits over RHEL on-premises physical systems or virtual machines (VMs):

- **Flexible and fine-grained allocation of resources**
  A cloud instance of RHEL runs as a VM on a cloud platform, which typically means a cluster of remote servers maintained by the provider of the cloud service. Therefore, allocating hardware resources to the instance, such as a specific type of CPU or storage, happens on the software level and is easily customizable.

  In comparison to a local RHEL system, you are also not limited by the capabilities of your physical host. Instead, you can choose from a variety of features, based on selection offered by the cloud provider.

- **Space and cost efficiency**
  You do not need to own any on-premises servers to host your cloud workloads. This avoids the space, power, and maintenance requirements associated with physical hardware.

  Instead, on public cloud platforms, you pay the cloud provider directly for using a cloud instance. The cost is typically based on the hardware allocated to the instance and the time you spend using it. Therefore, you can optimize your costs based on your requirements.

- **Software-controlled configurations**
  The entire configuration of a cloud instance is saved as data on the cloud platform, and is controlled by software. Therefore, you can easily create, remove, clone, or migrate the instance.

  A cloud instance is also operated remotely in a cloud provider console and is connected to remote storage by default.

  In addition, you can back up the current state of a cloud instance as a snapshot at any time. Afterwards, you can load the snapshot to restore the instance to the saved state.

- **Separation from the host and software compatibility**
  Similarly to a local VM, the RHEL guest operating system on a cloud instance runs on a virtualized kernel. This kernel is separate from the host operating system and from the client system that you use to connect to the instance.

  Therefore, any operating system can be installed on the cloud instance. This means that on a RHEL public cloud instance, you can run RHEL-specific applications that cannot be used on your local operating system.

  In addition, even if the operating system of the instance becomes unstable or is compromised, your client system is not affected in any way.

Additional resources

- **What is public cloud?**
1.2. PUBLIC CLOUD USE CASES FOR RHEL

Deploying on a public cloud provides many benefits, but might not be the most efficient solution in every scenario. If you are evaluating whether to migrate your RHEL deployments to the public cloud, consider whether your use case will benefit from the advantages of the public cloud.

Beneficial use cases

- Deploying public cloud instances is very effective for flexibly increasing and decreasing the active computing power of your deployments, also known as *scaling up* and *scaling down*. Therefore, using RHEL on public cloud is recommended in the following scenarios:
  - Clusters with high peak workloads and low general performance requirements. Scaling up and down based on your demands can be highly efficient in terms of resource costs.
  - Quickly setting up or expanding your clusters. This avoids high upfront costs of setting up local servers.
- Cloud instances are not affected by what happens in your local environment. Therefore, you can use them for backup and disaster recovery.

Potentially problematic use cases

- You are running an existing environment that cannot be adjusted. Customizing a cloud instance to fit the specific needs of an existing deployment may not be cost-effective in comparison with your current host platform.
- You are operating with a hard limit on your budget. Maintaining your deployment in a local data center typically provides less flexibility but more control over the maximum resource costs than the public cloud does.

Next steps

- Obtaining RHEL for public cloud deployments

Additional resources

- Should I migrate my application to the cloud? Here’s how to decide.

1.3. FREQUENT CONCERNS WHEN MIGRATING TO A PUBLIC CLOUD

Moving your RHEL workloads from a local environment to a public cloud platform might raise concerns about the changes involved. The following are the most commonly asked questions.

Will my RHEL work differently as a cloud instance than as a local virtual machine?

In most respects, RHEL instances on a public cloud platform work the same as RHEL virtual machines on a local host, such as an on-premises server. Notable exceptions include:
Instead of private orchestration interfaces, public cloud instances use provider-specific console interfaces for managing your cloud resources.

Certain features, such as nested virtualization, may not work correctly. If a specific feature is critical for your deployment, check the feature’s compatibility in advance with your chosen public cloud provider.

**Will my data stay safe in a public cloud as opposed to a local server?**

The data in your RHEL cloud instances is in your ownership, and your public cloud provider does not have any access to it. In addition, major cloud providers support data encryption in transit, which improves the security of data when migrating your virtual machines to the public cloud.

The general security of your RHEL public cloud instances is managed as follows:

- Your public cloud provider is responsible for the security of the cloud hypervisor
- Red Hat provides the security features of the RHEL guest operating systems in your instances
- You manage the specific security settings and practices in your cloud infrastructure

**What effect does my geographic region have on the functionality of RHEL public cloud instances?**

You can use RHEL instances on a public cloud platform regardless of your geographical location. Therefore, you can run your instances in the same region as your on-premises server.

However, hosting your instances in a physically distant region might cause high latency when operating them. In addition, depending on the public cloud provider, certain regions may provide additional features or be more cost-efficient. Before creating your RHEL instances, review the properties of the hosting regions available for your chosen cloud provider.

### 1.4. OBTAINING RHEL FOR PUBLIC CLOUD DEPLOYMENTS

To deploy a RHEL system in a public cloud environment, you need to:

1. Select the optimal cloud provider for your use case, based on your requirements and the current offer on the market.
   The cloud providers currently certified for running RHEL instances are:
   - Amazon Web Services (AWS)
   - Google Cloud Platform (GCP)
   - Microsoft Azure

   **NOTE**
   This document specifically talks about deploying RHEL on GCP.

2. Create a RHEL cloud instance on your chosen cloud platform. For more information, see [Methods for creating RHEL cloud instances](#).

3. To keep your RHEL deployment up-to-date, use [Red Hat Update Infrastructure (RHUI)](#).

**Additional resources**
1.5. METHODS FOR CREATING RHEL CLOUD INSTANCES

To deploy a RHEL instance on a public cloud platform, you can use one of the following methods:

Create a system image of RHEL and import it to the cloud platform.
- To create the system image, you can use the RHEL image builder or you can build the image manually.
- This method uses your existing RHEL subscription, and is also referred to as bring your own subscription (BYOS).
- You pre-pay a yearly subscription, and you can use your Red Hat customer discount.
- Your customer service is provided by Red Hat.
- For creating multiple images effectively, you can use the cloud-init tool.

Purchase a RHEL instance directly from the cloud provider marketplace.
- You post-pay an hourly rate for using the service. Therefore, this method is also referred to as pay as you go (PAYG).
- Your customer service is provided by the cloud platform provider.

NOTE

For detailed instructions on using various methods to deploy RHEL instances on Google Cloud Platform, see the following chapters in this document.

Additional resources

- What is a golden image?
- Configuring and managing cloud-init for RHEL 9
CHAPTER 2. UPLOADING IMAGES TO GCP WITH RHEL IMAGE BUILDER

With RHEL image builder, you can build a gce image, provide credentials for your user or GCP service account, and then upload the gce image directly to the GCP environment.

2.1. UPLOADING A GCE IMAGE TO GCP BY USING THE CLI

Follow the procedure to set up a configuration file with credentials to upload your gce image to GCP.

WARNING

You cannot manually import gce image to GCP, because the image will not boot. You must use either gcloud or RHEL image builder to upload it.

Prerequisites

- You have a valid Google account and credentials to upload your image to GCP. The credentials can be from a user account or a service account. The account associated with the credentials must have at least the following IAM roles assigned:
  - roles/storage.admin - to create and delete storage objects
  - roles/compute.storageAdmin - to import a VM image to Compute Engine.
- You have an existing GCP bucket.

Procedure

1. By using a text editor, create a gcp-config.toml configuration file with the following content:

```toml
provider = "gcp"

[settings]
bucket = "GCP_BUCKET"
region = "GCP_STORAGE_REGION"
object = "OBJECT_KEY"
credentials = "GCP_CREDENTIALS"
```

- **GCP_BUCKET** points to an existing bucket. It is used to store the intermediate storage object of the image which is being uploaded.
- **GCP_STORAGE_REGION** is both a regular Google storage region and, a dual or multi region.
- **OBJECT_KEY** is the name of an intermediate storage object. It must not exist before the upload, and it is deleted when the upload process is done. If the object name does not end with .tar.gz, the extension is automatically added to the object name.
• **GCP_CREDENTIALS** is a Base64-encoded scheme of the credentials JSON file downloaded from GCP. The credentials determine which project the GCP uploads the image to.

**NOTE**
Specifying **GCP_CREDENTIALS** in the `gcp-config.toml` file is optional if you use a different mechanism to authenticate with GCP. For other authentication methods, see Authenticating with GCP.

2. Retrieve the **GCP_CREDENTIALS** from the JSON file downloaded from GCP.

   ```bash
dsudo base64 -w 0 cee-gcp-nasa-476a1fa485b7.json
```

3. Create a compose with an additional image name and cloud provider profile:

   ```bash
dsudo composer-cli compose start BLUEPRINT-NAME gce IMAGE_KEY gcp-config.toml
```

   The image build, upload, and cloud registration processes can take up to ten minutes to complete.

**Verification**

- Verify that the image status is FINISHED:

  ```bash
dsudo composer-cli compose status
```

**Additional resources**

- Identity and Access Management
- Create storage buckets

### 2.2. HOW RHEL IMAGE BUILDER Sorts THE AUTHENTICATION ORDER OF DIFFERENT GCP CREDENTIALS

You can use several different types of credentials with RHEL image builder to authenticate with GCP. If RHEL image builder configuration is set to authenticate with GCP using multiple sets of credentials, it uses the credentials in the following order of preference:

1. Credentials specified with the **composer-cli** command in the configuration file.

2. Credentials configured in the **osbuild-composer** worker configuration.

3. **Application Default Credentials** from the Google GCP SDK library, which tries to automatically find a way to authenticate by using the following options:
   
   a. If the `GOOGLE_APPLICATION_CREDENTIALS` environment variable is set, Application Default Credentials tries to load and use credentials from the file pointed to by the variable.

   b. Application Default Credentials tries to authenticate by using the service account attached to the resource that is running the code. For example, Google Compute Engine VM.
NOTE
You must use the GCP credentials to determine which GCP project to upload the image to. Therefore, unless you want to upload all of your images to the same GCP project, you always must specify the credentials in the gcp-config.toml configuration file with the composer-cli command.

2.2.1. Specifying GCP credentials with the composer-cli command

You can specify GCP authentication credentials in the upload target configuration gcp-config.toml file. Use a Base64-encoded scheme of the Google account credentials JSON file to save time.

Procedure

1. Get the encoded content of the Google account credentials file with the path stored in GOOGLE_APPLICATION_CREDENTIALS environment variable, by running the following command:

   $ base64 -w 0 "${GOOGLE_APPLICATION_CREDENTIALS}"

2. In the upload target configuration gcp-config.toml file, set the credentials:

   provider = "gcp"

   [settings]
   provider = "gcp"

   [settings]
   ... credentials = "GCP_CREDENTIALS"

2.2.2. Specifying credentials in the osbuild-composer worker configuration

You can configure GCP authentication credentials to be used for GCP globally for all image builds. This way, if you want to import images to the same GCP project, you can use the same credentials for all image uploads to GCP.

Procedure

- In the /etc/osbuild-worker/osbuild-worker.toml worker configuration, set the following credential value:

   [gcp]
   credentials = "PATH_TO_GCP_ACCOUNT_CREDENTIALS"
CHAPTER 3. DEPLOYING A RED HAT ENTERPRISE LINUX IMAGE AS A GOOGLE COMPUTE ENGINE INSTANCE ON GOOGLE CLOUD PLATFORM

To deploy a Red Hat Enterprise Linux 9 (RHEL 9) as a Google Compute Engine (GCE) instance on Google Cloud Platform (GCP), follow the information below. This chapter:

- Discusses your options for choosing an image
- Lists or refers to system requirements for your host system and virtual machine (VM)
- Provides procedures for creating a custom VM from an ISO image, uploading it to GCE, and launching an instance

**NOTE**

For a list of Red Hat product certifications for GCP, see [Red Hat on Google Cloud Platform](#).

**IMPORTANT**

You can create a custom VM from an ISO image, but Red Hat recommends that you use the [Red Hat Image Builder](#) product to create customized images for use on specific cloud providers. See [Composing a Customized RHEL System Image](#) for more information.

**Prerequisites**

- You need a [Red Hat Customer Portal](#) account to complete the procedures in this chapter.
- Create an account with GCP to access the Google Cloud Platform Console. See [Google Cloud](#) for more information.

### 3.1. RED HAT ENTERPRISE LINUX IMAGE OPTIONS ON GCP

The following table lists image choices for RHEL 9 on Google Cloud Platform and the differences in the image options.

**Table 3.1. Image options**

<table>
<thead>
<tr>
<th>Image option</th>
<th>Subscriptions</th>
<th>Sample scenario</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deploy a Red Hat Gold Image.</td>
<td>Use your existing Red Hat subscriptions.</td>
<td>Select a Red Hat Gold Image on Google Cloud Platform. For details on Gold Images and how to access them on Google Cloud Platform, see the <a href="#">Red Hat Cloud Access Reference Guide</a>.</td>
<td>The subscription includes the Red Hat product cost; you pay Google for all other instance costs. Red Hat provides support directly for custom RHEL images.</td>
</tr>
<tr>
<td>Image option</td>
<td>Subscriptions</td>
<td>Sample scenario</td>
<td>Considerations</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Deploy a custom image that you move to GCP.</td>
<td>Use your existing Red Hat subscriptions.</td>
<td>Upload your custom image and attach your subscriptions.</td>
<td>The subscription includes the Red Hat product cost; you pay all other instance costs. Red Hat provides support directly for custom RHEL images.</td>
</tr>
<tr>
<td>Deploy an existing GCP image that includes RHEL.</td>
<td>The GCP images include a Red Hat product.</td>
<td>Choose a RHEL image when you launch an instance on the GCP Compute Engine, or choose an image from the Google Cloud Platform Marketplace.</td>
<td>You pay GCP hourly on a pay-as-you-go model. Such images are called &quot;on-demand&quot; images. GCP offers support for on-demand images through a support agreement.</td>
</tr>
</tbody>
</table>

**NOTE**
You can create a custom image for GCP by using Red Hat Image Builder. See [Composing a Customized RHEL System Image](#) for more information.

**IMPORTANT**
You cannot convert an on-demand instance to a custom RHEL instance. To change from an on-demand image to a custom RHEL *bring-your-own-subscription* (BYOS) image:

1. Create a new custom RHEL instance and migrate data from your on-demand instance.
2. Cancel your on-demand instance after you migrate your data to avoid double billing.

**Additional resources**
- [Red Hat in the Public Cloud](#)
- [Compute Engine images](#)
- [Creating an instance from a custom image](#)

### 3.2. UNDERSTANDING BASE IMAGES

To create a base VM from an ISO image, you can use preconfigured base images and their configuration settings.

#### 3.2.1. Using a custom base image
To manually configure a virtual machine (VM), first create a base (starter) VM image. Then, you can modify configuration settings and add the packages the VM requires to operate on the cloud. You can make additional configuration changes for your specific application after you upload the image.

Additional resources

- Red Hat Enterprise Linux

3.2.2. Virtual machine configuration settings

Cloud VMs must have the following configuration settings.

Table 3.2. VM configuration settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ssh</td>
<td>ssh must be enabled to provide remote access to your VMs.</td>
</tr>
<tr>
<td>dhcp</td>
<td>The primary virtual adapter should be configured for dhcp.</td>
</tr>
</tbody>
</table>

3.3. CREATING A BASE VM FROM AN ISO IMAGE

To create a RHEL 9 base image from an ISO image, enable your host machine for virtualization and create a RHEL virtual machine (VM).

Prerequisites

- Virtualization is enabled on your host machine.
- You have downloaded the latest Red Hat Enterprise Linux ISO image from the Red Hat Customer Portal and moved the image to /var/lib/libvirt/images.

3.3.1. Creating a VM from the RHEL ISO image

Procedure

1. Ensure that you have enabled your host machine for virtualization. See Enabling virtualization in RHEL 9 for information and procedures.

2. Create and start a basic Red Hat Enterprise Linux VM. For instructions, see Creating virtual machines.

   a. If you use the command line to create your VM, ensure that you set the default memory and CPUs to the capacity you want for the VM. Set your virtual network interface to virtio. For example, the following command creates a kvmtest VM by using the /home/username/Downloads/rhel9.iso image:

   ```bash
   # virt-install
   --name kvmtest --memory 2048 --vcpus 2
   --cdrom /home/username/Downloads/rhel9.iso,bus=virtio
   --os-variant=rhel9.0
   ```
If you use the web console to create your VM, follow the procedure in Creating virtual machines by using the web console, with these caveats:

- Do not check **Immediately Start VM**
- Change your **Memory** size to your preferred settings.
- Before you start the installation, ensure that you have changed **Model** under **Virtual Network Interface Settings** to **virtio** and change your **vCPUs** to the capacity settings you want for the VM.

### 3.3.2. Completing the RHEL installation

To finish the installation of a RHEL system that you want to deploy on Amazon Web Services (AWS), customize the **Installation Summary** view, begin the installation, and enable root access once the VM launches.

**Procedure**

1. Choose the language you want to use during the installation process.

2. On the **Installation Summary** view:
   a. Click **Software Selection** and check **Minimal Install**.
   b. Click **Done**.
   c. Click **Installation Destination** and check **Custom** under **Storage Configuration**.
      - Verify at least 500 MB for **/boot**. You can use the remaining space for root **/**.
      - Standard partitions are recommended, but you can use Logical Volume Management (LVM).
      - You can use xfs, ext4, or ext3 for the file system.
      - Click **Done** when you are finished with changes.

3. Click **Begin Installation**.

4. Set a **Root Password**. Create other users as applicable.

5. Reboot the VM and log in as **root** once the installation completes.

6. Configure the image.
   a. Register the VM and enable the Red Hat Enterprise Linux 9 repository.

```
    # subscription-manager register --auto-attach
```

b. Ensure that the **cloud-init** package is installed and enabled.

```
    # dnf install cloud-init
    # systemctl enable --now cloud-init.service
```
7. Power down the VM.

Additional resources
- Subscription autoattaching and updates
- Introduction to cloud-init

### 3.4. UPLOADING THE RHEL IMAGE TO GCP

To upload your RHEL 9 image to Google Cloud Platform (GCP), follow the procedures in this section.

#### 3.4.1. Creating a new project on GCP

Complete the following steps to create a new project on Google Cloud Platform (GCP).

**Prerequisites**
- You must have an account with GCP. If you do not, see [Google Cloud](#) for more information.

**Procedure**

1. Launch the [GCP Console](#).
2. Click the drop-down menu to the right of [Google Cloud Platform](#).
3. From the pop-up menu, click [NEW PROJECT](#).
4. From the [New Project](#) window, enter a name for your new project.
5. Check [Organization](#). Click the drop-down menu to change the organization, if necessary.
6. Confirm the [Location](#) of your parent organization or folder. Click [Browse](#) to search for and change this value, if necessary.
7. Click [CREATE](#) to create your new GCP project.

**NOTE**

Once you have installed the Google Cloud SDK, you can use the `gcloud projects create` CLI command to create a project. For example:

```
# gcloud projects create my-gcp-project3 --name project3
```

The example creates a project with the project ID `my-gcp-project3` and the project name `project3`. See [gcloud project create](#) for more information.

**Additional resources**
- [Creating and Managing Resources in Google Cloud](#)

#### 3.4.2. Installing the Google Cloud SDK

Complete the following steps to install the Google Cloud SDK.
Procedure

1. Follow the GCP instructions for downloading and extracting the Google Cloud SDK archive. See the GCP document Quickstart for Linux for details.

2. Follow the same instructions for initializing the Google Cloud SDK.

NOTE

Once you have initialized the Google Cloud SDK, you can use the gcloud CLI commands to perform tasks and obtain information about your project and instances. For example, you can display project information with the gcloud compute project-info describe --project <project-name> command.

Additional resources

- Quickstart for Linux
- gcloud command reference
- gcloud command-line tool overview

3.4.3. Creating SSH keys for Google Compute Engine

Perform the following procedure to generate and register SSH keys with GCE so that you can SSH directly into an instance by using its public IP address.

Procedure

1. Use the ssh-keygen command to generate an SSH key pair for use with GCE.

   # ssh-keygen -t rsa -f ~/.ssh/google_compute_engine

2. From the GCP Console Dashboard page, click the Navigation menu to the left of the Google Cloud Console banner and select Compute Engine and then select Metadata.

3. Click SSH Keys and then click Edit.

4. Enter the output generated from the ~/.ssh/google_compute_engine.pub file and click Save. You can now connect to your instance by using standard SSH.

   # ssh -i ~/.ssh/google_compute_engine <username>@<instance_external_ip>

NOTE

You can run the gcloud compute config-ssh command to populate your config file with aliases for your instances. The aliases allow simple SSH connections by instance name. For information about the gcloud compute config-ssh command, see gcloud compute config-ssh.

Additional resources

- gcloud compute config-ssh
3.4.4. Creating a storage bucket in GCP Storage

Importing to GCP requires a GCP Storage Bucket. Complete the following steps to create a bucket.

Procedure

1. If you are not already logged in to GCP, log in with the following command.
   
   ```
   # gcloud auth login
   ```

2. Create a storage bucket.
   
   ```
   # gsutil mb gs://bucket_name
   ```

   **NOTE**

   Alternatively, you can use the Google Cloud Console to create a bucket. See [Create a bucket](#) for information.

Additional resources

- [Create a bucket](#)

3.4.5. Converting and uploading your image to your GCP Bucket

Complete the following procedure to convert and upload your image to your GCP Bucket. The samples are representative; they convert an *qcow2* image to *raw* format and then tar that image for upload.

Procedure

1. Run the `qemu-img` command to convert your image. The converted image must have the name *disk.raw*.

   ```
   # qemu-img convert -f qcow2 -O raw rhel-{ProductNumber}.0-sample.qcow2 disk.raw
   ```

2. Tar the image.

   ```
   # tar --format=oldgnu -Sczf disk.raw.tar.gz disk.raw
   ```

3. Upload the image to the bucket you created previously. Upload could take a few minutes.

   ```
   # gsutil cp disk.raw.tar.gz gs://bucket_name
   ```

4. From the **Google Cloud Platform** home screen, click the collapsed menu icon and select **Storage** and then select **Browser**.

5. Click the name of your bucket.

   The tarred image is listed under your bucket name.
NOTE
You can also upload your image by using the GCP Console. To do so, click the name of your bucket and then click Upload files.

Additional resources
- Manually importing virtual disks
- Choosing an import method

3.4.6. Creating an image from the object in the GCP bucket
Perform the following procedure to create an image from the object in your GCP bucket.

Procedure
1. Run the following command to create an image for GCE. Specify the name of the image you are creating, the bucket name, and the name of the tarred image.

   # gcloud compute images create my-image-name --source-uri gs://my-bucket-name/disk.raw.tar.gz

   NOTE
   Alternatively, you can use the Google Cloud Console to create an image. See Creating, deleting, and deprecating custom images for more information.

2. Optionally, find the image in the GCP Console.
   a. Click the Navigation menu to the left of the Google Cloud Console banner.
   b. Select Compute Engine and then Images.

Additional resources
- Creating, deleting, and deprecating custom images
- gcloud compute images create

3.4.7. Creating a Google Compute Engine instance from an image
Complete the following steps to configure a GCE VM instance by using the GCP Console.

NOTE
The following procedure provides instructions for creating a basic VM instance by using the GCP Console. See Creating and starting a VM instance for more information about GCE VM instances and their configuration options.

Procedure
1. From the GCP Console Dashboard page, click the Navigation menu to the left of the Google Cloud Console banner and select Compute Engine and then select Images.

2. Select your image.

3. Click Create Instance.

4. On the Create an instance page, enter a Name for your instance.

5. Choose a Region and Zone.

6. Choose a Machine configuration that meets or exceeds the requirements of your workload.

7. Ensure that Boot disk specifies the name of your image.

8. Optionally, under Firewall, select Allow HTTP traffic or Allow HTTPS traffic.

9. Click Create.

NOTE
These are the minimum configuration options necessary to create a basic instance. Review additional options based on your application requirements.

10. Find your image under VM instances.

11. From the GCP Console Dashboard, click the Navigation menu to the left of the Google Cloud Console banner and select Compute Engine and then select VM instances.

NOTE
Alternatively, you can use the gcloud compute instances create CLI command to create a GCE VM instance from an image. A simple example follows.

```
gcloud compute instances create myinstance3 --zone=us-central1-a --image test-iso2-image
```

The example creates a VM instance named myinstance3 in zone us-central1-a based upon the existing image test-iso2-image. See gcloud compute instances create for more information.

### 3.4.8. Connecting to your instance

Perform the following procedure to connect to your GCE instance using its public IP address.

**Procedure**

1. Run the following command to ensure that your instance is running. The command lists information about your GCE instance, including whether the instance is running, and, if so, the public IP address of the running instance.

```bash
# gcloud compute instances list
```
2. Connect to your instance by using standard SSH. The example uses the `google_compute_engine` key created earlier.

```bash
# ssh -i ~/.ssh/google_compute_engine <user_name>@<instance_external_ip>
```

**NOTE**

GCP offers a number of ways to SSH into your instance. See [Connecting to instances](#) for more information. You can also connect to your instance using the root account and password you set previously.

**Additional resources**

- `gcloud compute instances list`
- [Connecting to instances](#)

### 3.4.9. Attaching Red Hat subscriptions

Using the `subscription-manager` command, you can register and attach your Red Hat subscription to a RHEL instance.

**Prerequisites**

- You must have enabled your subscriptions.

**Procedure**

1. Register your system.

```bash
# subscription-manager register --auto-attach
```

2. Attach your subscriptions.

- You can use an activation key to attach subscriptions. See [Creating Red Hat Customer Portal Activation Keys](#) for more information.

- Alternatively, you can manually attach a subscription by using the ID of the subscription pool (Pool ID). See [Attaching and Removing Subscriptions Through the Command Line](#).

3. **Optional**: To collect various system metrics about the instance in the Red Hat Hybrid Cloud Console, you can register the instance with Red Hat Insights.

```bash
# insights-client register --display-name <display-name-value>
```

For information on further configuration of Red Hat Insights, see [Client Configuration Guide for Red Hat Insights](#).

**Additional resources**

- [Creating Red Hat Customer Portal Activation Keys](#)
- [Attaching and Removing Subscriptions Through the Command Line](#)
3.5. ADDITIONAL RESOURCES

- Red Hat in the Public Cloud
- Google Cloud
CHAPTER 4. CONFIGURING A RED HAT HIGH AVAILABILITY CLUSTER ON GOOGLE CLOUD PLATFORM

To create a cluster where RHEL nodes automatically redistribute their workloads if a node failure occurs, use the Red Hat High Availability Add-On. Such high availability (HA) clusters can also be hosted on public cloud platforms, including Google Cloud Platform (GCP). Creating RHEL HA clusters on GCP is similar to creating HA clusters in non-cloud environments, with certain specifics.

To configure a Red Hat HA cluster on Google Cloud Platform (GCP) using Google Compute Engine (GCE) virtual machine (VM) instances as cluster nodes, see the following sections.

These provide information on:

- Prerequisite procedures for setting up your environment for GCP. Once you have set up your environment, you can create and configure VM instances.

- Procedures specific to the creation of HA clusters, which transform individual nodes into a cluster of HA nodes on GCP. These include procedures for installing the High Availability packages and agents on each cluster node, configuring fencing, and installing network resource agents.

### Prerequisites

- Red Hat Enterprise Linux 9 Server: rhel-9-server-rpms/8Server/x86_64

- Red Hat Enterprise Linux 9 Server (High Availability): rhel-9-server-ha-rpms/8Server/x86_64
  - You must belong to an active GCP project and have sufficient permissions to create resources in the project.
  - Your project should have a service account that belongs to a VM instance and not an individual user. See Using the Compute Engine Default Service Account for information about using the default service account instead of creating a separate service account.

If you or your project administrator create a custom service account, the service account should be configured for the following roles.

- Cloud Trace Agent
- Compute Admin
- Compute Network Admin
- Cloud Datastore User
- Logging Admin
- Monitoring Editor
- Monitoring Metric Writer
- Service Account Administrator
- Storage Admin
4.1. THE BENEFITS OF USING HIGH-AVAILABILITY CLUSTERS ON PUBLIC CLOUD PLATFORMS

A high-availability (HA) cluster is a set of computers (called nodes) that are linked together to run a specific workload. The purpose of HA clusters is to provide redundancy in case of a hardware or software failure. If a node in the HA cluster fails, the Pacemaker cluster resource manager distributes the workload to other nodes and no noticeable downtime occurs in the services that are running on the cluster.

You can also run HA clusters on public cloud platforms. In this case, you would use virtual machine (VM) instances in the cloud as the individual cluster nodes. Using HA clusters on a public cloud platform has the following benefits:

- Improved availability: In case of a VM failure, the workload is quickly redistributed to other nodes, so running services are not disrupted.
- Scalability: Additional nodes can be started when demand is high and stopped when demand is low.
- Cost-effectiveness: With the pay-as-you-go pricing, you pay only for nodes that are running.
- Simplified management: Some public cloud platforms offer management interfaces to make configuring HA clusters easier.

To enable HA on your Red Hat Enterprise Linux (RHEL) systems, Red Hat offers a High Availability Add-On. The High Availability Add-On provides all necessary components for creating HA clusters on RHEL systems. The components include high availability service management and cluster administration tools.

Additional resources
- High Availability Add-On overview

4.2. REQUIRED SYSTEM PACKAGES

To create and configure a base image of RHEL, your host system must have the following packages installed.

Table 4.1. System packages

<table>
<thead>
<tr>
<th>Package</th>
<th>Repository</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>libvirt</td>
<td>rhel-9-for-x86_64-appstream-rpms</td>
<td>Open source API, daemon, and management tool for managing platform virtualization</td>
</tr>
<tr>
<td>virt-install</td>
<td>rhel-9-for-x86_64-appstream-rpms</td>
<td>A command-line utility for building VMs</td>
</tr>
<tr>
<td>libguestfs</td>
<td>rhel-9-for-x86_64-appstream-rpms</td>
<td>A library for accessing and modifying VM file systems</td>
</tr>
</tbody>
</table>
4.3. RED HAT ENTERPRISE LINUX IMAGE OPTIONS ON GCP

The following table lists image choices for RHEL 9 on Google Cloud Platform and the differences in the image options.

**Table 4.2. Image options**

<table>
<thead>
<tr>
<th>Image option</th>
<th>Subscriptions</th>
<th>Sample scenario</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deploy a Red Hat Gold Image.</td>
<td>Use your existing Red Hat subscriptions.</td>
<td>Select a Red Hat Gold Image on Google Cloud Platform. For details on Gold Images and how to access them on Google Cloud Platform, see the Red Hat Cloud Access Reference Guide.</td>
<td>The subscription includes the Red Hat product cost; you pay Google for all other instance costs. Red Hat provides support directly for custom RHEL images.</td>
</tr>
<tr>
<td>Deploy a custom image that you move to GCP.</td>
<td>Use your existing Red Hat subscriptions.</td>
<td>Upload your custom image and attach your subscriptions.</td>
<td>The subscription includes the Red Hat product cost; you pay all other instance costs. Red Hat provides support directly for custom RHEL images.</td>
</tr>
<tr>
<td>Deploy an existing GCP image that includes RHEL.</td>
<td>The GCP images include a Red Hat product.</td>
<td>Choose a RHEL image when you launch an instance on the GCP Compute Engine, or choose an image from the Google Cloud Platform Marketplace.</td>
<td>You pay GCP hourly on a pay-as-you-go model. Such images are called &quot;on-demand&quot; images. GCP offers support for on-demand images through a support agreement.</td>
</tr>
</tbody>
</table>

**NOTE**

You can create a custom image for GCP by using Red Hat Image Builder. See Composing a Customized RHEL System Image for more information.
IMPORTANT

You cannot convert an on-demand instance to a custom RHEL instance. To change from an on-demand image to a custom RHEL *bring-your-own-subscription* (BYOS) image:

1. Create a new custom RHEL instance and migrate data from your on-demand instance.
2. Cancel your on-demand instance after you migrate your data to avoid double billing.

Additional resources

- Red Hat in the Public Cloud
- Compute Engine images
- Creating an instance from a custom image

4.4. INSTALLING THE GOOGLE CLOUD SDK

Complete the following steps to install the Google Cloud SDK.

Procedure

1. Follow the GCP instructions for downloading and extracting the Google Cloud SDK archive. See the GCP document *Quickstart for Linux* for details.
2. Follow the same instructions for initializing the Google Cloud SDK.

**NOTE**

Once you have initialized the Google Cloud SDK, you can use the `gcloud` CLI commands to perform tasks and obtain information about your project and instances. For example, you can display project information with the `gcloud compute project-info describe --project <project-name>` command.

Additional resources

- Quickstart for Linux
- `gcloud` command reference
- `gcloud` command-line tool overview

4.5. CREATING A GCP IMAGE BUCKET

The following document includes the minimum requirements for creating a *multi-regional* bucket in your default location.

Prerequisites

- GCP storage utility (gsutil)
1. If you are not already logged in to Google Cloud Platform, log in with the following command.
   ```bash
   # gcloud auth login
   ```

2. Create a storage bucket.
   ```bash
   $ gsutil mb gs://BucketName
   
   Example:
   $ gsutil mb gs://rhel-ha-bucket
   ```

### Additional resources
- Make buckets

### 4.6. CREATING A CUSTOM VIRTUAL PRIVATE CLOUD NETWORK AND SUBNET

Complete the following steps to create a custom virtual private cloud (VPC) network and subnet.

**Procedure**

1. Launch the GCP Console.
2. Select **VPC networks** under **Networking** in the left navigation pane.
3. Click **Create VPC Network**.
4. Enter a name for the VPC network.
5. Under the **New subnet**, create a **Custom subnet** in the region where you want to create the cluster.
6. Click **Create**.

### 4.7. PREPARING AND IMPORTING A BASE GCP IMAGE

Complete the following steps to prepare a Red Hat Enterprise Linux 9 image for GCP.

**Procedure**

1. Convert the file. Images uploaded to GCP must be in **raw** format and named **disk.raw**.
   ```bash
   $ qemu-img convert -f qcow2 imageName.qcow2 -O raw disk.raw
   ```
2. Compress the **raw** file. Images uploaded to GCP must be compressed.
   ```bash
   $ tar -Sczf imageName.tar.gz disk.raw
   ```
3. Import the compressed image to the bucket created earlier.
4.8. CREATING AND CONFIGURING A BASE GCP INSTANCE

Complete the following steps to create and configure a GCP instance that complies with GCP operating and security requirements.

Procedure

1. Create an image from the compressed file in the bucket.

   ```
   $ gcloud compute images create BaseImageName --source-uri gs://BucketName/BaseImageName.tar.gz
   ```

   Example:

   ```
   [admin@localhost ~]$ gcloud compute images create rhel-76-server --source-uri gs://user-rhelha/rhel-server-76.tar.gz
   Created [https://www.googleapis.com/compute/v1/projects/MyProject/global/images/rhel-server-76].
   NAME            PROJECT                 FAMILY  DEPRECATED  STATUS
   rhel-76-server  rhel-ha-testing-on-gcp                      READY
   ```

2. Create a template instance from the image. The minimum size required for a base RHEL instance is n1-standard-2. See `gcloud compute instances create` for additional configuration options.

   ```
   $ gcloud compute instances create BaseInstanceName --can-ip-forward --machine-type n1-standard-2 --image BaseImageName --service-account ServiceAccountEmail
   ```

   Example:

   ```
   [admin@localhost ~]$ gcloud compute instances create rhel-76-server-base-instance --can-ip-forward --machine-type n1-standard-2 --image rhel-76-server --service-account account@project-name-on-gcp.iam.gserviceaccount.com
   Created [https://www.googleapis.com/compute/v1/projects/rhel-ha-testing-on-gcp/zones/us-east1-b/instances/rhel-76-server-base-instance].
   NAME   ZONE   MACHINE_TYPE   PREEMPTIBLE  INTERNAL_IP  EXTERNAL_IP  STATUS
   rhel-76-server-base-instance  us-east1-bn1-standard-2          10.10.10.3   192.227.54.211  RUNNING
   ```

3. Connect to the instance with an SSH terminal session.

   ```
   $ ssh root@PublicIPaddress
   ```

4. Update the RHEL software.

   a. Register with Red Hat Subscription Manager (RHSM).

   ```
   ```

   b. Enable a Subscription Pool ID (or use the `--auto-attach` command).

   ```
   ```

   c. Disable all repositories.
# subscription-manager repos --disable=*

d. Enable the following repository.

# subscription-manager repos --enable=rhel-9-server-rpms

e. Run the `dnf update` command.

# dnf update -y

5. Install the GCP Linux Guest Environment on the running instance (in-place installation).
   See Install the guest environment in-place for instructions.

6. Select the CentOS/RHEL option.

7. Copy the command script and paste it at the command prompt to run the script immediately.

8. Make the following configuration changes to the instance. These changes are based on GCP recommendations for custom images. See gcloudcompute images list for more information.

   a. Edit the `/etc/chrony.conf` file and remove all NTP servers.

   b. Add the following NTP server.

   | metadata.google.internal iburst Google NTP server |

   c. Remove any persistent network device rules.

   | # rm -f /etc/udev/rules.d/70-persistent-net.rules |
   | # rm -f /etc/udev/rules.d/75-persistent-net-generator.rules |

   d. Set the network service to start automatically.

   | # chkconfig network on |

   e. Set the sshd service to start automatically.

   | # systemctl enable sshd |
   | # systemctl is-enabled sshd |

   f. Set the time zone to UTC.

   | # ln -sf /usr/share/zoneinfo/UTC /etc/localtime |

   g. (Optional) Edit the `/etc/ssh/ssh_config` file and add the following lines to the end of the file. This keeps your SSH session active during longer periods of inactivity.

   | # Server times out connections after several minutes of inactivity. |
   | # Keep alive ssh connections by sending a packet every 7 minutes. |
   | ServerAliveInterval 420 |
h. Edit the `/etc/ssh/sshd_config` file and make the following changes, if necessary. The `ClientAliveInterval 420` setting is optional; this keeps your SSH session active during longer periods of inactivity.

```plaintext
PermitRootLogin no
PasswordAuthentication no
AllowTcpForwarding yes
X11Forwarding no
PermitTunnel no
# Compute times out connections after 10 minutes of inactivity.
# Keep ssh connections alive by sending a packet every 7 minutes.
ClientAliveInterval 420
```

9. Disable password access.

```plaintext
ssh_pwauth from 1 to 0.
ssh_pwauth: 0
```

**IMPORTANT**

Previously, you enabled password access to allow SSH session access to configure the instance. You must disable password access. All SSH session access must be passwordless.

10. Unregister the instance from the subscription manager.

```plaintext
# subscription-manager unregister
```

11. Clean the shell history. Keep the instance running for the next procedure.

```plaintext
# export HISTSIZE=0
```

### 4.9. CREATING A SNAPSHOT IMAGE

Complete the following steps to preserve the instance configuration settings and create a snapshot.

**Procedure**

1. On the running instance, synchronize data to disk.

```plaintext
# sync
```

2. On your host system, create the snapshot.

```plaintext
$ gcloud compute disks snapshot InstanceName --snapshot-names SnapshotName
```

3. On your host system, create the configured image from the snapshot.

```plaintext
$ gcloud compute images create ConfiguredImageFromSnapshot --source-snapshot SnapshotName
```
Additional resources

- Creating Persistent Disk Snapshots

**4.10. CREATING AN HA NODE TEMPLATE INSTANCE AND HA NODES**

Once you have configured an image from the snapshot, you can create a node template. Use this template to create all HA nodes. Complete the following steps to create the template and HA nodes.

**Procedure**

1. Create an instance template.

   ```
   $ gcloud compute instance-templates create InstanceTemplateName --can-ip-forward --machine-type n1-standard-2 --image ConfiguredImageFromSnapshot --service-account ServiceAccountEmailAddress
   
   Example:
   
   [admin@localhost ~]$ gcloud compute instance-templates create rhel-91-instance-template --can-ip-forward --machine-type n1-standard-2 --image rhel-91-gcp-image --service-account account@project-name-on-gcp.iam.gserviceaccount.com
   Created [https://www.googleapis.com/compute/v1/projects/project-name-on-gcp/global/instanceTemplates/rhel-91-instance-template].
   NAME MACHINE_TYPE PREEMPTIBLE CREATION_TIMESTAMP
   rhel-91-instance-template n1-standard-2 2018-07-25T11:09:30.506-07:00
   
   2. Create multiple nodes in one zone.

   ```

   # gcloud compute instances create NodeName01 NodeName02 --source-instance-template InstanceTemplateName --zone RegionZone --network=NetworkName --subnet=SubnetName

   Example:

   [admin@localhost ~]$ gcloud compute instances create rhel81-node-01 rhel81-node-02 rhel81-node-03 --source-instance-template rhel-91-instance-template --zone us-west1-b --network=projectVPC --subnet=range0
   Created [https://www.googleapis.com/compute/v1/projects/project-name-on-gcp/zones/us-west1-b/instances/rhel81-node-01].
   Created [https://www.googleapis.com/compute/v1/projects/project-name-on-gcp/zones/us-west1-b/instances/rhel81-node-02].
   Created [https://www.googleapis.com/compute/v1/projects/project-name-on-gcp/zones/us-west1-b/instances/rhel81-node-03].
   NAME ZONE MACHINE_TYPE PREEMPTIBLE INTERNAL_IP EXTERNAL_IP STATUS
   rhel81-node-01 us-west1-b n1-standard-2 10.10.10.4 192.230.25.81 RUNNING
   rhel81-node-02 us-west1-b n1-standard-2 10.10.10.5 192.230.81.253 RUNNING
   rhel81-node-03 us-east1-b n1-standard-2 10.10.10.6 192.230.102.15 RUNNING
   
   4.11. INSTALLING HA PACKAGES AND AGENTS

   Complete the following steps on all nodes.
Procedure

1. In the Google Cloud Console, select **Compute Engine** and then select **VM instances**.

2. Select the instance, click the arrow next to **SSH**, and select the **View** gcloud command option.

3. Paste this command at a command prompt for passwordless access to the instance.

4. Enable sudo account access and register with Red Hat Subscription Manager.

5. Enable a Subscription Pool ID (or use the **--auto-attach** command).

6. Disable all repositories.

   ```
   # subscription-manager repos --disable=*
   ```

7. Enable the following repositories.

   ```
   # subscription-manager repos --enable=rhel-9-server-rpms
   # subscription-manager repos --enable=rhel-9-for-x86_64-highavailability-rpms
   ```

8. Install **pcs pacemaker**, the fence agents, and the resource agents.

   ```
   # dnf install -y pcs pacemaker fence-agents-gce resource-agents-gcp
   ```

9. Update all packages.

   ```
   # dnf update -y
   ```

### 4.12. CONFIGURING HA SERVICES

Complete the following steps on all nodes to configure HA services.

Procedure

1. The user **hacluster** was created during the **pcs** and **pacemaker** installation in the previous step. Create a password for the user **hacluster** on all cluster nodes. Use the same password for all nodes.

   ```
   # passwd hacluster
   ```

2. If the **firewalld** service is installed, add the HA service.

   ```
   # firewall-cmd --permanent --add-service=high-availability
   # firewall-cmd --reload
   ```

3. Start the **pcs** service and enable it to start on boot.

   ```
   # systemctl start pcsd.service
   # systemctl enable pcsd.service
   ```
Created symlink from /etc/systemd/system/multi-user.target.wants/pcsd.service to /usr/lib/systemd/system/pcsd.service.

Verification

1. Ensure the pcsd service is running.

   # systemctl status pcsd.service

   pcsd.service - PCS GUI and remote configuration interface
   Loaded: loaded (/usr/lib/systemd/system/pcsd.service; enabled; vendor preset: disabled)
   Active: active (running) since Mon 2018-06-25 19:21:42 UTC; 15s ago
   Docs: man:pcsd(8)
   man:pcs(8)
   Main PID: 5901 (pcsd)
   CGroup: /system.slice/pcsd.service
   └─ 5901 /usr/bin/ruby /usr/lib/pcsd/pcsd > /dev/null &

2. Edit the /etc/hosts file. Add RHEL host names and internal IP addresses for all nodes.

Additional resources

- How should the /etc/hosts file be set up on RHEL cluster nodes?

4.13. CREATING A CLUSTER

Complete the following steps to create the cluster of nodes.

Procedure

1. On one of the nodes, authenticate the pcs user. Specify the name of each node in the cluster in the command.

   # pcs host auth hostname1 hostname2 hostname3
   Username: hacluster
   Password:
   hostname1: Authorized
   hostname2: Authorized
   hostname3: Authorized

2. Create the cluster.

   # pcs cluster setup cluster-name hostname1 hostname2 hostname3

Verification

1. Run the following command to enable nodes to join the cluster automatically when started.

   # pcs cluster enable --all

2. Start the cluster.
# pcs cluster start --all

## 4.14. CREATING A FENCING DEVICE

Complete the following steps to create a fencing device.

Note that for most default configurations, the GCP instance names and the RHEL host names are identical.

### Procedure

1. Obtain GCP instance names. Note that the output of the following command also shows the internal ID for the instance.

   ```
   # fence_gce --zone us-west1-b --project=rhel-ha-on-gcp -o list
   ```

   **Example:**
   ```
   [root@rhel81-node-01 ~]# fence_gce --zone us-west1-b --project=rhel-ha-testing-on-gcp -o list
   4435801234567893181,InstanceName-3
   4081901234567896811,InstanceName-1
   7173601234567893341,InstanceName-2
   ```

2. Create a fence device.

   ```
   # pcs stonith create FenceDeviceName fence_gce zone=Region-Zone project=MyProject
   ```

### Verification

- Verify that the fence devices started.

  ```
  # pcs status
  ```

  **Example:**
  ```
  [root@rhel81-node-01 ~]# pcs status
  Cluster name: gcp-cluster
  Stack: corosync
  Current DC: rhel81-node-02 (version 1.1.18-11.el7_5.3-2b07d5c5a9) - partition with quorum
  Last updated: Fri Jul 27 12:53:25 2018
  Last change: Fri Jul 27 12:51:43 2018 by root via cibadmin on rhel81-node-01
  3 nodes configured
  3 resources configured
  Online: [ rhel81-node-01 rhel81-node-02 rhel81-node-03 ]
  Full list of resources:
  ```
4.15. CONFIGURING THE GCP-VCP-MOVE-VIP RESOURCE AGENT

The gcp-vpc-move-vip resource agent attaches a secondary IP address (alias IP) to a running instance. This is a floating IP address that can be passed between different nodes in the cluster.

To show more information about this resource:

```
# pcs resource describe gcp-vpc-move-vip
```

You can configure the resource agent to use a primary subnet address range or a secondary subnet address range:

**Primary subnet address range**

Complete the following steps to configure the resource for the primary VPC subnet.

**Procedure**

1. Create the aliasip resource. Include an unused internal IP address. Include the CIDR block in the command.

   ```bash
   # pcs resource create aliasip gcp-vpc-move-vip alias_ip=UnusedIpaddress/CIDRblock
   
   Example:
   
   [root@rhel81-node-01 ~]# pcs resource create aliasip gcp-vpc-move-vip
   alias_ip=10.10.10.200/32
   ```

2. Create an IPaddr2 resource for managing the IP on the node.

   ```bash
   # pcs resource create vip IPaddr2 nic=interface ip=AliasIpAddress cidr_netmask=32
   
   Example:
   
   [root@rhel81-node-01 ~]# pcs resource create vip IPaddr2 nic=eth0 ip=10.10.10.200
   cidr_netmask=32
   ```

3. Group the network resources under vipgrp.

   ```bash
   # pcs resource group add vipgrp aliasip vip
   ```

**Verification**

1. Verify that the resources have started and are grouped under vipgrp.
1. Verify that the resource can move to a different node.

   ```bash
   # pcs resource move vip Node
   ```

   Example:

   ```bash
   [root@rhel81-node-01 ~]# pcs resource move vip rhel81-node-03
   ```

2. Verify that the vip successfully started on a different node.

   ```bash
   # pcs status
   ```

---

**Secondary subnet address range**

Complete the following steps to configure the resource for a secondary subnet address range.

**Prerequisites**

- You have created a custom network and a subnet
- **Optional:** You have installed Google Cloud SDK. For instructions, see [Installing the Google Cloud SDK](#). Note, however, that you can use the `gcloud` commands in the following procedure in the terminal that you can activate in the Google Cloud web console.

**Procedure**

1. Create a secondary subnet address range.

   ```bash
   # gcloud compute networks subnets update SubnetName --region RegionName --add-secondary-ranges SecondarySubnetName=SecondarySubnetRange
   ```

   Example:

   ```bash
   # gcloud compute networks subnets update range0 --region us-west1 --add-secondary-ranges range1=10.10.20.0/24
   ```

2. Create the aliasip resource. Create an unused internal IP address in the secondary subnet address range. Include the CIDR block in the command.

   ```bash
   # pcs resource create aliasip gcp-vpc-move-vip alias_ip=UnusedIPaddress/CIDRblock
   ```

   Example:

   ```bash
   [root@rhel81-node-01 ~]# pcs resource create aliasip gcp-vpc-move-vip alias_ip=10.10.20.200/32
   ```

3. Create an IPaddr2 resource for managing the IP on the node.

   ```bash
   # pcs resource create vip IPaddr2 nic=interface ip=AliasIPaddress cidr_netmask=32
   ```
Example:

```
[root@rhel81-node-01 ~]# pcs resource create vip IPaddr2 nic=eth0 ip=10.10.20.200 cidr_netmask=32
```

4. Group the network resources under `vipgrp`.

```
# pcs resource group add vipgrp aliasip vip
```

**Verification**

1. Verify that the resources have started and are grouped under `vipgrp`.

```
# pcs status
```

2. Verify that the resource can move to a different node.

```
# pcs resource move vip Node
```

Example:

```
[root@rhel81-node-01 ~]# pcs resource move vip rhel81-node-03
```

3. Verify that the `vip` successfully started on a different node.

```
# pcs status
```

4.16. ADDITIONAL RESOURCES

- Support Policies for RHEL High Availability clusters - Transport Protocols
- VPC network overview
- Exploring RHEL High Availability’s Components, Concepts, and Features - Overview of Transport Protocols
- Design Guidance for RHEL High Availability Clusters - Selecting the Transport Protocol