



# Red Hat Enterprise Linux 9

## Composing a customized RHEL system image

Creating customized system images with RHEL image builder on Red Hat Enterprise Linux 9



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## Abstract

RHEL image builder is a tool for creating deployment-ready customized system images: installation disks, virtual machines, cloud vendor-specific images, and others. By using RHEL image builder, you can create these images faster if compared to manual procedures, because it eliminates the specific configurations required for each output type. This document describes how to set up RHEL image builder and create images with it.

## Table of Contents

<b>MAKING OPEN SOURCE MORE INCLUSIVE</b> .....	<b>4</b>
<b>PROVIDING FEEDBACK ON RED HAT DOCUMENTATION</b> .....	<b>5</b>
<b>CHAPTER 1. RHEL IMAGE BUILDER DESCRIPTION</b> .....	<b>6</b>
1.1. RHEL IMAGE BUILDER TERMINOLOGY	6
1.2. RHEL IMAGE BUILDER OUTPUT FORMATS	6
<b>CHAPTER 2. INSTALLING RHEL IMAGE BUILDER</b> .....	<b>8</b>
2.1. RHEL IMAGE BUILDER SYSTEM REQUIREMENTS	8
2.2. INSTALLING RHEL IMAGE BUILDER	8
<b>CHAPTER 3. CONFIGURING RHEL IMAGE BUILDER REPOSITORIES</b> .....	<b>11</b>
3.1. ADDING CUSTOM THIRD-PARTY REPOSITORIES TO RHEL IMAGE BUILDER	11
3.2. ADDING THIRD-PARTY REPOSITORIES WITH SPECIFIC DISTRIBUTIONS TO RHEL IMAGE BUILDER	12
3.3. CHECKING REPOSITORIES METADATA WITH GPG	12
3.4. RHEL IMAGE BUILDER OFFICIAL REPOSITORY OVERRIDES	14
3.5. OVERRIDING A SYSTEM REPOSITORY	14
3.6. OVERRIDING A SYSTEM REPOSITORY THAT REQUIRES SUBSCRIPTIONS	16
<b>CHAPTER 4. CREATING SYSTEM IMAGES BY USING RHEL IMAGE BUILDER CLI</b> .....	<b>18</b>
4.1. INTRODUCING THE RHEL IMAGE BUILDER COMMAND-LINE INTERFACE	18
4.2. USING RHEL IMAGE BUILDER AS A NON-ROOT USER	18
4.3. CREATING A BLUEPRINT BY USING THE COMMAND-LINE INTERFACE	18
4.4. EDITING A BLUEPRINT WITH COMMAND-LINE INTERFACE	20
4.5. CREATING A SYSTEM IMAGE WITH RHEL IMAGE BUILDER IN THE COMMAND-LINE INTERFACE	21
4.6. BASIC RHEL IMAGE BUILDER COMMAND-LINE COMMANDS	23
4.7. RHEL IMAGE BUILDER BLUEPRINT FORMAT	24
4.8. SUPPORTED IMAGE CUSTOMIZATIONS	25
4.8.1. Selecting a distribution	26
4.8.2. Selecting a package group	26
4.8.3. Setting the image hostname	26
4.8.4. Specifying additional users	27
4.8.5. Specifying additional groups	27
4.8.6. Setting SSH key for existing users	27
4.8.7. Appending a kernel argument	28
4.8.8. Setting time zone and NTP	28
4.8.9. Customizing the locale settings	29
4.8.10. Customizing firewall	29
4.8.11. Enabling or disabling services	30
4.8.12. Specifying a custom filesystem configuration	31
4.9. PACKAGES INSTALLED BY RHEL IMAGE BUILDER	35
4.10. ENABLED SERVICES ON CUSTOM IMAGES	38
<b>CHAPTER 5. CREATING SYSTEM IMAGES BY USING RHEL IMAGE BUILDER WEB CONSOLE INTERFACE</b> ...	<b>40</b>
5.1. ACCESSING THE RHEL IMAGE BUILDER DASHBOARD IN THE RHEL WEB CONSOLE	40
5.2. CREATING A BLUEPRINT IN THE WEB CONSOLE INTERFACE	40
5.3. IMPORTING A BLUEPRINT IN THE RHEL IMAGE BUILDER WEB CONSOLE INTERFACE	44
5.4. EXPORTING A BLUEPRINT FROM THE RHEL IMAGE BUILDER WEB CONSOLE INTERFACE	44
5.5. CREATING A SYSTEM IMAGE BY USING RHEL IMAGE BUILDER IN THE WEB CONSOLE INTERFACE	45
<b>CHAPTER 6. CREATING A BOOT ISO INSTALLER IMAGE WITH RHEL IMAGE BUILDER</b> .....	<b>47</b>

6.1. CREATING A BOOT ISO INSTALLER IMAGE USING THE RHEL IMAGE BUILDER CLI	47
6.2. CREATING A BOOT ISO INSTALLER IMAGE BY USING RHEL IMAGE BUILDER IN THE GUI	48
6.3. INSTALLING A BOOTABLE ISO TO A MEDIA AND BOOTING IT	50
<b>CHAPTER 7. CREATING PRE-HARDENED IMAGES WITH RHEL IMAGE BUILDER OPENSAP INTEGRATION</b>	<b>51</b>
7.1. DIFFERENCES BETWEEN KICKSTART AND PRE-HARDENED IMAGES	51
7.2. INSTALLING OPENSAP	51
7.3. THE OPENSAP BLUEPRINT CUSTOMIZATION	52
7.4. CREATING A PRE-HARDENED IMAGE WITH RHEL IMAGE BUILDER	53
<b>CHAPTER 8. PREPARING AND DEPLOYING A KVM GUEST IMAGE BY USING RHEL IMAGE BUILDER ...</b>	<b>55</b>
8.1. CREATING CUSTOMIZED KVM GUEST IMAGES BY USING RHEL IMAGE BUILDER	55
8.2. CREATING A VIRTUAL MACHINE FROM A KVM GUEST IMAGE	56
<b>CHAPTER 9. PUSHING A CONTAINER TO A REGISTRY AND EMBEDDING IT INTO AN IMAGE .....</b>	<b>58</b>
9.1. BLUEPRINT CUSTOMIZATION TO EMBED A CONTAINER INTO AN IMAGE	58
9.2. THE CONTAINER REGISTRY CREDENTIALS	58
9.3. PUSHING A CONTAINER ARTIFACT DIRECTLY TO A CONTAINER REGISTRY	59
9.4. BUILDING AN IMAGE AND PULLING THE CONTAINER INTO THE IMAGE	60
<b>CHAPTER 10. PREPARING AND UPLOADING CLOUD IMAGES BY USING RHEL IMAGE BUILDER .....</b>	<b>63</b>
10.1. PREPARING TO UPLOAD AWS AMI IMAGES	63
10.2. UPLOADING AN AMI IMAGE TO AWS BY USING THE CLI	64
10.3. PUSHING IMAGES TO AWS CLOUD AMI	66
10.4. PREPARING TO UPLOAD MICROSOFT AZURE VHD IMAGES	68
10.5. UPLOADING VHD IMAGES TO MICROSOFT AZURE CLOUD	69
10.6. PUSHING VHD IMAGES TO MICROSOFT AZURE CLOUD	70
10.7. CREATING A CUSTOMIZED RHEL VMDK SYSTEM IMAGE BY USING RHEL IMAGE BUILDER	72
10.8. UPLOADING VMDK IMAGES AND CREATING A RHEL VIRTUAL MACHINE IN VSPHERE	73
10.9. UPLOADING IMAGES TO GCP WITH RHEL IMAGE BUILDER	75
10.9.1. Uploading a gce image to GCP by using the CLI	75
10.9.2. How RHEL image builder sorts the authentication order of different GCP credentials	77
10.9.2.1. Specifying GCP credentials with the composer-cli command	77
10.9.2.2. Specifying credentials in the osbuild-composer worker configuration	77
10.10. PUSHING VMDK IMAGES TO VSPHERE USING THE RHEL IMAGE BUILDER GUI TOOL	78
10.11. PUSHING CUSTOMIZED IMAGES TO OCI	80
10.12. UPLOADING QCOW2 IMAGES TO OPENSTACK	81
10.13. PREPARING TO UPLOAD CUSTOMIZED RHEL IMAGES TO ALIBABA CLOUD	84
10.14. UPLOADING CUSTOMIZED RHEL IMAGES TO ALIBABA	85
10.15. IMPORTING IMAGES TO ALIBABA CLOUD	86
10.16. CREATING AN INSTANCE OF A CUSTOMIZED RHEL IMAGE USING ALIBABA CLOUD	87



## 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](#).



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# CHAPTER 1. RHEL IMAGE BUILDER DESCRIPTION

To deploy a system, create a system image. To create RHEL system images, use the RHEL image builder tool. You can use RHEL image builder to create customized system images of RHEL, including system images prepared for deployment on cloud platforms. RHEL image builder automatically handles the setup details for each output type and is therefore easier to use and faster to work with than manual methods of image creation. You can access the RHEL image builder functionalities by using the command-line interface in the **composer-cli** tool, or the graphical user interface in the RHEL web console.

## 1.1. RHEL IMAGE BUILDER TERMINOLOGY

RHEL image builder uses the following concepts:

### Blueprint

A blueprint is a description of a customized system image. It lists the packages and customizations that will be part of the system. You can edit blueprints with customizations and save them as a particular version. When you create a system image from a blueprint, the image is associated with the blueprint in the RHEL image builder interface.

Create blueprints in the TOML format.

### Compose

Composes are individual builds of a system image, based on a specific version of a particular blueprint. Compose as a term refers to the system image, the logs from its creation, inputs, metadata, and the process itself.

### Customizations

Customizations are specifications for the image that are not packages. This includes users, groups, and SSH keys.

## 1.2. RHEL IMAGE BUILDER OUTPUT FORMATS

RHEL image builder can create images in multiple output formats shown in the following table.

Table 1.1. RHEL image builder output formats

Description	CLI name	File extension
QEMU Image	<b>qcow2</b>	<b>.qcow2</b>
Disk Archive	<b>tar</b>	<b>.tar</b>
Amazon Web Services	<b>raw</b>	<b>.raw</b>
Microsoft Azure	<b>vhd</b>	<b>.vhd</b>
Google Cloud Platform	<b>gce</b>	<b>.tar.gz</b>
VMware vSphere	<b>vmdk</b>	<b>.vmdk</b>
VMware vSphere	<b>ova</b>	<b>.ova</b>

Description	CLI name	File extension
Openstack	<b>openstack</b>	<b>.qcow2</b>
RHEL for Edge Commit	<b>edge-commit</b>	<b>.tar</b>
RHEL for Edge Container	<b>edge-container</b>	<b>.tar</b>
RHEL for Edge Installer	<b>edge-installer</b>	<b>.iso</b>
RHEL for Edge Raw Image	<b>edge-raw-image</b>	<b>.raw.xz</b>
RHEL for Edge Simplified Installer	<b>edge-simplified-installer</b>	<b>.iso</b>
RHEL for Edge AMI	<b>edge-ami</b>	<b>.ami</b>
RHEL for Edge VMDK	<b>edge-vsphere</b>	<b>.vmdk</b>
RHEL Installer	<b>image-installer</b>	<b>.iso</b>
Oracle Cloud Infrastructure	<b>.oci</b>	<b>.qcow2</b>

To check the supported types, run the command:

```
# composer-cli compose types
```

## CHAPTER 2. INSTALLING RHEL IMAGE BUILDER

Before using RHEL image builder, you must install it.

### 2.1. RHEL IMAGE BUILDER SYSTEM REQUIREMENTS

The host that runs RHEL image builder must meet the following requirements:

Table 2.1. RHEL image builder system requirements

Parameter	Minimal Required Value
System type	A dedicated host or virtual machine. Note that RHEL image builder is not supported in containers, including Red Hat Universal Base Images (UBI).
Processor	2 cores
Memory	4 GiB
Disk space	20 GiB of free space in the <code>/var/cache/`</code> filesystem
Access privileges	root
Network	Internet connectivity to the Red Hat Content Delivery Network (CDN).



#### NOTE

If you do not have internet connectivity, use RHEL image builder in isolated networks. For that, you must override the default repositories to point to your local repositories to not connect to Red Hat Content Delivery Network (CDN). Ensure that you have your content mirrored internally or use Red Hat Satellite.

#### Additional resources

- [Configuring RHEL image builder repositories](#)
- [Provisioning to Satellite using a Red Hat image builder image](#)

### 2.2. INSTALLING RHEL IMAGE BUILDER

Install RHEL image builder to have access to all the **osbuild-composer** package functionalities.

#### Prerequisites

- You are logged in to the RHEL host on which you want to install RHEL image builder.
- The host is subscribed to Red Hat Subscription Manager (RHSM) or Red Hat Satellite.
- You have enabled the **BaseOS** and **AppStream** repositories to be able to install the RHEL image builder packages.

## Procedure

1. Install RHEL image builder and other necessary packages:

```
# dnf install osbuild-composer composer-cli cockpit-composer
```

- **osbuild-composer** - A service to build customized RHEL operating system images.
- **composer-cli**- This package enables access to the CLI interface.
- **cockpit-composer** - This package enables access to the Web UI interface. The web console is installed as a dependency of the **cockpit-composer** package.

2. Enable and start RHEL image builder socket:

```
# systemctl enable --now osbuild-composer.socket
```

3. If you want to use RHEL image builder in the web console, enable and start it.

```
# systemctl enable --now cockpit.socket
```

The **osbuild-composer** and **cockpit** services start automatically on first access.

4. Load the shell configuration script so that the autocomplete feature for the **composer-cli** command starts working immediately without logging out and in:

```
$ source /etc/bash_completion.d/composer-cli
```

5. Restart the running **osbuild-composer** service on your RHEL host.

```
# systemctl restart osbuild-composer
```

## Verification

- Verify that the installation works by running **composer-cli**:

```
# composer-cli status show
```

## Troubleshooting

You can use a system journal to track RHEL image builder activities. Additionally, you can find the log messages in the file.

- To find the journal output for traceback, run the following commands:

```
$ journalctl | grep osbuild
```

- To show both remote or local workers:

```
$ journalctl -u osbuild-worker*
```

- To show the running services:

```
$ journalctl -u osbuild-composer.service
```

-

## CHAPTER 3. CONFIGURING RHEL IMAGE BUILDER REPOSITORIES

To use RHEL image builder, you must ensure that the repositories are configured. You can use the following types of repositories in RHEL image builder:

### Official repository overrides

Use these if you want to download base system RPMs from elsewhere than the Red Hat Content Delivery Network (CDN) official repositories, for example, a custom mirror in your network. Using official repository overrides disables the default repositories, and your custom mirror must contain all the necessary packages.

### Custom third-party repositories

Use these to include packages that are not available in the official RHEL repositories.

## 3.1. ADDING CUSTOM THIRD-PARTY REPOSITORIES TO RHEL IMAGE BUILDER

You can add custom third-party sources to your repositories and manage these repositories by using the **composer-cli**.

### Prerequisites

- You have the URL of the custom third-party repository.

### Procedure

1. Create a repository source file, such as **/root/repo.toml**. For example:

```
id = "k8s"
name = "Kubernetes"
type = "yum-baseurl"
url = "https://server.example.com/repos/company_internal_packages/"
check_gpg = false
check_ssl = false
system = false
```

The **type** field accepts the following valid values: **yum-baseurl**, **yum-mirrorlist**, and **yum-metalink**.

2. Save the file in the TOML format.
3. Add the new third-party source to RHEL image builder:

```
$ composer-cli sources add <file-name>.toml
```

### Verification

1. Check if the new source was successfully added:

```
$ composer-cli sources list
```

2. Check the new source content:

```
$ composer-cli sources info <source_id>
```

## 3.2. ADDING THIRD-PARTY REPOSITORIES WITH SPECIFIC DISTRIBUTIONS TO RHEL IMAGE BUILDER

You can specify a list of distributions in the custom third-party source file by using the optional field **distro**. The repository file uses the distribution string list while resolving dependencies during the image building.

Any request that specifies **rhel-9** uses this source. For example, if you list packages and specify **rhel-9**, it includes this source. However, listing packages for the host distribution do not include this source.

### Prerequisites

- You have the URL of the custom third-party repository.
- You have the list of distributions that you want to specify.

### Procedure

1. Create a repository source file, such as **/root/repo.toml**. For example, to specify the distribution:

```
check_gpg = true
check_ssl = true
distros = ["rhel-9"]
id = "rh9-local"
name = "packages for RHEL"
system = false
type = "yum-baseurl"
url = "https://local/repos/rhel9/projectrepo"
```

2. Save the file in the TOML format.
3. Add the new third-party source to RHEL image builder:

```
$ composer-cli sources add <file-name>.toml
```

### Verification

1. Check if the new source was successfully added:

```
$ composer-cli sources list
```

2. Check the new source content:

```
$ composer-cli sources info <source_id>
```

## 3.3. CHECKING REPOSITORIES METADATA WITH GPG

To detect and avoid corrupted packages, you can use the DNF package manager to check the GNU Privacy Guard (GPG) signature on RPM packages, and also to check if the repository metadata has been signed with a GPG key.



You can either enter the **gpgkey** that you want to do the check over **https** by setting the **gpgkeys** field with the key URL. Alternatively, to improve security, you can also embed the whole key into the **gpgkeys** field, to import it directly instead of fetching the key from the URL.

## Prerequisites

- The directory that you want to use as a repository exists and contains packages.

## Procedure

1. Access the folder where you want to create a repository:

```
$ cd repo/
```

2. Run the **createrepo\_c** to create a repository from RPM packages:

```
$ createrepo_c .
```

3. Access the directory where the repodata is:

```
$ cd repodata/
```

4. Sign your **repomd.xml** file:

```
$ gpg -u <_gpg-key-email_> --yes --detach-sign --armor /srv/repo/example/repomd.xml
```

5. To enable GPG signature checks in the repository:

- a. Set **check\_repogpg = true** in the repository source.
- b. Enter the **gpgkey** that you want to do the check. If your key is available over **https**, set the **gpgkeys** field with the key URL for the key. You can add as many URL keys as you need. The following is an example:

```
check_gpg = true
check_ssl = true
id = "signed local packages"
name = "repository_name"
type = "yum-baseurl"
url = "https://local/repos/projectrepo/"
check_repogpg = true
gpgkeys=["https://local/keys/repokey.pub"]
```

As an alternative, add the GPG key directly in the **gpgkeys** field, for example:

```
check_gpg = true
check_ssl = true
check_repogpg
id = "custom-local"
name = "signed local packages"
type = "yum-baseurl"
url = "https://local/repos/projectrepo/"
gpgkeys=["https://remote/keys/other-repokey.pub",
```

```

"-----BEGIN PGP PUBLIC KEY BLOCK-----
...
-----END PGP PUBLIC KEY BLOCK-----"]

```

- If the test does not find the signature, the GPG tool shows an error similar to the following one:

```

$ GPG verification is enabled, but GPG signature is not available.
This may be an error or the repository does not support GPG verification:
Status code: 404 for http://repo-server/rhel/repodata/repomd.xml.asc (IP:
192.168.1.3)

```

- If the signature is invalid, the GPG tool shows an error similar to the following one:

```

repomd.xml GPG signature verification error: Bad GPG signature

```

### Verification

- Test the signature of the repository manually:

```

$ gpg --verify /srv/repo/example/repomd.xml.asc

```

## 3.4. RHEL IMAGE BUILDER OFFICIAL REPOSITORY OVERRIDES

RHEL image builder **osbuild-composer** back end does not inherit the system repositories located in the **/etc/yum.repos.d/** directory. Instead, it has its own set of official repositories defined in the **/usr/share/osbuild-composer/repositories** directory. This includes the Red Hat official repository, which contains the base system RPMs to install additional software or update already installed programs to newer versions. If you want to override the official repositories, you must define overrides in **/etc/osbuild-composer/repositories/**. This directory is for user defined overrides and the files located there take precedence over those in the **/usr/share/osbuild-composer/repositories/** directory.

The configuration files are not in the usual DNF repository format known from the files in **/etc/yum.repos.d/**. Instead, they are JSON files.

## 3.5. OVERRIDING A SYSTEM REPOSITORY

You can configure your own repository override for RHEL image builder in the **/etc/osbuild-composer/repositories** directory.

### Prerequisites

- You have a custom repository that is accessible from your host system.

### Procedure

1. Create the **/etc/osbuild-composer/repositories/** directory to store your repository overrides:

```

$ sudo mkdir -p /etc/osbuild-composer/repositories

```

2. Create a JSON file, using a name corresponding to your RHEL version. Alternatively, you can copy the file for your distribution from **/usr/share/osbuild-composer/** and modify its content.

For RHEL 9.3, use `/etc/osbuild-composer/repositories/rhel-93.json`.

3. Add the following structure to your JSON file. Specify only one of the following attributes, in the string format:

- **baseurl** - The base URL of the repository.
- **metalink** - The URL of a metalink file that contains a list of valid mirror repositories.
- **mirrorlist** - The URL of a mirrorlist file that contains a list of valid mirror repositories. The remaining fields, such as **gpgkey**, and **metadata\_expire**, are optional.

For example:

```
{
  "x86_64": [
    {
      "name": "baseos",
      "baseurl": "http://mirror.example.com/composes/released/RHEL-
9/9.0/BaseOS/x86_64/os/",
      "gpgkey": "-----BEGIN PGP PUBLIC KEY BLOCK-----\n\n (...)",
      "check_gpg": true
    }
  ]
}
```

Alternatively, you can copy the JSON file for your distribution, by replacing **rhel-version.json** with your RHEL version, for example: `rhel-9.json`.

```
$ cp /usr/share/osbuild-composer/repositories/rhel-version.json /etc/osbuild-
composer/repositories/
```

4. Optional: Verify the JSON file:

```
$ json_verify /etc/osbuild-composer/repositories/<file>.json
```

5. Edit the **baseurl** paths in the **rhel-9.json** file and save it. For example:

```
$ /etc/osbuild-composer/repositories/rhel-version.json
```

6. Restart the **osbuild-composer.service**:

```
$ sudo systemctl restart osbuild-composer.service
```

## Verification

- Check if the repository points to the correct URLs:

```
$ cat /etc/yum.repos.d/redhat.repo
```

You can see that the repository points to the correct URLs which are copied from the `/etc/yum.repos.d/redhat.repo` file.

## Additional resources

- The latest RPMs version available in repository not visible for **osbuild-composer**.

### 3.6. OVERRIDING A SYSTEM REPOSITORY THAT REQUIRES SUBSCRIPTIONS

You can set up the **osbuild-composer** service to use system subscriptions that are defined in the `/etc/yum.repos.d/redhat.repo` file. To use a system subscription in **osbuild-composer**, define a repository override that has the following details:

- The same **baseurl** as the repository defined in `/etc/yum.repos.d/redhat.repo`.
- The value of **"rhsm": true** defined in the JSON object.



#### NOTE

**osbuild-composer** does not automatically use repositories defined in `/etc/yum.repos.d/`. You need to manually specify them either as a system repository override or as an additional **source** by using **composer-cli**. The "BaseOS" and "AppStream" repositories usually use system repository overrides, whereas all the other repositories use **composer-cli** sources.

#### Prerequisites

- Your system has a subscription defined in `/etc/yum.repos.d/redhat.repo`
- You have created a repository override. See [Overriding a system repository](#).

#### Procedure

1. Get the **baseurl** from the `/etc/yum.repos.d/redhat.repo` file:

```
# cat /etc/yum.repos.d/redhat.repo
[AppStream]
name = AppStream mirror example
baseurl = https://mirror.example.com/RHEL-9/9.0/AppStream/x86_64/os/
enabled = 1
gpgcheck = 0
sslverify = 1
sslcacert = /etc/pki/ca1/ca.crt
sslclientkey = /etc/pki/ca1/client.key
sslclientcert = /etc/pki/ca1/client.crt
metadata_expire = 86400
enabled_metadata = 0
```

2. Configure the repository override to use the same **baseurl** and set **rhsm** to true:

```
{
  "x86_64": [
    {
      "name": "AppStream mirror example",
      "baseurl": "https://mirror.example.com/RHEL-9/9.0/AppStream/x86_64/os/",
      "gpgkey": "-----BEGIN PGP PUBLIC KEY BLOCK-----\n\n (...)",
      "check_gpg": true,
      "rhsm": true
    }
  ]
}
```

```
    }  
  ]  
}
```

3. Restart the **osbuild-composer.service**:

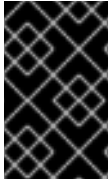
```
$ sudo systemctl restart osbuild-composer.service
```

### Additional resources

- [RHEL image builder uses CDN repositories when host is registered to Satellite 6](#)

## CHAPTER 4. CREATING SYSTEM IMAGES BY USING RHEL IMAGE BUILDER CLI

RHEL image builder is a tool for creating custom system images. To control RHEL image builder and create your custom system images, you can use the command-line interface (CLI) or the web console interface.



### IMPORTANT

The RHEL image builder tool does not support building RHEL 9 images on a RHEL 8 system. You can only build an image from the earlier version of the image you use in the host distribution.

### 4.1. INTRODUCING THE RHEL IMAGE BUILDER COMMAND-LINE INTERFACE

You can use the RHEL image builder command-line interface (CLI) to create blueprints, by running the **composer-cli** command with the suitable options and subcommands.

The workflow for the command-line interface can be summarized as follows:

1. Create a blueprint or export (save) an existing blueprint definition to a plain text file
2. Edit this file in a text editor
3. Import the blueprint text file back into image builder
4. Run a compose to build an image from the blueprint
5. Export the image file to download it

Apart from the basic subcommands to create a blueprint, the **composer-cli** command offers many subcommands to examine the state of configured blueprints and composes.

### 4.2. USING RHEL IMAGE BUILDER AS A NON-ROOT USER

To run the **composer-cli** commands as non-root, the user must be in the **weldr** group.

#### Prerequisites

- You have created a user

#### Procedure

- To add a user to the **weldr** or **root** groups, run the following commands:

```
$ sudo usermod -a -G weldr user
$ newgrp weldr
```

### 4.3. CREATING A BLUEPRINT BY USING THE COMMAND-LINE INTERFACE

You can create a new RHEL image builder blueprint using the command-line interface (CLI). The blueprint describes the final image and its customizations, such as packages, and kernel customizations.

## Prerequisite

- You are logged in as the root user or a user who is a member of the welder group

## Procedure

1. Create a plain text file with the following contents:

```
name = "BLUEPRINT-NAME"
description = "LONG FORM DESCRIPTION TEXT"
version = "0.0.1"
modules = []
groups = []
```

Replace *BLUEPRINT-NAME* and *LONG FORM DESCRIPTION TEXT* with a name and description for your blueprint.

Replace *0.0.1* with a version number according to the Semantic Versioning scheme.

2. For every package that you want to be included in the blueprint, add the following lines to the file:

```
[[packages]]
name = "package-name"
version = "package-version"
```

Replace *package-name* with the name of the package, such as **httpd**, **gdb-doc**, or **coreutils**.

Optionally, replace *package-version* with the version to use. This field supports **dnf** version specifications:

- For a specific version, use the exact version number such as **8.7.0**.
  - For the latest available version, use the asterisk **\***.
  - For the latest minor version, use formats such as **8.\***.
3. Customize your blueprints to suit your needs. For example, disable Simultaneous Multi Threading (SMT), add the following lines to the blueprint file:

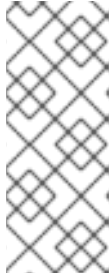
```
[customizations.kernel]
append = "nosmt=force"
```

For additional customizations available, see [Supported Image Customizations](#).

4. Save the file, for example, as *BLUEPRINT-NAME.toml* and close the text editor.
5. Push the blueprint:

```
# composer-cli blueprints push BLUEPRINT-NAME.toml
```

Replace *BLUEPRINT-NAME* with the value you used in previous steps.



## NOTE

To create images using **composer-cli** as non-root, add your user to the **weldr** or **root** groups.

```
# usermod -a -G weldr user
$ newgrp weldr
```

## Verification

- List the existing blueprints to verify that the blueprint has been pushed and exists:

```
# composer-cli blueprints list
```

- Display the blueprint configuration you have just added:

```
# composer-cli blueprints show BLUEPRINT-NAME
```

- Check whether the components and versions listed in the blueprint and their dependencies are valid:

```
# composer-cli blueprints depsolve BLUEPRINT-NAME
```

If RHEL image builder is unable to solve the dependencies of a package from your custom repositories, remove the **osbuild-composer** cache:

```
$ sudo rm -rf /var/cache/osbuild-composer/*
$ sudo systemctl restart osbuild-composer
```

## Additional resources

- [osbuild-composer is unable to depsolve a package from my custom repository](#)
- [Composing a customized RHEL system image with proxy server](#)

## 4.4. EDITING A BLUEPRINT WITH COMMAND-LINE INTERFACE

You can edit an existing blueprint in the command-line (CLI) interface to, for example, add a new package, or define a new group, and to create your customized images. For that, follow the steps:

### Prerequisites

- You have created a blueprint

### Procedure

- List the existing blueprints:

```
# composer-cli blueprints list
```

- Save the blueprint to a local text file:



```
# composer-cli blueprints save BLUEPRINT-NAME
```

3. Edit the *BLUEPRINT-NAME*.toml file with a text editor and make your changes.
4. Before finishing the edits, verify that the file is a valid blueprint:
  - a. Remove the following line from the blueprint, if present:

```
packages = []
```

- b. Increase the version number, for example, from 0.0.1 to 0.1.0. Remember that RHEL image builder blueprint versions must use the Semantic Versioning scheme. Note also that if you do not change the version, the **patch** version component increases automatically.
5. Save the file and close the text editor.
6. Push the blueprint back into RHEL image builder:

```
# composer-cli blueprints push BLUEPRINT-NAME.toml
```



#### NOTE

To import the blueprint back into RHEL image builder, supply the file name including the **.toml** extension, while in other commands use only the blueprint name.

#### Verification

1. To verify that the contents uploaded to RHEL image builder match your edits, list the contents of blueprint:

```
# composer-cli blueprints show BLUEPRINT-NAME
```

2. Check whether the components and versions listed in the blueprint and their dependencies are valid:

```
# composer-cli blueprints depsolve BLUEPRINT-NAME
```

#### Additional resources

- [Supported Image Customizations](#)

## 4.5. CREATING A SYSTEM IMAGE WITH RHEL IMAGE BUILDER IN THE COMMAND-LINE INTERFACE

You can build a customized RHEL image by using the RHEL image builder command-line interface. For that, you must specify a blueprint and an image type. Optionally, you can also specify a distribution. If you do not specify a distribution, it will use the same distribution and version as the host system. The architecture is also the same as the one on the host.

#### Prerequisites

- You have a blueprint prepared for the image. See [Creating a RHEL image builder blueprint using the command-line interface](#).

## Procedure

1. Optional: List the image formats you can create:

```
# composer-cli compose types
```

2. Start the compose:

```
# composer-cli compose start BLUEPRINT-NAME IMAGE-TYPE
```

Replace *BLUEPRINT-NAME* with the name of the blueprint, and *IMAGE-TYPE* with the type of the image. For the available values, see the output of the **composer-cli compose types** command.

The compose process starts in the background and shows the composer Universally Unique Identifier (UUID).

3. The image creation can take up to ten minutes to complete.  
To check the status of the compose:

```
# composer-cli compose status
```

A finished compose shows the **FINISHED** status value. To identify your compose in the list, use its UUID.

4. After the compose process is finished, download the resulting image file:

```
# composer-cli compose image UUID
```

Replace *UUID* with the UUID value shown in the previous steps.

## Verification

After you create your image, you can check the image creation progress using the following commands:

- Download the metadata of the image to get a **.tar** file of the metadata for the compose:

```
$ sudo composer-cli compose metadata UUID
```

- Download the logs of the image:

```
$ sudo composer-cli compose logs UUID
```

The command creates a **.tar** file that contains the logs for the image creation. If the logs are empty, you can check the journal.

- Check the journal:

```
$ journalctl | grep osbuild
```

- Check the manifest of the image:

```
$ sudo cat /var/lib/osbuild-composer/jobs/job_UUID.json
```

You can find the `job_UUID.json` in the journal.

### Additional resources

- [Tracing RHEL image builder](#)

## 4.6. BASIC RHEL IMAGE BUILDER COMMAND-LINE COMMANDS

The RHEL image builder command-line interface offers the following subcommands.

### Blueprint manipulation

#### List all available blueprints

```
# composer-cli blueprints list
```

#### Show a blueprint contents in the TOML format

```
# composer-cli blueprints show <BLUEPRINT-NAME>
```

#### Save (export) blueprint contents in the TOML format into a file `<BLUEPRINT-NAME>.toml`

```
# composer-cli blueprints save <BLUEPRINT-NAME>
```

#### Remove a blueprint

```
# composer-cli blueprints delete <BLUEPRINT-NAME>
```

#### Push (import) a blueprint file in the TOML format into RHEL image builder

```
# composer-cli blueprints push <BLUEPRINT-NAME>
```

### Composing images from blueprints

#### List the available image types

```
# composer-cli compose types
```

#### Start a compose

```
# composer-cli compose start <BLUEPRINT> <COMPOSE-TYPE>
```

#### List all composes

```
# composer-cli compose list
```

#### List all composes and their status

```
# composer-cli compose status
```

### Cancel a running compose

```
# composer-cli compose cancel <COMPOSE-UUID>
```

### Delete a finished compose

```
# composer-cli compose delete <COMPOSE-UUID>
```

### Show detailed information about a compose

```
# composer-cli compose info <COMPOSE-UUID>
```

### Download image file of a compose

```
# composer-cli compose image <COMPOSE-UUID>
```

### See more subcommands and options

```
# composer-cli help
```

### Additional resources

- *composer-cli(1)* man page

## 4.7. RHEL IMAGE BUILDER BLUEPRINT FORMAT

RHEL image builder blueprints are presented to the user as plain text in the TOML format.

The elements of a typical blueprint file include the following:

### The blueprint metadata

```
name = "<BLUEPRINT-NAME>"  
description = "<LONG FORM DESCRIPTION TEXT>"  
version = "<VERSION>"
```

The *BLUEPRINT-NAME* and *LONG FORM DESCRIPTION TEXT* field are a name and description for your blueprint.

The *VERSION* is a version number according to the Semantic Versioning scheme, and is present only once for the entire blueprint file.

### Groups to include in the image

```
[[groups]]  
name = "group-name"
```

The *group* entry describes a group of packages to be installed into the image. Groups use the following package categories:

- Mandatory
- Default
- Optional

The *group-name* is the name of the group, for example, **anaconda-tools**, **widget**, **wheel** or **users**. Blueprints install the mandatory and default packages. There is no mechanism for selecting optional packages.

### Packages to include in the image

```
[[packages]]
name = "<package-name>"
version = "<package-version>"
```

*package-name* is the name of the package, such as **httpd**, **gdb-doc**, or **coreutils**.

*package-version* is a version to use. This field supports **dnf** version specifications:

- For a specific version, use the exact version number such as **8.7.0**.
- For latest available version, use the asterisk **\***.
- For a latest minor version, use a format such as **8.\***.

Repeat this block for every package to include.



#### NOTE

There are no differences between packages and modules in the RHEL image builder tool. Both are treated as RPM package dependencies.

## 4.8. SUPPORTED IMAGE CUSTOMIZATIONS

You can customize your image by adding customizations to your blueprint, such as:

- Adding an additional RPM package
- Enabling a service
- Customizing a kernel command line parameter.

Between others. You can use several image customizations within blueprints. By using the customizations, you can add packages and groups to the image that are not available in the default packages. To use these options, configure the customizations in the blueprint and import (push) it to RHEL image builder.

#### Additional resources

- [Blueprint import fails after adding filesystem customization "size"](#) .

### 4.8.1. Selecting a distribution

You can use the **distro** field to select the distribution to use when composing your images, or depsolving the blueprint. If **distro** is left blank it will use the host distribution. If you do not specify a distribution, the blueprint uses the host distribution. In case you upgrade the host operating system, the blueprints with no distribution set build images using the new operating system version. You cannot build an operating system image that differs from the RHEL image builder host.

#### Procedure

- Customize the blueprint with the **distro** to always build the specified RHEL image:

```
name = "blueprint_name"
description = "blueprint_version"
version = "0.1"
distro = "different_minor_version"
```

Replace "**different\_minor\_version**" to build a different minor version, for example, if you want to build a RHEL 9.3 image, use **distro** = "rhel-93". On RHEL 9.3 image, you can build minor versions such as RHEL 9.2, RHEL 8.9 and earlier releases.

### 4.8.2. Selecting a package group

Customize the blueprint with packages and modules. The **name** attribute is a required string. The **version** attribute is an optional string that, if not provided, uses the latest version in the repositories.



#### NOTE

Currently, there are no differences between packages and modules in **osbuild-composer**. Both are treated as an RPM package dependency.

#### Procedure

- Customize your blueprint with a package:

```
[[packages]]
name = "package_group_name"
```

Replace "*package\_group\_name*" with the name of the group. For example, "tmux".

```
[[packages]]
name = "tmux"
version = "2.9a"
```

### 4.8.3. Setting the image hostname

The **customizations.hostname** is an optional string that you can use to configure the final image hostname. This customization is optional, and if you do not set it, the blueprint uses the default hostname.

#### Procedure

- Customize the blueprint to configure the hostname:

```
[customizations]
hostname = "baseimage"
```

#### 4.8.4. Specifying additional users

Add a user to the image, and optionally, set their SSH key. All fields for this section are optional except for the **name**.

##### Procedure

- Customize the blueprint to add a user to the image:

```
[[customizations.user]]
name = "USER-NAME"
description = "USER-DESCRIPTION"
password = "PASSWORD-HASH"
key = "PUBLIC-SSH-KEY"
home = "/home/USER-NAME/"
shell = "/usr/bin/bash"
groups = ["users", "wheel"]
uid = NUMBER
gid = NUMBER
```

The GID is optional and must already exist in the image. Optionally, a package creates it, or the blueprint creates the GID by using the **[[customizations.group]]** entry.

Replace *PASSWORD-HASH* with the actual **password hash**. To generate the **password hash**, use a command such as:

```
$ python3 -c 'import crypt,getpass;pw=getpass.getpass();print(crypt.crypt(pw) if
(pw==getpass.getpass("Confirm: ")) else exit()'
```

Replace the other placeholders with suitable values.

Enter the **name** value and omit any lines you do not need.

Repeat this block for every user to include.

#### 4.8.5. Specifying additional groups

Specify a group for the resulting system image. Both the **name** and the **gid** attributes are mandatory.

##### Procedure

- Customize the blueprint with a group:

```
[[customizations.group]]
name = "GROUP-NAME"
gid = NUMBER
```

Repeat this block for every group to include.

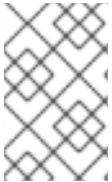
#### 4.8.6. Setting SSH key for existing users

You can use **customizations.sshkey** to set an SSH key for the existing users in the final image. Both **user** and **key** attributes are mandatory.

### Procedure

- Customize the blueprint by setting an SSH key for existing users:

```
[[customizations.sshkey]]
user = "root"
key = "PUBLIC-SSH-KEY"
```



### NOTE

You can only configure the **customizations.sshkey** customization for existing users. To create a user and set an SSH key, see the **User specifications for the resulting system image** customization.

## 4.8.7. Appending a kernel argument

You can append arguments to the boot loader kernel command line. By default, RHEL image builder builds a default kernel into the image. However, you can customize the kernel by configuring it in the blueprint.

### Procedure

- Append a kernel boot parameter option to the defaults:

```
[customizations.kernel]
append = "KERNEL-OPTION"
```

- Define a kernel name to use in an image

```
[customizations.kernel]
name = "KERNEL-rt"
```

## 4.8.8. Setting time zone and NTP

You can customize your blueprint to configure the time zone and the *Network Time Protocol* (NTP). Both **timezone** and **ntpservers** attributes are optional strings. If you do not customize the time zone, the system uses *Universal Time, Coordinated* (UTC). If you do not set NTP servers, the system uses the default distribution.

### Procedure

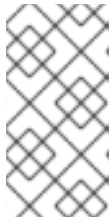
- Customize the blueprint with the **timezone** and the **ntpservers** you want:

```
[customizations.timezone]
timezone = "TIMEZONE"
ntpservers = "NTP_SERVER"
```

For example:



```
[customizations.timezone]
timezone = "US/Eastern"
ntpservers = ["0.north-america.pool.ntp.org", "1.north-america.pool.ntp.org"]
```



#### NOTE

Some image types, such as Google Cloud, already have NTP servers set up. You cannot override it because the image requires the NTP servers to boot in the selected environment. However, you can customize the time zone in the blueprint.

### 4.8.9. Customizing the locale settings

You can customize the locale settings for your resulting system image. Both **language** and the **keyboard** attributes are mandatory. You can add many other languages. The first language you add is the primary language and the other languages are secondary.

#### Procedure

- Set the locale settings:

```
[customizations.locale]
languages = ["LANGUAGE"]
keyboard = "KEYBOARD"
```

For example:

```
[customizations.locale]
languages = ["en_US.UTF-8"]
keyboard = "us"
```

- To list the values supported by the languages, run the following command:

```
$ localectl list-locales
```

- To list the values supported by the keyboard, run the following command:

```
$ localectl list-keymaps
```

### 4.8.10. Customizing firewall

Set the firewall for the resulting system image. By default, the firewall blocks incoming connections, except for services that enable their ports explicitly, such as **sshd**.

If you do not want to use the **[customizations.firewall]** or the **[customizations.firewall.services]**, either remove the attributes, or set them to an empty list []. If you only want to use the default firewall setup, you can omit the customization from the blueprint.



#### NOTE

The Google and OpenStack templates explicitly disable the firewall for their environment. You cannot override this behavior by setting the blueprint.

## Procedure

- Customize the blueprint with the following settings to open other ports and services:

```
[customizations.firewall]
ports = ["PORTS"]
```

Where **ports** is an optional list of strings that contain ports or a range of ports and protocols to open. You can configure the ports by using the following format: **port:protocol** format. You can configure the port ranges by using the **portA-portB:protocol** format. For example:

```
[customizations.firewall]
ports = ["22:tcp", "80:tcp", "imap:tcp", "53:tcp", "53:udp", "30000-32767:tcp", "30000-32767:udp"]
```

You can use numeric ports, or their names from the **/etc/services** to enable or disable port lists.

- Specify which firewall services to enable or disable in the **customizations.firewall.service** section:

```
[customizations.firewall.services]
enabled = ["SERVICES"]
disabled = ["SERVICES"]
```

- You can check the available firewall services:

```
$ firewall-cmd --get-services
```

For example:

```
[customizations.firewall.services]
enabled = ["ftp", "ntp", "dhcp"]
disabled = ["telnet"]
```



### NOTE

The services listed in **firewall.services** are different from the **service-names** available in the **/etc/services** file.

## 4.8.11. Enabling or disabling services

You can control which services to enable during the boot time. Some image types already have services enabled or disabled to ensure that the image works correctly and you cannot override this setup. The **[customizations.services]** settings in the blueprint do not replace these services, but add the services to the list of services already present in the image templates.

## Procedure

- Customize which services to enable during the boot time:

```
[customizations.services]
enabled = ["SERVICES"]
disabled = ["SERVICES"]
```

For example:

```
[customizations.services]
enabled = ["sshd", "cockpit.socket", "httpd"]
disabled = ["postfix", "telnetd"]
```

#### 4.8.12. Specifying a custom filesystem configuration

You can specify a custom filesystem configuration in your blueprints and therefore create images with a specific disk layout, instead of the default layout configuration. By using the non-default layout configuration in your blueprints, you can benefit from:

- Security benchmark compliance
- Protection against out-of-disk errors
- Improved performance
- Consistency with existing setups



#### NOTE

The filesystem customization is not supported for OSTree systems, because OSTree images have their own mount rule, such as read-only.

The blueprint supports the following **mountpoints** and their sub-directories:

- `/` - the root mount point
- `/var`
- `/home`
- `/opt`
- `/srv`
- `/usr`
- `/app`
- `/data`
- `/boot` - The blueprint supports the `/boot` customization from RHEL 8.7 and RHEL 9.1 onward.



#### NOTE

Customizing mount points is only supported from RHEL 9.0 distributions onward, by using the CLI. In earlier distributions, you can only specify the **root** partition as a mount point and specify the **size** argument as an alias for the image size.

If you have more than one partition in the customized image, you can create images with a customized file system partition on LVM and resize those partitions at runtime. To do this, you can specify a customized filesystem configuration in your blueprint and therefore create images with the required disk

layout. The default filesystem layout remains unchanged - if you use plain images without file system customization, and **cloud-init** resizes the root partition.

The blueprint automatically converts the file system customization to an LVM partition.

You can use the custom file blueprint customization to create new files or to replace existing files. The parent directory of the file you specify must exist, otherwise, the image build fails. Ensure that the parent directory exists by specifying it in the **[[customizations.directories]]** customization.



### WARNING

If you combine the files customizations with other blueprint customizations, it might affect the functioning of the other customizations, or it might override the current files customizations.

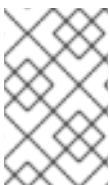
With the **[[customizations.files]]** blueprint customization you can:

- Create new text files.
- Modifying existing files. WARNING: this can override the existing content.
- Set user and group ownership for the file you are creating.
- Set the mode permission in the octal format.

You cannot create or replace the following files:

- **/etc/fstab**
- **/etc/shadow**
- **/etc/passwd**
- **/etc/group**

You can create customized files and directories in your image, by using the **[[customizations.files]]** and the **[[customizations.directories]]** blueprint customizations. You can use these customizations only in the **/etc** directory.



### NOTE

These blueprint customizations are supported by all image types, except the image types that deploy OSTree commits, such as **edge-raw-image**, **edge-installer**, and **edge-simplified-installer**.

**WARNING**

If you use the **customizations.directories** with a directory path which already exists in the image with **mode**, **user** or **group** already set, the image build fails to prevent changing the ownership or permissions of the existing directory.

With the **[[customizations.directories]]** blueprint customization you can:

- Create new directories.
- Set user and group ownership for the directory you are creating.
- Set the directory mode permission in the octal format.
- Ensure that parent directories are created as needed.

With the **[[customizations.files]]** blueprint customization you can:

- Create new text files.
- Modifying existing files. **WARNING:** this can override the existing content.
- Set user and group ownership for the file you are creating.
- Set the mode permission in the octal format.

**NOTE**

You cannot create or replace the following files:

- **/etc/fstab**
- **/etc/shadow**
- **/etc/passwd**
- **/etc/group**

**Procedure**

- Customize the filesystem configuration in your blueprint:

```
[[customizations.filesystem]]
mountpoint = "MOUNTPOINT"
size = MINIMUM-PARTITION-SIZE
```

The **MINIMUM-PARTITION-SIZE** value has no default size format. The blueprint customization supports the following values and units: kB to TB and KiB to TiB. For example, you can define the mount point size in bytes:

```
[[customizations.filesystem]]
mountpoint = "/var"
size = 1073741824
```

- Define the mount point size by using units. For example:

```
[[customizations.filesystem]]
mountpoint = "/opt"
size = "20 GiB"
```

```
[[customizations.filesystem]]
mountpoint = "/boot"
size = "1 GiB"
```

- Create customized directories under the **/etc** directory for your image by using **[[customizations.directories]]**:

```
[[customizations.directories]]
path = "/etc/directory_name"
mode = "octal_access_permission"
user = "user_string_or_integer"
group = "group_string_or_integer"
ensure_parents = boolean
```

The blueprint entries are described as following:

- **path** - Mandatory - enter the path to the directory that you want to create. It must be an absolute path under the **/etc** directory.
- **mode** - Optional - set the access permission on the directory, in the octal format. If you do not specify a permission, it defaults to 0755. The leading zero is optional.
- **user** - Optional - set a user as the owner of the directory. If you do not specify a user, it defaults to **root**. You can specify the user as a string or as an integer.
- **group** - Optional - set a group as the owner of the directory. If you do not specify a group, it defaults to **root**. You can specify the group as a string or as an integer.
- **ensure\_parents** - Optional - Specify whether you want to create parent directories as needed. If you do not specify a value, it defaults to **false**.
- Create customized file under the **/etc** directory for your image by using **[[customizations.files]]**:

```
[[customizations.files]]
path = "/etc/directory_name"
mode = "octal_access_permission"
user = "user_string_or_integer"
group = "group_string_or_integer"
data = "Hello world!"
```

The blueprint entries are described as following:

- **path** - Mandatory - enter the path to the file that you want to create. It must be an absolute path under the **/etc** directory.

- **mode** Optional - set the access permission on the file, in the octal format. If you do not specify a permission, it defaults to 0644. The leading zero is optional.
- **user** - Optional - set a user as the owner of the file. If you do not specify a user, it defaults to **root**. You can specify the user as a string or as an integer.
- **group** - Optional - set a group as the owner of the file. If you do not specify a group, it defaults to **root**. You can specify the group as a string or as an integer.
- **data** - Optional - Specify the content of a plain text file. If you do not specify a content, it creates an empty file.

## 4.9. PACKAGES INSTALLED BY RHEL IMAGE BUILDER

When you create a system image using RHEL image builder, the system installs a set of base package groups.



### NOTE

When you add additional components to your blueprint, ensure that the packages in the components you added do not conflict with any other package components. Otherwise, the system fails to solve dependencies and creating your customized image fails. You can check if there is no conflict between the packages by running the command:

```
# composer-cli blueprints depsolve BLUEPRINT-NAME
```

Table 4.1. Default packages to support image type creation

Image type	Default Packages
ami	checkpolicy, chrony, cloud-init, cloud-utils-growpart, @Core, dhcp-client, gdisk, insights-client, kernel, langpacks-en, net-tools, NetworkManager, redhat-release, redhat-release-eula, rng-tools, rsync, selinux-policy-targeted, tar, yum-utils
openstack	@core, langpacks-en
qcow2	@core, chrony, dnf, kernel, dnf, nfs-utils, dnf-utils, cloud-init, python3-jjsonschema, qemu-guest-agent, cloud-utils-growpart, dracut-norescue, tar, tcpdump, rsync, dnf-plugin-spacewalk, rhn-client-tools, rhnlib, rhnsd, rhn-setup, NetworkManager, dhcp-client, cockpit-ws, cockpit-system, subscription-manager-cockpit, redhat-release, redhat-release-eula, rng-tools, insights-client
tar	polycoreutils, selinux-policy-targeted
vhd	@core, langpacks-en

Image type	Default Packages
<b>vmdk</b>	<b>@core, chrony, cloud-init, firewalld, langpacks-en, open-vm-tools, selinux-policy-targeted</b>
<b>edge-commit</b>	<b>attr, audit, basesystem, bash, bash-completion, chrony, clevis, clevis-dracut, clevis-luks, container-selinux, coreutils, criu, cryptsetup, curl, dnsmasq, dosfstools, dracut-config-generic, dracut-network, e2fsprogs, firewalld, fuse-overlayfs, fwupd, glibc, glibc-minimal-langpack, gnupg2, greenboot, gzip, hostname, ima-evm-utils, iproute, iptables, iputils, keyutils, less, lvm2, NetworkManager, NetworkManager-wifi, NetworkManager-wwan, nss-altfiles, openssh-clients, openssh-server, passwd, pinentry, platform-python, podman, policycoreutils, policycoreutils-python-utils, polkit, procps-ng, redhat-release, rootfiles, rpm, rpm-ostree, rsync, selinux-policy-targeted, setools-console, setup, shadow-utils, shadow-utils, skopeo, slirp4netns, sudo, systemd, tar, tmux, traceroute, usbguard, util-linux, vim-minimal, wpa_supplicant, xz</b>
<b>edge-container</b>	<b>dnf, dosfstools, e2fsprogs, glibc, lorax-templates-generic, lorax-templates-rhel, lvm2, policycoreutils, python36, python3-iniparse, qemu-img, selinux-policy-targeted, systemd, tar, xfsprogs, xz</b>



Image type	Default Packages
edge-installer	aajohan-comfortaa-fonts, abattis-cantarell-fonts, alsa-firmware, alsa-tools-firmware, anaconda, anaconda-install-env-deps, anaconda-widgets, audit, bind-utils, bitmapfangsongti-fonts, bzip2, cryptsetup, dbus-x11, dejavu-sans-fonts, dejavu-sans-mono-fonts, device-mapper-persistent-data, dnf, dump, ethtool, fcoe-utils, ftp, gdb-gdbserver, gdisk, gfs2-utils, glibc-all-langpacks, google-noto-sans-cjk-ttc-fonts, gsettings-desktop-schemas, hdparm, hexedit, initscripts, ipmitool, iwl3945-firmware, iwl4965-firmware, iwl6000g2a-firmware, iwl6000g2b-firmware, jomolhari-fonts, kacst-farsi-fonts, kacst-qurn-fonts, kbd, kbd-misc, kdump-anaconda-addon, khmeros-base-fonts, libblockdev-lvm-dbus, libertas-sd8686-firmware, libertas-sd8787-firmware, libertas-usb8388-firmware, libertas-usb8388-olpc-firmware, libibverbs, libreport-plugin-bugzilla, libreport-plugin-reportuploader, libreport-rhel-anaconda-bugzilla, librsvg2, linux-firmware, lklug-fonts, lldpad, lohit-assamese-fonts, lohit-bengali-fonts, lohit-devanagari-fonts, lohit-gujarati-fonts, lohit-gurmukhi-fonts, lohit-kannada-fonts, lohit-odia-fonts, lohit-tamil-fonts, lohit-telugu-fonts, lsof, madan-fonts, metacity, mtr, mt-st, net-tools, nmap-ncat, nm-connection-editor, nss-tools, openssh-server, oscap-anaconda-addon, pciutils, perl-interpreter, pigz, python3-pyatspi, rdma-core, redhat-release-eula, rpm-ostree, rsync, rsyslog, sg3_utils, sil-abyssinica-fonts, sil-padauk-fonts, sil-scheherazade-fonts, smartmontools, smc-meera-fonts, spice-vdagent, strace, system-storage-manager, thai-scalable-waree-fonts, tigervnc-server-minimal, tigervnc-server-module, udisks2, udisks2-iscsi, usbutils, vim-minimal, volume_key, wget, xfsdump, xorg-x11-drivers,xorg-x11-fonts-misc,xorg-x11-server-utils,xorg-x11-server-Xorg, xorg-x11-xauth

Image type	Default Packages
<b>edge-simplified-installer</b>	<b>attr, basesystem, binutils, bsdtar, clevis-dracut, clevis-luks, cloud-utils-growpart, coreos-installer, coreos-installer-dracut, coreutils, device-mapper-multipath, dnsmasq, dosfstools, dracut-live, e2fsprogs, fcoe-utils, fdo-init, gzip, ima-evm-utils, iproute, iptables, iputils, iscsi-initiator-utils, keyutils, lldpad, lvm2, passwd, policycoreutils, policycoreutils-python-utils, procps-ng, rootfiles, setools-console, sudo, traceroute, util-linux</b>
<b>image-installer</b>	<b>anaconda-dracut, curl, dracut-config-generic, dracut-network, hostname, iwl100-firmware, iwl1000-firmware, iwl105-firmware, iwl135-firmware, iwl2000-firmware, iwl2030-firmware, iwl3160-firmware, iwl5000-firmware, iwl5150-firmware, iwl6000-firmware, iwl6050-firmware, iwl7260-firmware, kernel, less, nfs-utils, openssh-clients, ostree, plymouth, prefixdevname, rng-tools, rpcbind, selinux-policy-targeted, systemd, tar, xfsprogs, xz</b>
<b>edge-raw-image</b>	<b>dnf, dosfstools, e2fsprogs, glibc, lorax-templates-generic, lorax-templates-rhel, lvm2, policycoreutils, python36, python3-iniparse, qemu-img, selinux-policy-targeted, systemd, tar, xfsprogs, xz</b>
<b>gce</b>	<b>@core, langpacks-en, acpid, dhcp-client, dnf-automatic, net-tools, python3, rng-tools, tar, vim</b>

#### Additional resources

- [RHEL image builder description](#)

## 4.10. ENABLED SERVICES ON CUSTOM IMAGES

When you use image builder to configure a custom image, the default services that the image uses are determined by the following:

- The RHEL release on which you use the **osbuild-composer** utility
- The image type

For example, the **ami** image type enables the **sshd**, **chronyd**, and **cloud-init** services by default. If these services are not enabled, the custom image does not boot.

**Table 4.2.** Enabled services to support image type creation

Image type	Default enabled Services
<b>ami</b>	sshd, cloud-init, cloud-init-local, cloud-config, cloud-final
<b>openstack</b>	sshd, cloud-init, cloud-init-local, cloud-config, cloud-final
<b>qcow2</b>	cloud-init
<b>rhel-edge-commit</b>	No extra service enables by default
<b>tar</b>	No extra service enables by default
<b>vhd</b>	sshd, chronyd, waagent, cloud-init, cloud-init-local, cloud-config, cloud-final
<b>vmdk</b>	sshd, chronyd, vmtoolsd, cloud-init

Note: You can customize which services to enable during the system boot. However, the customization does not override services enabled by default for the mentioned image types.

#### Additional resources

- [Supported Image Customizations](#)

## CHAPTER 5. CREATING SYSTEM IMAGES BY USING RHEL IMAGE BUILDER WEB CONSOLE INTERFACE

RHEL image builder is a tool for creating custom system images. To control RHEL image builder and create your custom system images, you can use the web console interface. Note that the [command-line interface](#) is the currently preferred alternative, because it offers more features.

### 5.1. ACCESSING THE RHEL IMAGE BUILDER DASHBOARD IN THE RHEL WEB CONSOLE

With the **cockpit-composer** plugin for the RHEL web console, you can manage image builder blueprints and composes using a graphical interface.

#### Prerequisites

- You must have root access to the system.
- You installed RHEL image builder.
- You installed the **cockpit-composer** package.

#### Procedure

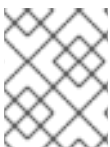
1. On the host, open **https://<\_localhost\_>:9090/** in a web browser.
2. Log in to the web console as the root user.
3. To display the RHEL image builder controls, click the **Image Builder** button, in the upper-left corner of the window.  
The RHEL image builder dashboard opens, listing existing blueprints, if any.

#### Additional resources

- [Managing systems using the RHEL 9 web console](#)

### 5.2. CREATING A BLUEPRINT IN THE WEB CONSOLE INTERFACE

Creating a blueprint is a necessary step before creating the customized RHEL system image. All the customizations are optional.



#### NOTE

These blueprint customizations are available for Red Hat Enterprise Linux 9.2 or later versions and Red Hat Enterprise Linux 8.8 or later versions.

#### Prerequisites

- You have opened the RHEL image builder app from the web console in a browser. See [Accessing RHEL image builder GUI in the RHEL web console](#) .

#### Procedure

1. Click **Create Blueprint** in the upper-right corner.  
A dialog wizard with fields for the blueprint name and description opens.
2. On the **Details** page:
  - a. Enter the name of the blueprint and, optionally, its description.
  - b. Click **Next**.
3. Optional: In the **Packages** page:
  - a. On the **Available packages** search, enter the package name
  - b. Click the > button to move it to the **Chosen packages** field.
  - c. Repeat the previous steps to search and include as many packages as you want.
  - d. Click **Next**.

**NOTE**

These customizations are all optional unless otherwise specified.

4. On the **Kernel** page, enter a kernel name and the command-line arguments.
5. On the **File system** page, you can select **Use automatic partitioning** or **Manually configure partitions** for your image file system. For manually configuring the partitions, complete the following steps:
  - a. Click the **Manually configure partitions** button.  
The **Configure partitions** section opens, showing the configuration based on Red Hat standards and security guides.
  - b. From the dropdown menu, provide details to configure the partitions:
    - i. For the **Mount point** field, select one of the following mount point type options:
      - / - the root mount point
      - /var
      - /home
      - /opt
      - /srv
      - /usr
      - /app
      - /data
      - /tmp
      - /usr/local

You can also add an additional path to the **Mount point**, such as **/tmp**. For example: **/var** as a prefix and **/tmp** as an additional path results in **/var/tmp**.

**NOTE**

Depending on the Mount point type you choose, the file system type changes to **xfs**.

- ii. For the **Minimum size partition** field of the file system, enter the needed minimum partition size. In the Minimum size dropdown menu, you can use common size units such as **GiB**, **MiB**, or **KiB**. The default unit is **GiB**.

**NOTE**

**Minimum size** means that RHEL image builder can still increase the partition sizes, in case they are too small to create a working image.

- c. To add more partitions, click the **Add partition** button. If you see the following error message: **Duplicate partitions: Only one partition at each mount point can be created.**, you can:
    - i. Click the **Remove** button to remove the duplicated partition.
    - ii. Choose a new mount point for the partition you want to create.
  - d. After you finish the partitioning configuration, click **Next**.
6. On the **Services** page, you can enable or disable services:
    - a. Enter the service names you want to enable or disable, separating them by a comma, by space, or by pressing the **Enter** key. Click **Next**.
  7. On the **Firewall** page, set up your firewall setting:
    - a. Enter the **Ports**, and the firewall services you want to enable or disable.
    - b. Click the **Add zone** button to manage your firewall rules for each zone independently. Click **Next**.
  8. On the **Users** page, add a users by following the steps:
    - a. Click **Add user**.
    - b. Enter a **Username**, a **password**, and a **SSH key**. You can also mark the user as a privileged user, by clicking the **Server administrator** checkbox. Click **Next**.
  9. On the **Groups** page, add groups by completing the following steps:
    - a. Click the **Add groups** button:
      - i. Enter a **Group name** and a **Group ID**. You can add more groups. Click **Next**.
  10. On the **SSH keys** page, add a key:
    - a. Click the **Add key** button.
      - i. Enter the SSH key.

- ii. Enter a **User**. Click **Next**.
11. On the **Timezone** page, set your time zone settings:
  - a. On the **Timezone** field, enter the time zone you want to add to your system image. For example, add the following time zone format: "US/Eastern".  
If you do not set a time zone, the system uses Universal Time, Coordinated (UTC) as default.
  - b. Enter the **NTP** servers. Click **Next**.
12. On the **Locale** page, complete the following steps:
  - a. On the **Keyboard** search field, enter the package name you want to add to your system image. For example: ["en\_US.UTF-8"].
  - b. On the **Languages** search field, enter the package name you want to add to your system image. For example: "us". Click **Next**.
13. On the **Others** page, complete the following steps:
  - a. On the **Hostname** field, enter the hostname you want to add to your system image. If you do not add a hostname, the operating system determines the hostname.
  - b. Mandatory only for the Simplifier Installer image: On the **Installation Devices** field, enter a valid node for your system image. For example: **dev/sda1**. Click **Next**.
14. Mandatory only when building FIDO images: On the **FIDO device onboarding** page, complete the following steps:
  - a. On the **Manufacturing server URL** field, enter the following information:
    - i. On the **DIUN public key insecure** field, enter the insecure public key.
    - ii. On the **DIUN public key hash** field, enter the public key hash.
    - iii. On the **DIUN public key root certs** field, enter the public key root certs. Click **Next**.
15. On the **OpenSCAP** page, complete the following steps:
  - a. On the **Datastream** field, enter the **datastream** remediation instructions you want to add to your system image.
  - b. On the **Profile ID** field, enter the **profile\_id** security profile you want to add to your system image. Click **Next**.
16. Mandatory only when building Ignition images: On the **Ignition** page, complete the following steps:
  - a. On the **Firstboot URL** field, enter the package name you want to add to your system image.
  - b. On the **Embedded Data** field, drag or upload your file. Click **Next**.
17. . On the **Review** page, review the details about the blueprint. Click **Create**.

The RHEL image builder view opens, listing existing blueprints.

## 5.3. IMPORTING A BLUEPRINT IN THE RHEL IMAGE BUILDER WEB CONSOLE INTERFACE

You can import and use an already existing blueprint. The system automatically resolves all the dependencies.

### Prerequisites

- You have opened the RHEL image builder app from the web console in a browser.
- You have a blueprint that you want to import to use in the RHEL image builder web console interface.

### Procedure

1. On the RHEL image builder dashboard, click **Import blueprint**. The **Import blueprint** wizard opens.
2. From the **Upload** field, either drag or upload an existing blueprint. This blueprint can be in either **TOML** or **JSON** format.
3. Click **Import**. The dashboard lists the blueprint you imported.

### Verification

When you click the blueprint you imported, you have access to a dashboard with all the customizations for the blueprint that you imported.

- To verify the packages that have been selected for the imported blueprint, navigate to the **Packages** tab.
  - To list all the package dependencies, click **All**. The list is searchable and can be ordered.

### Next steps

- Optional: To modify any customization:
  - From the **Customizations** dashboard, click the customization you want to make a change. Optionally, you can click **Edit blueprint** to navigate to all the available customization options.

### Additional resources

- [Creating a system image by using RHEL image builder in the web console interface](#) .

## 5.4. EXPORTING A BLUEPRINT FROM THE RHEL IMAGE BUILDER WEB CONSOLE INTERFACE

You can export a blueprint to use the customizations in another system. You can export the blueprint in the **TOML** or in the **JSON** format. Both formats work on the CLI and also in the API interface.

### Prerequisites

- You have opened the RHEL image builder app from the web console in a browser.



- You have a blueprint that you want to export.

### Procedure

1. On the image builder dashboard, select the blueprint you want to export.
2. Click **Export blueprint**. The **Export blueprint** wizard opens.
3. Click the **Export** button to download the blueprint as a file or click the **Copy** button to copy the blueprint to the clipboard.
  - a. Optionally, click the **Copy** button to copy the blueprint.

### Verification

- Open the exported blueprint in a text editor to inspect and review it.

## 5.5. CREATING A SYSTEM IMAGE BY USING RHEL IMAGE BUILDER IN THE WEB CONSOLE INTERFACE

You can create a customized RHEL system image from a blueprint by completing the following steps.

### Prerequisites

- You opened the RHEL image builder app from the web console in a browser.
- You created a blueprint.

### Procedure

1. In the RHEL image builder dashboard, click the blueprint tab.
2. On the blueprint table, find the blueprint you want to build an image.
3. On the right side of the chosen blueprint, click **Create Image**. The **Create image** dialog wizard opens.
4. On the **Image output** page, complete the following steps:
  - a. From the **Select a blueprint** list, select the image type you want.
  - b. From the **Image output type** list, select the image output type you want. Depending on the image type you select, you need to add further details.
5. Click **Next**.
6. On the **Review** page, review the details about the image creation and click **Create image**. The image build starts and takes up to 20 minutes to complete.

### Verification

After the image finishes building, you can:

- Download the image.
  - On the RHEL image builder dashboard, click the **Node options (■)** menu and select **Download image**.

**Download image.**

- Download the logs of the image to inspect the elements and verify if any issue is found.
  - On the RHEL image builder dashboard, click the **Node options (■)** menu and select **Download logs**.

## CHAPTER 6. CREATING A BOOT ISO INSTALLER IMAGE WITH RHEL IMAGE BUILDER

You can use RHEL image builder to create bootable ISO Installer images. These images consist of a **.tar** file that has a root file system. You can use the bootable ISO image to install the file system to a bare metal server.

RHEL image builder builds a manifest that creates a boot ISO that contains a root file system. To create the ISO image, select the image type **image-installer**. RHEL image builder builds a **.tar** file with the following content:

- a standard Anaconda installer ISO
- an embedded RHEL system tar file
- a default Kickstart file that installs the commit with minimal default requirements

The created installer ISO image includes a pre-configured system image that you can install directly to a bare metal server.

### 6.1. CREATING A BOOT ISO INSTALLER IMAGE USING THE RHEL IMAGE BUILDER CLI

You can create a customized boot ISO installer image by using the RHEL image builder command-line interface. As a result, image builder builds an **.iso** file that contains a **.tar** file, which you can install for the Operating system. The **.iso** file is set up to boot Anaconda and install the **.tar** file to set up the system. You can use the created ISO image file on a hard disk or to boot in a virtual machine, for example, in an HTTP Boot or a USB installation.



#### WARNING

The Installer (**.iso**) image type does not accept partitions customization. If you try to manually configure the filesystem customization, it is not applied to any system built by the Installer image. Mounting an ISO image built with RHEL image builder file system customizations causes an error in the Kickstart, and the installation does not reboot automatically. For more information, see [Automate a RHEL ISO installation generated by image builder](#) and [Automate a RHEL ISO installation generated by image builder](#).

#### Prerequisites

- You have created a blueprint for the image and customized it with a user included and pushed it back into RHEL image builder. See [Blueprint customizations](#).

#### Procedure

1. Create the ISO image:

```
# composer-cli compose start BLUEPRINT-NAME image-installer
```

- *BLUEPRINT-NAME* with name of the blueprint you created
- *image-installer* is the image type  
The compose process starts in the background and the UUID of the compose is shown. Wait until the compose is finished. This might take several minutes.

2. Check the status of the compose:

```
# composer-cli compose status
```

A finished compose shows a status value of **FINISHED**.

3. Identify the compose in the list by its UUID.

```
# composer-cli compose list
```

4. After the compose is finished, download the created image file to the current directory:

```
# composer-cli compose image UUID
```

Replace *UUID* with the UUID value obtained in the previous steps.

RHEL image builder builds a **.iso** file that contains a **.tar** file. The **.tar** file is the image that will be installed for the Operating system. The **.iso** is set up to boot Anaconda and install the **.tar** file to set up the system.

## Next steps

In the directory where you downloaded the image file.

1. Locate the **.iso** image you downloaded.
2. Mount the ISO.

```
$ mount -o ro path_to_ISO /mnt
```

You can find the **.tar** file at the **/mnt/liveimg.tar.gz** directory.

3. List the **.tar** file content:

```
$ tar ztvf /mnt/liveimg.tar.gz
```

## Additional resources

- [Creating system images with RHEL image builder command-line interface](#)
- [Creating a bootable installation medium for RHEL](#)

## 6.2. CREATING A BOOT ISO INSTALLER IMAGE BY USING RHEL IMAGE BUILDER IN THE GUI

You can build a customized boot ISO installer image by using the RHEL image builder GUI. You can use the resulting ISO image file on a hard disk or boot it in a virtual machine. For example, in an HTTP Boot or a USB installation.



## WARNING

The Installer (**.iso**) image type does not accept partitions customization. If you try to manually configure the filesystem customization, it is not applied to any system built by the Installer image. Mounting an ISO image built with RHEL image builder file system customizations causes an error in the Kickstart, and the installation does not reboot automatically. For more information, see [Automate a RHEL ISO installation generated by image builder](#) and [Automate a RHEL ISO installation generated by image builder](#).

## Prerequisites

- You have opened the RHEL image builder app from the web console in a browser.
- You have created a blueprint for your image. See [Creating a RHEL image builder blueprint in the web console interface](#).

## Procedure

1. On the RHEL image builder dashboard, locate the blueprint that you want to use to build your image. Optionally, enter the blueprint name or a part of it into the search box at upper left, and click **Enter**.
2. On the right side of the blueprint, click the corresponding **Create Image** button. The **Create image** dialog wizard opens.
3. On the **Create image** dialog wizard:
  - a. In the **Image Type** list, select **"RHEL Installer (.iso)"**.
  - b. Click **Next**.
  - c. On the **Review** tab, click **Create**.  
RHEL image builder adds the compose of a RHEL ISO image to the queue.

After the process is complete, you can see the image build complete status. RHEL image builder creates the ISO image.

## Verification

After the image is successfully created, you can download it.

1. Click **Download** to save the **"RHEL Installer (.iso)"** image to your system.
2. Navigate to the folder where you downloaded the **"RHEL Installer (.iso)"** image.
3. Locate the .tar image you downloaded.
4. Extract the **"RHEL Installer (.iso)"** image content.

```
$ tar -xf content.tar
```

### Additional resources

- [Creating a RHEL image builder blueprint in the web console interface](#)
- [Creating system images with RHEL image builder command-line interface](#)
- [Creating a bootable installation medium for RHEL](#)

## 6.3. INSTALLING A BOOTABLE ISO TO A MEDIA AND BOOTING IT

Install the bootable ISO image you created by using RHEL image builder to a bare metal system.

### Prerequisites

- You created the bootable ISO image by using RHEL image builder. See [Creating a boot ISO installer image using the RHEL image builder in the command-line interface](#).
- You have downloaded the bootable ISO image.
- You installed the **dd** tool.
- You have a USB flash drive with enough capacity for the ISO image. The required size varies depending on the packages you selected in your blueprint, but the recommended minimum size is 8 GB.

### Procedure

1. Write the bootable ISO image directly to the USB drive using the **dd** tool. For example:

```
dd if=installer.iso of=/dev/sdX
```

Where **installer.iso** is the ISO image file name and **/dev/sdX** is your USB flash drive device path.

2. Insert the flash drive into a USB port of the computer you want to boot.
3. Boot the ISO image from the USB flash drive.  
When the installation environment starts, you might need to complete the installation manually, similarly to the default Red Hat Enterprise Linux installation.

### Additional resources

- [Booting the installation](#)
- [Customizing your installation](#)
- [Creating a bootable USB device on Linux](#)

## CHAPTER 7. CREATING PRE-HARDENED IMAGES WITH RHEL IMAGE BUILDER OPENSAP INTEGRATION

RHEL image builder on-premise supports the OpenSCAP integration. This integration enables the production of pre-hardened RHEL images. By setting up a blueprint, you can perform the following actions:

- Customize it with a set of predefined security profiles
- Add a set of packages or add-on files
- Build a customized RHEL image ready to deploy on your chosen platform that is more suitable to your environment

Red Hat provides regularly updated versions of the security hardening profiles that you can choose when you build your systems so that you can meet your current deployment guidelines.



### WARNING

RHEL image builder does not include support for FIPS boot mode. Consequently, OpenSCAP profiles that require the FIPS mode to be enabled, such as DISA STIG, are not supported.

### 7.1. DIFFERENCES BETWEEN KICKSTART AND PRE-HARDENED IMAGES

For the traditional image creation using a Kickstart file, you have to choose which packages you must install and ensure that the system is not affected by a vulnerability. With the RHEL image builder OpenSCAP integration, you can build security hardened images. During the image build process an OSBuild **oscap remediation stage** runs the **OpenSCAP** tool in the chroot, on the filesystem tree. The **OpenSCAP** tool runs the standard evaluation for the profile you choose and applies the remediations to the image. With this, you can build a more completely hardened image, if you compare it to running the remediation on a live system.

### 7.2. INSTALLING OPENSAP

Install the OpenSCAP tool to have access to SCAP tools to help you to create standard security checklists for your systems.

#### Procedure

1. Install OpenSCAP on your system:

```
# *dnf install openscap-scanner*
```

2. Install **scap-security-guide** package:

```
# *dnf install scap-security-guide*
```

After the installation is completed you can start using the **oscap** command line tool. The SCAP content will be installed in the `/usr/share/xml/scap/ssg/content/` directory.

### 7.3. THE OPENSAP BLUEPRINT CUSTOMIZATION

With the OpenSCAP support for blueprint customization, you can create blueprints and then use them to build your own pre-hardened images. To create a pre-hardened image you can customize the mount points and configure the file system layout according to the selected security profile. After you select the OpenSCAP profile, the OpenSCAP blueprint customization configures the image to trigger the remediation during the image build with the selected profile. During the image build, OpenSCAP applies a first-boot remediation.

To use the OpenSCAP blueprint customization in your image blueprints, you need to provide the following information:

- The datastream path to the **datastream** remediation instructions. The datastream path is located in the `/usr/share/xml/scap/ssg/content/` directory.
- The **profile\_id** of the required security profile. The value of the **profile\_id** field accepts both the long and short forms, for example, the following are acceptable: **cis** or **xccdf\_org.ssgproject.content\_profile\_cis**. See [SCAP Security Guide profiles supported in RHEL 9](#) for more details.

The following is a blueprint with OpenSCAP customization example:

```
[customizations]
datastream = "/usr/share/xml/scap/ssg/content/ssg-rhel8-ds.xml"
profile_id = "xccdf_org.ssgproject.content_profile_cis"
```

The most common SCAP file type is an SCAP source datastream. You can find more details about the SCAP source datastream from the **scap-security-guide** package, enter the command:

```
$ oscap info /usr/share/xml/scap/ssg/content/ssg-rhel8-ds.xml
```

The **oscap** tool runs on the image tree to perform an offline scan of a file system that is mounted at an arbitrary path. You can use it for scanning of custom objects that are not supported by **oscap-docker** or **oscap-vm**, such as containers in formats other than Docker. **oscap-chroot** mimics the usage and options of the **oscap** tool.

RHEL image builder generates the necessary configurations for the **osbuild** stage based on your blueprint customization. Additionally, RHEL image builder adds two packages to the image:

- **openscap-scanner** - the **OpenSCAP** tool.
- **scap-security-guide** - package which contains the remediation instructions.



#### NOTE

The remediation stage uses the **scap-security-guide** package for the datastream because this package is installed on the image by default. If you want to use a different datastream, add the necessary package to the blueprint, and specify the path to the datastream in the **oscap** configuration.

#### Additional resources



- [SCAP Security Guide profiles supported in RHEL 9](#) .

## 7.4. CREATING A PRE-HARDENED IMAGE WITH RHEL IMAGE BUILDER

With the OpenSCAP and RHEL image builder integration, you can create pre-hardened images that you can deploy in a VM.

### Prerequisite

- You are logged in as the root user or a user who is a member of the **welder** group.

### Procedure

1. Create a blueprint in the TOML format, with the following content:

```
name = "blueprint_name"
description = "blueprint_description"
version = "0.0.1"
modules = []
groups = []
distro = ""

[customizations]
[[customizations.user]]
name = "scap-security-guide"
description = "Admin account"
password = secure_password_hash
key = ssh-key
home = "/home/scap-security-guide"
group = ["wheel"]

[[customizations.filesystem]]
mountpoint = "/tmp"
size = "20 GiB"

[customizations.openscap]
datastream = "/usr/share/xml/scap/ssg/content/ssg-rhel8-ds.xml "
profile_id = "cis"
```

2. Start the build of a OpenSCAP image:

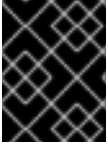
```
# composer-cli compose start blueprint_name qcow2
```

Where *blueprint\_name* is the blueprint name.

After the image build is ready, you can use your pre-hardened image on your deployments. See [Creating a virtual machine](#).

### Verification

After you deploy your pre-hardened image in a VM, you can perform a configuration compliance scan to verify that the image is aligned to the selected security profile.



## IMPORTANT

Performing a configuration compliance scanning does not guarantee the system is compliant. For more information, see [Configuration compliance scanning](#).

1. Connect to the image using SSH.
2. Run the **oscap** scanner.

```
# scap-workbench
```

3. On the SCAP Workbench:
  - a. Select the version of the system you want to scan. Click **Load content**.
  - b. Select the profile you want to scan and click **Scan**. OpenSCAP checks all the requirements for the system.
  - c. Click **Scan** to scan your system with the selected profile.
  - d. After the scan finishes, click **Show Report**.

### Additional resources

- [Using SCAP Workbench to scan and remediate the system](#) .
- [Scanning the system for configuration compliance and vulnerabilities](#) .

## CHAPTER 8. PREPARING AND DEPLOYING A KVM GUEST IMAGE BY USING RHEL IMAGE BUILDER

Use RHEL image builder to create a **.qcow2** purpose-built that you can deploy on a Kernel-based Virtual Machine (KVM) based hypervisor.

Creating a customized KVM guest image involves the following high-level steps:

1. Create a blueprint for the **.qcow2** image.
2. Create a **.qcow2** image by using RHEL image builder.
3. Create a virtual machine from the KVM guest image.

### 8.1. CREATING CUSTOMIZED KVM GUEST IMAGES BY USING RHEL IMAGE BUILDER

You can create a customized **.qcow2** KVM guest image by using RHEL image builder. The following procedure shows the steps on the GUI, but you can also use the CLI.

#### Prerequisites

- You must be in the **root** or **weldr** group to access the system.
- The **cockpit-composer** package is installed.
- On a RHEL system, you have opened the RHEL image builder dashboard of the web console.
- You have created a blueprint. See [Creating a blueprint in the web console interface](#) .

#### Procedure

1. Click the blueprint name you created.
2. Select the tab **Images**.
3. Click **Create Image** to create your customized image. The **Create Image** window opens.
4. From the **Type** drop-down menu list, select **QEMU Image(.qcow2)**.
5. Set the size that you want the image to be when instantiated and click **Create**.
6. A small pop-up on the upper right side of the window informs you that the image creation has been added to the queue. After the image creation process is complete, you can see the **Image build complete** status.

#### Verification

- Click the breadcrumbs icon and select the **Download** option. RHEL image builder downloads the KVM guest image **.qcow2** file at your default download location.

#### Additional resources

- [Creating a blueprint in the web console interface](#) .

## 8.2. CREATING A VIRTUAL MACHINE FROM A KVM GUEST IMAGE

With RHEL image builder, you can build a **.qcow2** image, and use a KVM guest image to create a VM. The KVM guest images created using RHEL image builder already have **cloud-init** installed and enabled.

### Prerequisites

- You created a **.qcow2** image by using RHEL image builder. See [Creating a blueprint in the web console interface](#).
- You have the **qemu-kvm** package installed on your system. You can check if the **/dev/kvm** device is available on your system, and virtualization features are enabled in the BIOS.
- You have the **libvirt** and **virt-install** packages installed on your system.
- You have the **genisoimage** utility, that is provided by the **xorriso** package, installed on your system.

### Procedure

1. Move the **.qcow2** image that you created by using RHEL image builder to the **/var/lib/libvirt/images/** directory.
2. Create a directory, for example, **cloudinitiso** and navigate to this newly created directory:

```
$ mkdir cloudinitiso
$ cd cloudinitiso
```

3. Create a file named **meta-data**. Add the following information to this file:

```
instance-id: citest
local-hostname: vmname
```

4. Create a file named **user-data**. Add the following information to the file:

```
#cloud-config
user: admin
password: password
chpasswd: {expire: False}
ssh_pwauth: True
ssh_authorized_keys:
- ssh-rsa AAA...fhHQ== your.email@example.com
```

**ssh\_authorized\_keys** is your SSH public key. You can find your SSH public key in **~/.ssh/<id\_rsa.pub>**.

5. Use the **genisoimage** utility to create an ISO image that includes the **user-data** and **meta-data** files.

```
# genisoimage -output cloud-init.iso -volid cidata -joliet -rock user-data meta-data

I: -input-charset not specified, using utf-8 (detected in locale settings)
Total translation table size: 0
Total rockridge attributes bytes: 331
Total directory bytes: 0
```

```

Path table size(bytes): 10
Max brk space used 0
183 extents written (0 MB)

```

6. Create a new VM from the KVM Guest Image using the **virt-install** command. Include the ISO image you created on step 4 as an attachment to the VM image.

```

# virt-install \
  --memory 4096 \
  --vcpus 4 \
  --name myvm \
  --disk rhel-9-x86_64-kvm.qcow2,device=disk,bus=virtio,format=qcow2 \
  --disk cloud-init.iso,device=cdrom \
  --os-variant rhel 9 \
  --virt-type kvm \
  --graphics none \
  --import

```

- `--graphics none` - means it is a headless RHEL 9 VM.
- `--vcpus 4` - means that it uses 4 virtual CPUs.
- `--memory 4096` - means it uses 4096 MB RAM.

7. The VM installation starts:

```

Starting install...
Connected to domain mytestcivm
...
[ OK ] Started Execute cloud user/final scripts.
[ OK ] Reached target Cloud-init target.

Red Hat Enterprise Linux 9 (Ootpa)
Kernel 4.18.0-221.el8.x86_64 on an x86_64

```

## Verification

After the boot is complete, the VM shows a text login interface. To log in to the local console of the VM, use the details from the **user-data** file:

1. Enter **admin** as a username and press **Enter**.
2. Enter **password** as password and press **Enter**.  
After the login authentication is complete, you have access to the VM using the CLI.

## Additional resources

- [Enabling virtualization.](#)
- [Configuring and managing cloud-init for RHEL 9 .](#)
- [cloud-init significant directories and files.](#)

## CHAPTER 9. PUSHING A CONTAINER TO A REGISTRY AND EMBEDDING IT INTO AN IMAGE

With RHEL image builder, you can build security hardened images using the OpenSCAP tool. You can take advantage of the support for container customization in the blueprints to create a container and embed it directly into the image you create.

### 9.1. BLUEPRINT CUSTOMIZATION TO EMBED A CONTAINER INTO AN IMAGE

To embed a container from [registry.access.redhat.com](https://registry.access.redhat.com) registry, you must add a container customization to your blueprint. For example:

```
[[containers]]
source = "registry.access.redhat.com/ubi9/ubi:latest"
name = "local-name"
tls-verify = true
```

- **source** - Mandatory field. It is a reference to the container image at a registry. This example uses the **registry.access.redhat.com** registry. You can specify a tag version. The default tag version is **latest**.
- **name** - The name of the container in the local registry.
- **tls-verify** - Boolean field. The **tls-verify** boolean field controls the transport layer security. The default value is **true**.  
RHEL image builder pulls the container during the image build and stores the container into the image. The default local container storage location depends on the image type, so that all support **container-tools**, such as Podman, are able to work with it. The embedded containers are not started. To access protected container resources, you can use a **containers-auth.json** file.

### 9.2. THE CONTAINER REGISTRY CREDENTIALS

The **osbuild-worker** service is responsible for the communication with the container registry. To enable that, you can set up the **/etc/osbuild-worker/osbuild-worker.toml** configuration file.



#### NOTE

After setting the **/etc/osbuild-worker/osbuild-worker.toml** configuration file, you must restart the **osbuild-worker** service, because it reads the **/etc/osbuild-worker/osbuild-worker.toml** configuration file only once, during the **osbuild-worker** service start.

The **/etc/osbuild-worker/osbuild-worker.toml** configuration file has a **containers** section with an **auth\_field\_path** entry that is a string referring to a path of a **containers-auth.json** file to be used for accessing protected resources. The container registry credentials are only used to pull a container image from a registry, when embedding the container into the image.

For example:

```
[containers]
auth_file_path = "/etc/osbuild-worker/containers-auth.json"
```

## Additional resources

- The **containers-auth.json** man page

## 9.3. PUSHING A CONTAINER ARTIFACT DIRECTLY TO A CONTAINER REGISTRY

You can push container artifacts, such as RHEL for Edge container images directly, directly to a container registry after you build it, by using the RHEL image builder CLI.

### Prerequisites

- Access to [quay.io registry](https://quay.io). This example uses the **quay.io** container registry as a target registry, but you can use a container registry of your choice.

### Procedure

1. Set up a **registry-config.toml** file to select the container provider. The credentials are optional.

```
provider = "container_provider"

[settings]
tls_verify = false
username = "admin"
password = "your_password"
```

2. Create a blueprint in the **.toml** format. This is a blueprint for the container in which you install an **nginx** package into the blueprint.

```
name = "simple-container"
description = "Simple RHEL container"
version = "0.0.1"

[[packages]]
name = "nginx"
version = ""
```

3. Push the blueprint:

```
# composer-cli blueprints push blueprint.toml
```

4. Build the container image, by passing the registry and the repository to the **composer-cli** tool as arguments.

```
# composer-cli compose start simple-container container "quay.io:8080/osbuild/repository"
registry-config.toml
```

- `simple-container` - is the blueprint name.
- `container` - is the image type.
- `"quay.io:8080/osbuild/repository"` - **quay.io** is the target registry, **osbuild** is the organization and **repository** is the location to push the container when it finishes building. Optionally, you can set a **tag**. If you do not set a value for **:tag**, it uses **:latest** tag by default.

**NOTE**

Building the container image takes time because of resolving dependencies of the customized packages.

5. After the image build finishes, the container you created is available in [quay.io](https://quay.io).

**Verification**

1. Open [quay.io](https://quay.io) and click **Repository Tags**.

You can see details about the container you created, such as:

- last modified
- image size
- the `manifest ID``, that you can copy to the clipboard.

2. Copy the **manifest ID** value to build the image in which you want to embed a container.

**Additional resources**

- [Quay.io - Working with tags](#).

## 9.4. BUILDING AN IMAGE AND PULLING THE CONTAINER INTO THE IMAGE

After you have created the container image, you can build your customized image and pull the container image into it. For that, you must specify a **container customization** in the blueprint, and the **container name** for the final image. During the build process, the container image is fetched and placed in the local Podman container storage.

**Prerequisites**

- You created a container image and pushed it into your local **quay.io** container registry instance. See [Pushing a container artifact directly to a container registry](#).
- You have access to [registry.access.redhat.com](https://registry.access.redhat.com).
- You have a container **manifest ID**.
- You have the **qemu-kvm** and **qemu-img** packages installed.

**Procedure**

1. Create a blueprint to build a **qcow2** image. The blueprint must contain the customization.

```
name = "image"
description = "A qcow2 image with a container"
version = "0.0.1"
distro = "rhel-90"

[[packages]]
name = "podman"
version = ""
```



```
[[containers]]
source = "registry.access.redhat.com/ubi9:8080/osbuild/container/container-
image@sha256:manifest-ID-from-Repository-tag:tag-version"
name = "source-name"
tls-verify = true
```

2. Push the blueprint:

```
# composer-cli blueprints push blueprint-image.toml
```

3. Build the container image:

```
# composer-cli start compose image qcow2
```

- *image* is the blueprint name.
- **qcow2** is the image type.



#### NOTE

Building the image takes time because it checks the container on **quay.io** registry.

4. To check the status of the compose:

```
# composer-cli compose status
```

A finished compose shows the **FINISHED** status value. To identify your compose in the list, use its UUID.

5. After the compose process is finished, download the resulting image file to your default download location:

```
# composer-cli compose image UUID
```

Replace UUID with the UUID value shown in the previous steps.

You can use the **qcow2** image you created and downloaded to create a VM.

## Verification

From the resulting **qcow2** image that you downloaded, perform the following steps:

1. Start the **qcow2** image in a VM. See [Creating a virtual machine from a KVM guest image](#) .
2. The **qemu** wizard opens. Login in to the **qcow2** image.
  - a. Enter the username and password. These can be the username and password you set up in the **.qcow2** blueprint in the "customizations.user" section, or created at boot time with **cloud-init**.
3. Run the container image and open a shell prompt inside the container:

```
# podman run -it registry.access.redhat.com/ubi9:8080/osbuild/repository /bin/bash/
```

**registry.access.redhat.com** is the target registry, **osbuild** is the organization and **repository** is the location to push the container when it finishes building.

4. Check that the packages you added to the blueprint are available:

```
# type -a nginx
```

The output shows you the **nginx** package path.

### Additional resources

- [Red Hat Container Registry Authentication](#) .
- [Accessing and Configuring the Red Hat Registry](#) .
- [Basic Podman commands](#) .
- [Running Skopeo in a container](#) .

# CHAPTER 10. PREPARING AND UPLOADING CLOUD IMAGES BY USING RHEL IMAGE BUILDER

RHEL image builder can create custom system images ready for use on various cloud platforms. To use your customized RHEL system image in a cloud, create the system image with RHEL image builder using the chosen output type, configure your system for uploading the image, and upload the image to your cloud account. You can push customized image clouds through the **Image Builder** application in the RHEL web console, available for a subset of the service providers that we support, such as **AWS** and **Microsoft Azure** clouds. See [Pushing images to AWS Cloud AMI](#) and [Pushing VHD images to Microsoft Azure cloud](#).

## 10.1. PREPARING TO UPLOAD AWS AMI IMAGES

Before uploading an AWS AMI image, you must configure a system for uploading the images.

### Prerequisites

- You must have an Access Key ID configured in the [AWS IAM account manager](#).
- You must have a writable [S3 bucket](#) prepared.

### Procedure

1. Install Python 3 and the **pip** tool:

```
# dnf install python3 python3-pip
```

2. Install the [AWS command-line tools](#) with **pip**:

```
# pip3 install awscli
```

3. Set your profile. The terminal prompts you to provide your credentials, region and output format:

```
$ aws configure
AWS Access Key ID [None]:
AWS Secret Access Key [None]:
Default region name [None]:
Default output format [None]:
```

4. Define a name for your bucket and create a bucket:

```
$ BUCKET=bucketname
$ aws s3 mb s3://$BUCKET
```

Replace *bucketname* with the actual bucket name. It must be a globally unique name. As a result, your bucket is created.

5. To grant permission to access the S3 bucket, create a **vmimport** S3 Role in the AWS Identity and Access Management (IAM), if you have not already done so in the past:
  - a. Create a **trust-policy.json** file with the trust policy configuration, in the JSON format. For example:

```
{
  "Version": "2022-10-17",
  "Statement": [{
    "Effect": "Allow",
    "Principal": {
      "Service": "vmie.amazonaws.com"
    },
    "Action": "sts:AssumeRole",
    "Condition": {
      "StringEquals": {
        "sts:Externalid": "vmimport"
      }
    }
  ]
}
```

- b. Create a **role-policy.json** file with the role policy configuration, in the JSON format. For example:

```
{
  "Version": "2012-10-17",
  "Statement": [{
    "Effect": "Allow",
    "Action": ["s3:GetBucketLocation", "s3:GetObject", "s3:ListBucket"],
    "Resource": ["arn:aws:s3:::%s", "arn:aws:s3:::%s/*"], { "Effect": "Allow", "Action":
["ec2:ModifySnapshotAttribute", "ec2:CopySnapshot", "ec2:RegisterImage",
"ec2:Describe"],
    "Resource": "*"
  }
  ]
}
$BUCKET $BUCKET
```

- c. Create a role for your Amazon Web Services account, by using the **trust-policy.json** file:

```
$ aws iam create-role --role-name vmimport --assume-role-policy-document file://trust-policy.json
```

- d. Embed an inline policy document, by using the **role-policy.json** file:

```
$ aws iam put-role-policy --role-name vmimport --policy-name vmimport --policy-document file://role-policy.json
```

### Additional resources

- [Using high-level \(s3\) commands with the AWS CLI](#)

## 10.2. UPLOADING AN AMI IMAGE TO AWS BY USING THE CLI

You can use RHEL image builder to build **ami** images and push them directly to Amazon AWS Cloud service provider, by using the CLI.

### Prerequisites

- You have an **Access Key ID** configured in the [AWS IAM](#) account manager.
- You have a writable [S3 bucket](#) prepared.
- You have a defined blueprint.

## Procedure

1. Using the text editor, create a configuration file with the following content:

```
provider = "aws"

[settings]
accessKeyID = "AWS_ACCESS_KEY_ID"
secretAccessKey = "AWS_SECRET_ACCESS_KEY"
bucket = "AWS_BUCKET"
region = "AWS_REGION"
key = "IMAGE_KEY"
```

Replace values in the fields with your credentials for **accessKeyID**, **secretAccessKey**, **bucket**, and **region**. The **IMAGE\_KEY** value is the name of your VM Image to be uploaded to EC2.

2. Save the file as *CONFIGURATION-FILE.toml* and close the text editor.
3. Start the compose to upload it to AWS:

```
# composer-cli compose start blueprint-name image-type image-key configuration-file.toml
```

Replace:

- *blueprint-name* with the name of the blueprint you created
- *image-type* with the **ami** image type.
- *image-key* with the name of your VM Image to be uploaded to EC2.
- *configuration-file.toml* with the name of the configuration file of the cloud provider.



### NOTE

You must have the correct AWS Identity and Access Management (IAM) settings for the bucket you are going to send your customized image to. You have to set up a policy to your bucket before you are able to upload images to it.

4. Check the status of the image build:

```
# composer-cli compose status
```

After the image upload process is complete, you can see the "FINISHED" status.

## Verification

To confirm that the image upload was successful:

1. Access [EC2](#) on the menu and select the correct region in the AWS console. The image must have the **available** status, to indicate that it was successfully uploaded.
2. On the dashboard, select your image and click **Launch**.

### Additional Resources

- [Required service role to import a VM](#)

## 10.3. PUSHING IMAGES TO AWS CLOUD AMI

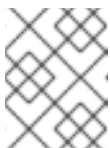
You can create a **(.raw)** image by using RHEL image builder, and choose to check the **Upload to AWS** checkbox to push the output image that you create directly to the **Amazon AWS Cloud AMI** service provider.

### Prerequisites

- You must have **root** or **wheel** group user access to the system.
- You have opened the RHEL image builder interface of the RHEL web console in a browser.
- You have created a blueprint. See [Creating a blueprint in the web console interface](#) .
- You must have an Access Key ID configured in the [AWS IAM](#) account manager.
- You must have a writable [S3 bucket](#) prepared.

### Procedure

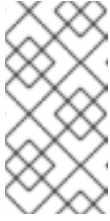
1. In the RHEL image builder dashboard, click the **blueprint name** that you previously created.
2. Select the tab **Images**.
3. Click **Create Image** to create your customized image.  
The **Create Image** window opens.
  - a. From the **Type** drop-down menu list, select **Amazon Machine Image Disk (.raw)**.
  - b. Check the **Upload to AWS** checkbox to upload your image to the AWS Cloud and click **Next**.
  - c. To authenticate your access to AWS, type your **AWS access key ID** and **AWS secret access key** in the corresponding fields. Click **Next**.



#### NOTE

You can view your AWS secret access key only when you create a new Access Key ID. If you do not know your Secret Key, generate a new Access Key ID.

- d. Type the name of the image in the **Image name** field, type the Amazon bucket name in the **Amazon S3 bucket name** field and type the **AWS region** field for the bucket you are going to add your customized image to. Click **Next**.
- e. Review the information and click **Finish**.  
Optionally, click **Back** to modify any incorrect detail.

**NOTE**

You must have the correct IAM settings for the bucket you are going to send your customized image. This procedure uses the IAM Import and Export, so you have to set up **a policy** to your bucket before you are able to upload images to it. For more information, see [Required Permissions for IAM Users](#).

4. A pop-up on the upper right informs you of the saving progress. It also informs that the image creation has been initiated, the progress of this image creation and the subsequent upload to the AWS Cloud.  
After the process is complete, you can see the **Image build complete** status.
5. In a browser, access [Service→EC2](#).
  - a. On the AWS console dashboard menu, choose the [correct region](#). The image must have the **Available** status, to indicate that it is uploaded.
  - b. On the AWS dashboard, select your image and click **Launch**.
6. A new window opens. Choose an instance type according to the resources you need to start your image. Click **Review and Launch**.
7. Review your instance start details. You can edit each section if you need to make any changes. Click **Launch**
8. Before you start the instance, select a public key to access it.  
You can either use the key pair you already have or you can create a new key pair.  
  
Follow the next steps to create a new key pair in EC2 and attach it to the new instance.
  - a. From the drop-down menu list, select **Create a new key pair**.
  - b. Enter the name to the new key pair. It generates a new key pair.
  - c. Click **Download Key Pair** to save the new key pair on your local system.
9. Then, you can click **Launch Instance** to start your instance.  
You can check the status of the instance, which displays as **Initializing**.
10. After the instance status is **running**, the **Connect** button becomes available.
11. Click **Connect**. A window appears with instructions on how to connect by using SSH.
  - a. Select **A standalone SSH client** as the preferred connection method to and open a terminal.
  - b. In the location you store your private key, ensure that your key is publicly viewable for SSH to work. To do so, run the command:

```
$ chmod 400 _your-instance-name.pem_&gt;
```

- c. Connect to your instance by using its Public DNS:

```
$ ssh -i &lt;_your-instance-name.pem_&gt; ec2-user@&lt;_your-instance-IP-address_&gt;
```

- d. Type **yes** to confirm that you want to continue connecting.  
As a result, you are connected to your instance over SSH.

### Verification

- Check if you are able to perform any action while connected to your instance by using SSH.

### Additional resources

- [Open a case on Red Hat Customer Portal](#)
- [Connecting to your Linux instance by using SSH](#)
- [Open support cases](#)

## 10.4. PREPARING TO UPLOAD MICROSOFT AZURE VHD IMAGES

You can use RHEL image builder to create a VHD image that can be uploaded to **Microsoft Azure** cloud.

### Prerequisites

- You must have a Microsoft Azure resource group and storage account.
- You have Python installed. The **AZ CLI** tool depends on python.

### Procedure

1. Import the Microsoft repository key:

```
# rpm --import https://packages.microsoft.com/keys/microsoft.asc
```

2. Create a local **azure-cli.repo** repository with the following information. Save the **azure-cli.repo** repository under **/etc/yum.repos.d/**:

```
[azure-cli]
name=Azure CLI
baseurl=https://packages.microsoft.com/yumrepos/vscode
enabled=1
gpgcheck=1
gpgkey=https://packages.microsoft.com/keys/microsoft.asc
```

3. Install the Microsoft Azure CLI:

```
# dnfdownloader azure-cli
# rpm -ivh --nodeps azure-cli-2.0.64-1.el7.x86_64.rpm
```



### NOTE

The downloaded version of the Microsoft Azure CLI package can vary depending on the current available version.

4. Run the Microsoft Azure CLI:



```
$ az login
```

The terminal shows the following message **Note, we have launched a browser for you to login. For old experience with device code, use "az login --use-device-code**. Then, the terminal opens a browser with a link to <https://microsoft.com/devicelogin> from where you can login.



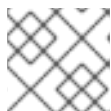
#### NOTE

If you are running a remote (SSH) session, the login page link will not open in the browser. In this case, you can copy the link to a browser and login to authenticate your remote session. To sign in, use a web browser to open the page <https://microsoft.com/devicelogin> and enter the device code to authenticate.

- List the keys for the storage account in Microsoft Azure:

```
$ az storage account keys list --resource-group <resource_group_name> --account-name
<storage_account_name>
```

Replace *resource-group-name* with name of your Microsoft Azure resource group and *storage-account-name* with name of your Microsoft Azure storage account.



#### NOTE

You can list the available resources using the following command:

```
$ az resource list
```

Make note of value **key1** in the output of the previous command.

- Create a storage container:

```
$ az storage container create --account-name <storage_account_name> \
--account-key <key1_value> --name <storage_account_name>
```

Replace *storage-account-name* with name of the storage account.

#### Additional resources

- [Microsoft Azure CLI](#).

## 10.5. UPLOADING VHD IMAGES TO MICROSOFT AZURE CLOUD

After you have created your customized VHD image, you can upload it to the Microsoft Azure cloud.

#### Prerequisites

- Your system must be set up for uploading Microsoft Azure VHD images. See [Preparing to upload Microsoft Azure VHD images](#).
- You must have a Microsoft Azure VHD image created by RHEL image builder.

- In the CLI, use the **vhd** output type. NOTE: When creating a **.vhd** image using the CLI, image builder writes temporary files to the **/var** subdirectory. To prevent the **.vhd** image creation from failing, increase the **/var** subdirectory capacity to at least 15 to 20 GB free space to ensure availability.
- In the GUI, use the **Azure Disk Image (.vhd)** image type.

## Procedure

1. Push the image to Microsoft Azure and create an instance from it:

```
$ az storage blob upload --account-name <account_name> --container-name
<container_name> --file <_image_-disk.vhd> --name <_image_-disk.vhd> --type page
...
```

2. After the upload to the Microsoft Azure Blob storage completes, create a Microsoft Azure image from it:

```
$ az image create --resource-group &lt;_resource_group_name_&gt;; --name &lt;_image_-
disk.vhd&gt;; --os-type linux --location eastus --source
https://$ACCOUNT.blob.core.windows.net/&lt;_container_name_&gt;; &lt;_image_-
disk.vhd&gt;;
- Running ...
```

## Verification

1. Create an instance either with the Microsoft Azure portal, or a command similar to the following:

```
$ az vm create --resource-group &lt;_resource_group_name_&gt;; --location eastus --name
&lt;_image_-disk.vhd&gt;; --image &lt;_image_-disk.vhd&gt;; --admin-username azure-user --
generate-ssh-keys
- Running ...
```

2. Use your private key via SSH to access the resulting instance. Log in as **azure-user**. This username was set on the previous step.

## Additional Resources

- [Composing an image for the .vhd format fails.](#)

## 10.6. PUSHING VHD IMAGES TO MICROSOFT AZURE CLOUD

You can create **.vhd** images by using RHEL image builder. Then, you can push the output **.vhd** images to a Blob Storage of the Microsoft Azure Cloud service provider.

### Prerequisites

- You have root access to the system.
- You have access to the RHEL image builder interface of the RHEL web console.
- You created a blueprint. See [Creating a RHEL image builder blueprint in the web console interface.](#)

- You have a [Microsoft Storage Account](#) created.
- You have a writable [Blob Storage](#) prepared.

## Procedure

1. In the RHEL image builder dashboard, select the blueprint you want to use.
2. Click the **Images** tab.
3. Click **Create Image** to create your customized **.vhd** image. The **Create image** wizard opens.
  - a. Select **Microsoft Azure (.vhd)** from the **Type** drop-down menu list.
  - b. Check the **Upload to Azure** checkbox to upload your image to the Microsoft Azure Cloud.
  - c. Enter the **Image Size** and click **Next**.
4. On the **Upload to Azure** page, enter the following information:
  - a. On the Authentication page, enter:
    - i. Your **Storage account** name. You can find it on the **Storage account** page, in the [Microsoft Azure portal](#).
    - ii. Your **Storage access key**. You can find it on the **Access Key Storage** page.
    - iii. Click **Next**.
  - b. On the **Authentication** page, enter:
    - i. The image name.
    - ii. The **Storage container**. It is the blob container to which you will upload the image. Find it under the **Blob service** section, in the [Microsoft Azure portal](#).
    - iii. Click **Next**.
5. On the **Review** page, click **Create**. The RHEL image builder and upload processes start. Access the image you pushed into **Microsoft Azure Cloud**.
6. Access the [Microsoft Azure portal](#).
7. In the search bar, type "storage account" and click **Storage accounts** from the list.
8. On the search bar, type "Images" and select the first entry under **Services**. You are redirected to the **Image dashboard**.
9. On the navigation panel, click **Containers**.
10. Find the container you created. Inside the container is the **.vhd** file you created and pushed by using RHEL image builder.

## Verification

1. Verify that you can create a VM image and launch it.

- a. In the search bar, type images account and click **Images** from the list.
  - b. Click **+Create**.
  - c. From the dropdown list, choose the resource group you used earlier.
  - d. Enter a name for the image.
  - e. For the **OS type**, select **Linux**.
  - f. For the **VM generation**, select **Gen 2**.
  - g. Under **Storage Blob**, click **Browse** and click through the storage accounts and container until you reach your VHD file.
  - h. Click **Select** at the end of the page.
    - i. Choose an Account Type, for example, **Standard SSD**.
    - j. Click **Review + Create** and then **Create**. Wait a few moments for the image creation.
2. To launch the VM, follow the steps:
- a. Click **Go to resource**.
  - b. Click **+ Create VM** from the menu bar on the header.
  - c. Enter a name for your virtual machine.
  - d. Complete the **Size** and **Administrator account** sections.
  - e. Click **Review + Create** and then **Create**. You can see the deployment progress. After the deployment finishes, click the virtual machine name to retrieve the public IP address of the instance to connect by using SSH.
  - f. Open a terminal to create an SSH connection to connect to the VM.

### Additional resources

- [Microsoft Azure Storage Documentation](#) .
- [Create a Microsoft Azure Storage account](#) .
- [Open a case on Red Hat Customer Portal](#) .
- [Help + support](#).
- [Contacting Red Hat](#).

## 10.7. CREATING A CUSTOMIZED RHEL VMDK SYSTEM IMAGE BY USING RHEL IMAGE BUILDER

With RHEL image builder, you can create customized system images in the Open virtualization format (**.ova**). You can upload these images to the VMware vSphere client. The Open virtualization format (**.ova**) is a **.vmdk** image with additional metadata about the virtual hardware, which contains a minimal template. After importing the **.ova** image to the vSphere client, you can configure it with any additional hardware, such as network, disks, and CD ROMS.

You can import the Open virtualization format (**.ova**) image by using either the vSphere GUI or the **govc** client. To upload the image by using the **govc** client, see [Uploading VMDK images and creating a RHEL virtual machine in vSphere](#).

### Prerequisites

- You opened the RHEL image builder app from the web console in a browser.
- You created a blueprint.

### Procedure

1. In the RHEL image builder dashboard, click the **Blueprint** tab.
2. On the blueprint table, find the blueprint you want to build an image.
3. On the right side of the chosen blueprint, click **Create Image**. The **Create image** dialog wizard opens.
4. On the **Image output** page, complete the following steps:
  - a. From the **Select a blueprint** list, select the image type you want.
  - b. From the **Image output type** list, select the image output type you want.
  - c. Optional: Check **Upload to VMWare** checkbox to upload the image directly to VMware.
  - d. Enter a size for the image.
  - e. Click **Next**.
5. On the **Upload to VMware** page, enter the following information:
  - a. **Image name**: Enter the image name.
  - b. **Host**: Enter the VMware vSphere instance URL where the image file will be uploaded.
  - c. **Cluster**: Enter the cluster name page to which the image will be uploaded.
  - d. **Datacenter**: Datacenter name to which the image will be uploaded.
  - e. **Datastore**: Datastore name to which the image will be uploaded.
  - f. **Folder**: Folder name to which the image will be uploaded.
  - g. Click **Next**.
6. On the **Review** page, review the details about the image creation and click **Create**.  
The image creation starts, the progress of this image creation and the subsequent upload to the VMware vSphere client.

## 10.8. UPLOADING VMDK IMAGES AND CREATING A RHEL VIRTUAL MACHINE IN VSPHERE

With RHEL image builder, you can create customized VMware vSphere system images, either in the Open virtualization format (**.ova**) or in the Virtual disk (**.vmdk**) format. You can upload these images to

the VMware vSphere client. You can upload the **.vmdk** or **.ova** image to VMware vSphere using the **govc import.vmdk** CLI tool. The **vmdk** you create contains the **cloud-init** package installed and you can use it to provision users by using user data, for example.



## NOTE

Uploading **vmdk** images by using the VMware vSphere GUI is not supported.

## Prerequisites

- You created a blueprint with username and password customizations.
- You created a VMware vSphere image either in the **.ova** or **.vmdk** format by using RHEL image builder and downloaded it to your host system.
- You installed and configured the **govc** CLI tool, to be able use the **import.vmdk** command.

## Procedure

1. Configure the following values in the user environment with the GOVC environment variables:

```
GOVC_URL
GOVC_DATACENTER
GOVC_FOLDER
GOVC_DATASTORE
GOVC_RESOURCE_POOL
GOVC_NETWORK
```

2. Navigate to the directory where you downloaded your VMware vSphere image.
3. Launch the VMware vSphere image on vSphere by following the steps:
  - a. Import the VMware vSphere image in to vSphere:

```
$ govc import.vmdk ./composer-api.vmdk foldername
```

For the **.ova** format:

```
$ govc import.ova ./composer-api.ova foldername
```

- b. Create the VM in vSphere without powering it on:

```
govc vm.create \
-net.adapter=vmxnet3 \
-m=4096 -c=2 -g=rhel8_64Guest \
-firmware=efi -disk="foldername/composer-api.vmdk" \
-disk.controller=scsi -on=false \
vmname
```

For the **.ova** format, replace the line **-firmware=efi -disk="*foldername/composer-api.vmdk*"** \ with **-firmware=efi -disk="*foldername/composer-api.ova*"** \

- c. Power-on the VM:

```
govc vm.power -on vmname
```

d. Retrieve the VM IP address:

```
govc vm.ip vmname
```

e. Use SSH to log in to the VM, using the username and password you specified in your blueprint:

```
$ ssh admin@<_ip_address_of_the_vm_>
```



#### NOTE

If you copied the **.vmdk** image from your local host to the destination using the **govc datastore.upload** command, using the resulting image is not supported. There is no option to use the **import.vmdk** command in the vSphere GUI and as a result, the vSphere GUI does not support the direct upload. As a consequence, the **.vmdk** image is not usable from the vSphere GUI.

## 10.9. 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.

### 10.9.1. 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:

```
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.

```
$ sudo base64 -w 0 cee-gcp-nasa-476a1fa485b7.json
```

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

```
$ sudo 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:

```
$ sudo composer-cli compose status
```

#### Additional resources

- [Identity and Access Management](#)
- [Create storage buckets](#)



## 10.9.2. 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.

### 10.9.2.1. 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"
```

### 10.9.2.2. 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"
```

## 10.10. PUSHING VMDK IMAGES TO VSPHERE USING THE RHEL IMAGE BUILDER GUI TOOL

You can build VMware images by using the RHEL image builder GUI tool and push the images directly to your vSphere instance, to avoid having to download the image file and push it manually. The **vmdk** you create contains the **cloud-init** package installed and you can use it to provision users by using user data, for example. To build **.vmdk** images by using RHEL image builder and push them directly to vSphere instances service provider, follow the steps:

### Prerequisites

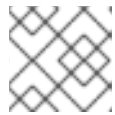
- You are a member of the **root** or the **weldr** group.
- You have opened link:https://localhost:9090/RHEL image builder in a browser.
- You have created a blueprint. See [Creating a RHEL image builder blueprint in the web console interface](#).
- You have a [vSphere Account](#).

### Procedure

1. For the blueprint you created, click the **Images** tab .
2. Click **Create Image** to create your customized image.  
The Image type window opens.
3. In the **Image type** window:
  - a. From the dropdown menu, select the Type: VMware vSphere (.vmdk).
  - b. Check the **Upload to VMware** checkbox to upload your image to the vSphere.
  - c. Optional: Set the size of the image you want to instantiate. The minimal default size is 2 GB.
  - d. Click **Next**.
4. In the **Upload to VMware** window, under **Authentication**, enter the following details:
  - a. **Username**: username of the vSphere account.
  - b. **Password**: password of the vSphere account.

5. In the **Upload to VMware** window, under **Destination**, enter the following details about the image upload destination:
  - a. **Image name:** a name for the image.
  - b. **Host:** The URL of your VMware vSphere.
  - c. **Cluster:** The name of the cluster.
  - d. **Data center:** The name of the data center.
  - e. **Data store:** The name of the Data store.
  - f. Click **Next**.
6. In the **Review** window, review the details of the image creation and click **Finish**. You can click **Back** to modify any incorrect detail.

RHEL image builder adds the compose of a RHEL vSphere image to the queue, and creates and uploads the image to the Cluster on the vSphere instance you specified.



#### NOTE

The image build and upload processes take a few minutes to complete.

After the process is complete, you can see the **Image build complete** status.

### Verification

After the image status upload is completed successfully, you can create a Virtual Machine (VM) from the image you uploaded and login into it. To do so:

1. Access VMware vSphere Client.
2. Search for the image in the Cluster on the vSphere instance you specified.
3. Select the image you uploaded.
4. Right-click the selected image.
5. Click **New Virtual Machine**.  
A **New Virtual Machine** window opens.

In the **New Virtual Machine** window, provide the following details:

- a. Select **New Virtual Machine**.
- b. Select a name and a folder for your VM.
- c. Select a computer resource: choose a destination computer resource for this operation.
- d. Select storage: For example, select NFS-Node1
- e. Select compatibility: The image should be BIOS only.
- f. Select a guest operating system: For example, select *Linux and Red Hat Fedora (64-bit)*.

- g. **Customize hardware:** When creating a VM, on the **Device Configuration** button on the upper right, delete the default New Hard Disk and use the drop-down to select an Existing Hard Disk disk image:
  - h. Ready to complete: Review the details and click **Finish** to create the image.
6. Navigate to the **VMs** tab.
  - a. From the list, select the VM you created.
  - b. Click the **Start** button from the panel. A new window appears, showing the VM image loading.
  - c. Log in with the credentials you created for the blueprint.
  - d. You can verify if the packages you added to the blueprint are installed. For example:

```
$ rpm -qa | grep firefox
```

### Additional resources

- [Introduction to vSphere Installation and Setup](#).

## 10.11. PUSHING CUSTOMIZED IMAGES TO OCI

With RHEL image builder, you can build customized images and push them directly to your Oracle Cloud Infrastructure (OCI) instance. Then, you can start an image instance from the OCI dashboard.

### Prerequisites

- You have **root** or **weldr** group user access to the system.
- You have an [Oracle Cloud](#) account.
- You must be granted security access in an **OCI policy** by your administrator.
- You have created an OCI Bucket in the **OCI\_REGION** of your choice.

### Procedure

1. Open the RHEL image builder interface of the web console in a browser.
2. Click **Create blueprint**. The **Create blueprint** wizard opens.
3. On the **Details** page, enter a name for the blueprint, and optionally, a description. Click **Next**.
4. On the **Packages** page, select the components and packages that you want to include in the image. Click **Next**.
5. On the **Customizations** page, configure the customizations that you want for your blueprint. Click **Next**.
6. On the **Review** page, click **Create**.
7. To create an image, click **Create Image**. The **Create image** wizard opens.

8. On the **Image output** page, complete the following steps:
  - a. From the **"Select a blueprint"** drop-down menu, select the blueprint you want.
  - b. From the **"Image output type"** drop-down menu, select **Oracle Cloud Infrastructure (.qcow2)**.
  - c. Check the **"Upload OCI"** checkbox to upload your image to the OCI.
  - d. Enter the **"image size"**. Click **Next**.
9. On the **Upload to OCI - Authentication** page, enter the following mandatory details:
  - a. User OCID: you can find it in the Console on the page showing the user's details.
  - b. Private key
10. On the **Upload to OCI - Destination** page, enter the following mandatory details and click **Next**.
  - a. Image name: a name for the image to be uploaded.
  - b. OCI bucket
  - c. Bucket namespace
  - d. Bucket region
  - e. Bucket compartment
  - f. Bucket tenancy
11. Review the details in the wizard and click **Finish**.

RHEL image builder adds the compose of a RHEL **.qcow2** image to the queue.

### Verification

1. Access the [OCI dashboard](#) → Custom Images.
2. Select the **Compartment** you specified for the image and locate the image in the **Import image** table.
3. Click the image name and verify the image information.

### Additional resources

- [Managing custom images in the OCI](#).
- [Managing buckets in the OCI](#).
- [Generating SSH keys](#).

## 10.12. UPLOADING QCOW2 IMAGES TO OPENSTACK

With the RHEL image builder tool, you can create customized **.qcow2** images that are suitable for uploading to OpenStack cloud deployments, and starting instances there. RHEL image builder creates images in the QCOW2 format, but with further changes specific to OpenStack.



### WARNING

Do not mistake the generic **QCOW2** image type output format you create by using RHEL image builder with the OpenStack image type, which is also in the QCOW2 format, but contains further changes specific to OpenStack.

## Prerequisites

- You have created a blueprint.

## Procedure

1. Start the compose of a **QCOW2** image.

```
# composer-cli compose start blueprint_name openstack
```

2. Check the status of the building.

```
# composer-cli compose status
```

After the image build finishes, you can download the image.

3. Download the **QCOW2** image:

```
# composer-cli compose image UUID
```

4. Access the OpenStack dashboard and click **+Create Image**.

5. On the left menu, select the **Admin** tab.

6. From the **System Panel**, click **Image**.  
The **Create An Image** wizard opens.

7. In the **Create An Image** wizard:

- a. Enter a name for the image
- b. Click **Browse** to upload the **QCOW2** image.
- c. From the **Format** dropdown list, select the **QCOW2 - QEMU Emulator**.
- d. Click **Create Image**.

**Create An Image**

**Name: \***  
96268ffb-2c71-4e97-a855-7ac25e983a6e-disk.qcow2

**Description:**  
Specify an image to upload to the Image Service.  
Currently only images available via an HTTP URL are supported. The image location must be accessible to the Image Service. Compressed image binaries are supported (.zip and .tar.gz.)  
**Please note:** The Image Location field MUST be a valid and direct URL to the image binary. URLs that redirect or serve error pages will result in unusable images.

**Image Source:**  
Image File

**Image File**  
Browse... 96268ffb-2c71-4e97-a85...c25e98

**Format: \***  
QCOW2 - QEMU Emulator

**Architecture:**  
x86\_64

**Minimum Disk (GB):**  
5

**Minimum Ram (MB):**  
1024

**Public:**

**Protected:**

Cancel Create Image

8. On the left menu, select the **Project** tab.
  - a. From the **Compute** menu, select **Instances**.
  - b. Click the **Launch Instance** button.  
The **Launch Instance** wizard opens.
  - c. On the **Details** page, enter a name for the instance. Click **Next**.
  - d. On the **Source** page, select the name of the image you uploaded. Click **Next**.
  - e. On the **Flavor** page, select the machine resources that best fit your needs. Click **Launch**.

## Launch Instance ✕

Details \*
Access & Security \*
Networking \*
Post-Creation
Advanced Options

**Availability Zone:**  
nova

**Instance Name: \***  
my-instance

**Flavor: \***  
m1.small

Some flavors not meeting minimum image requirements have been disabled.

**Instance Count: \***  
1

**Instance Boot Source: \***  
Boot from image

**Image Name:**  
96268ffb-2c71-4e97-a855-7ac25e983a6e-disk.qc

Specify the details for launching an instance.  
The chart below shows the resources used by this project in relation to the project's quotas.

**Flavor Details**

<b>Name</b>	m1.small
<b>VCPUs</b>	1
<b>Root Disk</b>	20 GB
<b>Ephemeral Disk</b>	0 GB
<b>Total Disk</b>	20 GB
<b>RAM</b>	2,048 MB

**Project Limits**

**Number of Instances** 4 of 10 Used

**Number of VCPUs** 17 of 20 Used

**Total RAM** 34,816 of 51,200 MB Used

Cancel
Launch

9. You can run the image instance using any mechanism (CLI or OpenStack web UI) from the image. Use your private key via SSH to access the resulting instance. Log in as **cloud-user**.

## 10.13. PREPARING TO UPLOAD CUSTOMIZED RHEL IMAGES TO ALIBABA CLOUD

To deploy a customized RHEL image to the Alibaba Cloud, first you need to verify the customized image. The image needs a specific configuration to boot successfully, because Alibaba Cloud requests the custom images to meet certain requirements before you use it.



### NOTE

RHEL image builder generates images that conform to Alibaba's requirements. However, Red Hat recommends also using the Alibaba **image\_check tool** to verify the format compliance of your image.

### Prerequisites

- You must have created an Alibaba image by using RHEL image builder.

### Procedure

1. Connect to the system containing the image that you want to check by using the Alibaba **image\_check tool**.



2. Download the **image\_check** tool:

```
$ curl -O https://docs-aliyun.cn-hangzhou.oss.aliyun-inc.com/assets/attach/73848/cn_zh/1557459863884/image_check
```

3. Change the file permission of the image compliance tool:

```
# chmod +x image_check
```

4. Run the command to start the image compliance tool checkup:

```
# ./image_check
```

The tool verifies the system configuration and generates a report that is displayed on your screen. The **image\_check** tool saves this report in the same folder where the image compliance tool is running.

## Troubleshooting

If any of the **Detection Items** fail, follow the instructions in the terminal to correct it.

### Additional resources

- [Image Compliance Tool](#).

## 10.14. UPLOADING CUSTOMIZED RHEL IMAGES TO ALIBABA

You can upload a customized **AMI** image you created by using RHEL image builder to the Object Storage Service (OSS).

### Prerequisites

- Your system is set up for uploading Alibaba images. See [Preparing for uploading images to Alibaba](#).
- You have created an **ami** image by using RHEL image builder.
- You have a bucket. See [Creating a bucket](#).
- You have an [active Alibaba Account](#).
- You activated [OSS](#).

### Procedure

1. Log in to the [OSS console](#).
2. In the Bucket menu on the left, select the bucket to which you want to upload an image.
3. In the upper right menu, click the **Files** tab.
4. Click **Upload**. A dialog window opens on the right side. Configure the following:
  - **Upload To:** Choose to upload the file to the **Current** directory or to a **Specified** directory.

- **File ACL:** Choose the type of permission of the uploaded file.
5. Click **Upload**.
  6. Select the image you want to upload to the OSS Console..
  7. Click **Open**.

#### Additional resources

- [Upload an object](#).
- [Creating an instance from custom images](#).
- [Importing images](#).

## 10.15. IMPORTING IMAGES TO ALIBABA CLOUD

To import a customized Alibaba RHEL image that you created by using RHEL image builder to the Elastic Compute Service (ECS), follow the steps:

#### Prerequisites

- Your system is set up for uploading Alibaba images. See [Preparing for uploading images to Alibaba](#).
- You have created an **ami** image by using RHEL image builder.
- You have a bucket. See [Creating a bucket](#).
- You have an [active Alibaba Account](#).
- You activated [OSS](#).
- You have uploaded the image to Object Storage Service (OSS). See [Uploading images to Alibaba](#).

#### Procedure

1. Log in to the [ECS console](#).
  - i. On the left-side menu, click **Images**.
  - ii. On the upper right side, click **Import Image**. A dialog window opens.
  - iii. Confirm that you have set up the correct region where the image is located. Enter the following information:
    - a. **OSS Object Address:** See how to obtain [OSS Object Address](#).
    - b. **Image Name**
    - c. **Operating System**
    - d. **System Disk Size**

- e. **System Architecture**
- f. **Platform:** Red Hat
- iv. Optionally, provide the following details:
  - g. **Image Format:** `qcow2` or `ami`, depending on the uploaded image format.
  - h. **Image Description**
  - i. **Add Images of Data Disks**  
The address can be determined in the OSS management console. After selecting the required bucket in the left menu:
- 2. Select **Files** section.
- 3. Click the **Details** link on the right for the appropriate image.  
A window appears on the right side of the screen, showing image details. The **OSS** object address is in the **URL** box.
- 4. Click **OK**.

**NOTE**

The importing process time can vary depending on the image size.

The customized image is imported to the **ECS** Console.

**Additional resources**

- [Notes for importing images.](#)
- [Creating an instance from custom images.](#)
- [Upload an object.](#)

## 10.16. CREATING AN INSTANCE OF A CUSTOMIZED RHEL IMAGE USING ALIBABA CLOUD

You can create instances of a customized RHEL image by using the Alibaba ECS Console.

**Prerequisites**

- You have activated [OSS](#) and uploaded your custom image.
- You have successfully imported your image to ECS Console. See [Importing images to Alibaba](#).

**Procedure**

1. Log in to the [ECS console](#).
2. On the left-side menu, select **Instances**.
3. In the upper-right corner, click **Create Instance**. You are redirected to a new window.

4. Complete all the required information. See [Creating an instance by using the wizard](#) for more details.
5. Click **Create Instance** and confirm the order.



#### NOTE

You can see the option **Create Order** instead of **Create Instance**, depending on your subscription.

As a result, you have an active instance ready for deployment from the **Alibaba ECS Console**.

#### Additional resources

- [Creating an instance by using a custom image.](#)
- [Create an instance by using the wizard.](#)