Red Hat Enterprise Linux 9

Configuring and managing cloud-init for RHEL 9

Using cloud-init to automate the initialization of cloud instances
Using cloud-init to automate the initialization of cloud instances
Abstract

You can efficiently create multiple cloud instances of RHEL by using the cloud-init package. Doing so allows for consistent and repeatable deployment of RHEL on a variety of cloud platforms. The following chapters provide information on: How cloud-init works, How to use cloud-init to initiate cloud instances, What uses of cloud-init Red Hat supports.
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MAKING OPEN SOURCE MORE INCLUSIVE

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

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

Submitting feedback through Jira (account required)

1. Log in to the Jira website.
2. Click Create in the top navigation bar
3. Enter a descriptive title in the Summary field.
4. Enter your suggestion for improvement in the Description field. Include links to the relevant parts of the documentation.
5. Click Create at the bottom of the dialogue.
CHAPTER 1. INTRODUCING RHEL ON PUBLIC CLOUD PLATFORMS

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

To learn more about RHEL on public cloud platforms, see:

- Benefits of using RHEL in a public cloud
- Public cloud use cases for RHEL
- Frequent concerns when migrating to a public cloud
- Obtaining RHEL for public cloud deployments
- Methods for creating RHEL cloud instances

1.1. BENEFITS OF USING RHEL IN A PUBLIC CLOUD

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

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

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

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

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

- **Software-controlled configurations**
  The entire configuration of a cloud instance is saved as data on the cloud platform, and is controlled by software. Therefore, you can easily create, remove, clone, or migrate the instance. A cloud instance is also operated remotely in a cloud provider console and is connected to remote storage by default.

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

- **Separation from the host and software compatibility**
  Similarly to a local VM, the RHEL guest operating system on a cloud instance runs on a virtualized kernel. This kernel is separate from the host operating system and from the client system that you use to connect to the instance.
Therefore, any operating system can be installed on the cloud instance. This means that on a RHEL public cloud instance, you can run RHEL-specific applications that cannot be used on your local operating system.

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

Additional resources

- What is public cloud?
- What is a hyperscaler?
- Types of cloud computing
- Public cloud use cases for RHEL
- Obtaining RHEL for public cloud deployments

1.2. PUBLIC CLOUD USE CASES FOR RHEL

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

Beneficial use cases

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

Potentially problematic use cases

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

Next steps

- Obtaining RHEL for public cloud deployments

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

1.3. FREQUENT CONCERNS WHEN MIGRATING TO A PUBLIC CLOUD

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

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

In most respects, RHEL instances on a public cloud platform work the same as RHEL virtual machines on a local host, such as an on-premises server. Notable exceptions include:

- Instead of private orchestration interfaces, public cloud instances use provider-specific console interfaces for managing your cloud resources.

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

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

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

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

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

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

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

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

1.4. OBTAINING RHEL FOR PUBLIC CLOUD DEPLOYMENTS

To deploy a RHEL system in a public cloud environment:

1. Select the optimal cloud provider for your use case, based on your requirements and the current offer on the market.
   The cloud providers currently certified for running RHEL instances are:

   - Amazon Web Services (AWS)
     - For more information, see Deploying RHEL 9 on Amazon Web Services.
   - Google Cloud Platform (GCP)
For more information, see Deploying RHEL 9 on Google Cloud Platform.

Microsoft Azure

For more information, see Deploying RHEL 9 on Microsoft Azure.

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

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

Additional resources

- RHUI documentation
- Red Hat Open Hybrid Cloud

1.5. METHODS FOR CREATING RHEL CLOUD INSTANCES

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

Create a system image of RHEL and import it to the cloud platform.

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

Purchase a RHEL instance directly from the cloud provider marketplace.

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

Additional resources

- What is a golden image?
CHAPTER 2. INTRODUCTION TO CLOUD-INIT

cloud-init is a software package that automates the initialization of cloud instances during system boot. You can configure cloud-init to perform a variety of tasks. Some sample tasks that cloud-init can perform include:

- Configuring a host name
- Installing packages on an instance
- Running scripts
- Suppressing default virtual machine (VM) behavior

Where you obtain your image for configuring cloud-init depends on how you intend to use it.

- The cloud-init package is installed on KVM Guest Images that you download from the Red Hat Customer Portal. When you launch an instance, cloud-init is enabled. KVM Guest Images that you download from the Red Hat Customer Portal are intended for use with Red Hat Virtualization (RHV), the Red Hat OpenStack Platform (RHOSP), and Red Hat OpenShift Virtualization.

- You can also download a RHEL ISO image from the Red Hat Customer Portal to create your own custom guest image. In this case, you need to install the cloud-init package on your guest image yourself.

- If you plan to use an image with a cloud provider (for example, AWS or Azure), use Red Hat Image Builder to create the image. Image Builder images are customized for use for specific cloud providers. The image types AMI, VHD, and qcow2 include cloud-init already installed. Refer to Composing a Customized RHEL System Image for information about Image Builder.

Most cloud platforms support cloud-init, though configuration procedures and supported options vary. Alternatively, you can configure cloud-init for a NoCloud environment.

You can configure cloud-init on one VM and then use that VM as a template for additional VMs or clusters of VMs.

Specific Red Hat products (for example, Red Hat Virtualization) have documented procedures for configuring cloud-init for use with those products.

This document refers to the cloud-init documentation in a number of places. Refer to the referenced cloud-init documentation for complete information about cloud-init.

Prerequisites

- Sign up for a Red Hat Customer Portal account.

2.1. CLOUD-INIT CONFIGURATION

cloud-init uses YAML-formatted file instructions to perform tasks. You decide the initial configuration you want cloud-init to perform by providing instructions within the YAML files. When an instance boots, the cloud-init service starts and searches for and executes the instructions. Tasks complete during the first boot or on subsequent boots of your VM, based on your cloud-init configuration.

You define the tasks by configuring the /etc/cloud/cloud.cfg file and adding directives under the /etc/cloud/cloud.cfg.d/ directory.
The `cloud.cfg` file includes directives, such as those for user access and authentication and system information. The file also includes default and optional modules for `cloud-init`. The modules are executed in order within three phases that include the `cloud-init` initialization phase, the configuration phase, and the final phase. Within the `cloud.cfg` file, modules for the three phases are listed under `cloud_init_modules`, `cloud_config_modules`, and `cloud_final_modules`, respectively.

The `cloud.cfg.d` directory is where you can add additional directives for `cloud-init`. When you add directives to the `cloud.cfg.d` directory, you typically add them to a file named `*.cfg`, and you always include `#cloud-config` at the top of the file.

### 2.2. CLOUD-INIT OPERATES IN STAGES

`cloud-init` operates in five stages during a system boot. Those stages determine whether `cloud-init` runs and where it finds its datasources, among other tasks. The stages are as follows:

1. The `cloud-init` generator stage, through the `systemd` service, determines whether to run `cloud-init` upon the boot.
2. During the local stage, `cloud-init` finds local datasources and applies network configuration.
3. During the network stage, `cloud-init` processes user data and runs the modules listed under `cloud_init_modules` in your `cloud.cfg` file. You can enable, disable, or add modules to the `cloud_init_modules` section.
4. During the config stage, `cloud-init` runs the modules listed under `cloud_config_modules` in your `cloud.cfg` file. You can enable, disable, or add modules to the `cloud_config_modules` section.
5. During the final stage, `cloud-init` can run what you have included under `cloud_final_modules` in your `cloud.cfg` file. You can include package installations that you would typically run after a system boots and can also include configuration management plug-ins and user scripts. You can enable, disable, or add modules to the `cloud_final_modules` section.

The five boot stages are described in the `cloud-init` Documentation section [Boot Stages](#).

### 2.3. CLOUD-INIT MODULES EXECUTE IN PHASES

When `cloud-init` runs, it executes the modules within `cloud.cfg` in order within three phases:

1. The network phase (`cloud_init_modules`)
2. The configuration phase (`cloud_config_modules`)
3. The final phase (`cloud_final_modules`)

When `cloud-init` runs for the first time on a VM, all the modules you have configured run in their respective phases. On a subsequent running of `cloud-init`, whether a module runs within a phase depends on the `module frequency` of the individual module. Some modules run every time `cloud-init` runs; some modules only run the first time `cloud-init` runs, even if the instance ID changes.

**NOTE**

An instance ID uniquely identifies an instance. When an instance ID changes, `cloud-init` treats the instance as a new instance.
The possible module frequency values are as follows:

- **Per instance** means that the module runs on first boot of an instance. For example, if you clone an instance or create a new instance from a saved image, the modules designated as per instance run again.

- **Per once** means that the module runs only once. For example, if you clone an instance or create a new instance from a saved image, the modules designated per once do not run again on those instances.

- **Per always** means the module runs on every boot.

**NOTE**

You can override a module’s frequency when you configure the module or by using the command line.

### 2.4. CLOUD-INIT ACTS UPON USER DATA, METADATA, AND VENDOR DATA

**cloud-init** consumes and acts upon user data, metadata, and vendor data.

- User data includes directives you specify in the `cloud.cfg` file and in the `cloud.cfg.d` directory, for example, user data can include files to run, packages to install, and shell scripts. Refer to the **cloud-init** Documentation section **User-Data Formats** for information about the types of user data that **cloud-init** allows.

- Metadata includes data associated with a specific datasource, for example, metadata can include a server name and instance ID. If you are using a specific cloud platform, the platform determines where your instances find user data and metadata. Your platform may require that you add metadata and user data to an HTTP service; in this case, when **cloud-init** runs it consumes metadata and user data from the HTTP service.

- Vendor data is optionally provided by the organization (for example, a cloud provider) and includes information that can customize the image to better fit the environment where the image runs. **cloud-init** acts upon optional vendor data and user data after it reads any metadata and initializes the system. By default, vendor data runs on the first boot. You can disable vendor data execution. Refer to the **cloud-init** Documentation section **Instance Metadata** for a description of metadata; **Datasources** for a list of datasources; and **Vendor Data** for more information about vendor data.

### 2.5. CLOUD-INIT IDENTIFIES THE CLOUD PLATFORM

**cloud-init** attempts to identify the cloud platform using the script **ds-identify**. The script runs on the first boot of an instance.

Adding a datasource directive can save time when **cloud-init** runs. You would add the directive in the `/etc/cloud/cloud.cfg` file or in the `/etc/cloud/cloud.cfg.d` directory. For example:

```
datasource_list:[Ec2]
```

Beyond adding the directive for your cloud platform, you can further configure **cloud-init** by adding additional configuration details, such as metadata URLs.
datasource_list: [Ec2]
  datasource:
    Ec2:

After `cloud-init` runs, you can view a log file (`run/cloud-init/ds-identify.log`) that provides detailed information about the platform.

Additional resources

- Datasources
- How to identify the datasource I’m using
- How can I debug my user data?

2.6. ADDITIONAL RESOURCES

- Upstream documentation for cloud-init
CHAPTER 3. RED HAT SUPPORT FOR CLOUD-INIT

This chapter covers Red Hat support for cloud-init. It includes information about Red Hat products that use cloud-init, cloud-init modules that Red Hat supports, and default directories and files.

3.1. CLOUD-INIT SIGNIFICANT DIRECTORIES AND FILES

The following table includes important directories and files. Review these directories and files; they allow you to perform tasks like:

- Configuring cloud-init
- Finding information about your configuration after cloud-init has run
- Examining log files
- Finding templates

Depending on your scenario and datasource, there can be additional files and directories important to your configuration.

Table 3.1. cloud-init directories and files

<table>
<thead>
<tr>
<th>Directory or File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/etc/cloud/cloud.cfg</td>
<td>The cloud.cfg file includes the basic cloud-init configuration and lets you know in what phase each module runs.</td>
</tr>
<tr>
<td>/etc/cloud/cloud.cfg.d</td>
<td>The cloud.cfg.d directory is where you can add additional directives for cloud-init.</td>
</tr>
<tr>
<td>/var/lib/cloud</td>
<td>When cloud-init runs, it creates a directory layout under /var/lib/cloud. The layout includes directories and files that give specifics on your instance configuration.</td>
</tr>
<tr>
<td>/usr/share/doc/cloud-init/examples</td>
<td>The examples directory includes multiple examples. You can use them to help model your own directives.</td>
</tr>
<tr>
<td>/etc/cloud/templates</td>
<td>This directory includes templates that you can enable in cloud-init for certain scenarios. The templates provide direction for enabling.</td>
</tr>
<tr>
<td>/var/log/cloud-init.log</td>
<td>The cloud-init.log file provides log information helpful for debugging.</td>
</tr>
<tr>
<td>/run/cloud-init</td>
<td>The /run/cloud-init directory includes logged information about your datasource and the ds-identify script.</td>
</tr>
</tbody>
</table>
3.2. RED HAT PRODUCTS THAT USE CLOUD-INIT

You can use `cloud-init` with the following Red Hat products.

- **Red Hat Virtualization.** Once you install `cloud-init` on a VM, you can create a template and leverage `cloud-init` functions for all VMs created from that template. Refer to [Using Cloud-Init to Automate the Configuration of Virtual Machines](#) for information about using `cloud-init` with VMs.

- **Red Hat OpenStack Platform.** You can use `cloud-init` to help configure images for OpenStack. Refer to the [Instances and Images Guide](#) for more information.

- **Red Hat Satellite.** You can use `cloud-init` with Red Hat Satellite. Refer to [Preparing Cloud-init Images in Red Hat Virtualization](#) for more information.

- **Red Hat OpenShift.** You can use `cloud-init` when you create VMs for OpenShift. Refer to [Creating Virtual Machines](#) for more information.

3.3. RED HAT SUPPORTS THESE CLOUD-INIT MODULES

Red Hat supports most `cloud-init` modules. Individual modules can contain multiple configuration options. The following table lists all of the `cloud-init` modules that Red Hat currently supports and provides a brief description and the default module frequency. Refer to [Modules](#) in the cloud-init Documentation section for complete descriptions and options for these modules.

<table>
<thead>
<tr>
<th><code>cloud-init</code> Module</th>
<th>Description</th>
<th>Default Module Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>bootcmd</td>
<td>Runs commands early in the boot process</td>
<td>per always</td>
</tr>
<tr>
<td>ca_certs</td>
<td>Adds CA certificates</td>
<td>per instance</td>
</tr>
<tr>
<td>debug</td>
<td>Enables or disables output of internal information to assist with debugging</td>
<td>per instance</td>
</tr>
<tr>
<td>disable_ec2_metadata</td>
<td>Enables or disables the AWS EC2 metadata</td>
<td>per always</td>
</tr>
<tr>
<td>disk_setup</td>
<td>Configures simple partition tables and file systems</td>
<td>per instance</td>
</tr>
<tr>
<td>final_message</td>
<td>Specifies the output message once <code>cloud-init</code> completes</td>
<td>per always</td>
</tr>
<tr>
<td>foo</td>
<td>Example shows module structure (Module does nothing)</td>
<td>per instance</td>
</tr>
<tr>
<td>growpart</td>
<td>Resizes partitions to fill the available disk space</td>
<td>per always</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>cloud-init Module</th>
<th>Description</th>
<th>Default Module Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>keys_to_console</td>
<td>Allows controls of fingerprints and keys that can be written to the console</td>
<td>per instance</td>
</tr>
<tr>
<td>landscape</td>
<td>Installs and configures a landscape client</td>
<td>per instance</td>
</tr>
<tr>
<td>locale</td>
<td>Configures the system locale and applies it system-wide</td>
<td>per instance</td>
</tr>
<tr>
<td>mcollective</td>
<td>Installs, configures, and starts mcollective</td>
<td>per instance</td>
</tr>
<tr>
<td>migrator</td>
<td>Moves old versions of cloud-init to newer versions</td>
<td>per always</td>
</tr>
<tr>
<td>mounts</td>
<td>Configures mount points and swap files</td>
<td>per instance</td>
</tr>
<tr>
<td>phone_home</td>
<td>Posts data to a remote host after boot completes</td>
<td>per instance</td>
</tr>
<tr>
<td>power_state_change</td>
<td>Completes shutdown and reboot after all configuration modules have run</td>
<td>per instance</td>
</tr>
<tr>
<td>puppet</td>
<td>Installs and configures puppet</td>
<td>per instance</td>
</tr>
<tr>
<td>resizefs</td>
<td>Resizes a file system to use all available space on a partition</td>
<td>per always</td>
</tr>
<tr>
<td>resolv_conf</td>
<td>Configures resolv.conf</td>
<td>per instance</td>
</tr>
<tr>
<td>rh_subscription</td>
<td>Registers a Red Hat Enterprise Linux system</td>
<td>per instance</td>
</tr>
<tr>
<td>rightscale_userdata</td>
<td>Adds support for RightScale configuration hooks to cloud-init</td>
<td>per instance</td>
</tr>
<tr>
<td>rsyslog</td>
<td>Configures remote system logging using rsyslog</td>
<td>per instance</td>
</tr>
<tr>
<td>runcmd</td>
<td>Runs arbitrary commands</td>
<td>per instance</td>
</tr>
<tr>
<td>salt_minion</td>
<td>Installs, configures, and starts salt minion</td>
<td>per instance</td>
</tr>
</tbody>
</table>
### cloud-init Module

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
<th>Default Module Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>scripts_per_boot</td>
<td>Runs per boot scripts</td>
<td>per always</td>
</tr>
<tr>
<td>scripts_per_instance</td>
<td>Runs per instance scripts</td>
<td>per instance</td>
</tr>
<tr>
<td>scripts_per_once</td>
<td>Runs scripts once</td>
<td>per once</td>
</tr>
<tr>
<td>scripts_user</td>
<td>Runs user scripts</td>
<td>per instance</td>
</tr>
<tr>
<td>scripts_vendor</td>
<td>Runs vendor scripts</td>
<td>per instance</td>
</tr>
<tr>
<td>seed_random</td>
<td>Provides random seed data</td>
<td>per instance</td>
</tr>
<tr>
<td>set_hostname</td>
<td>Sets host name and fully qualified domain name (FQDN)</td>
<td>per always</td>
</tr>
<tr>
<td>set_passwords</td>
<td>Sets user passwords and enables or disables SSH password authentication</td>
<td>per instance</td>
</tr>
<tr>
<td>ssh_authkey_fingerprints</td>
<td>Logs fingerprints of user SSH keys</td>
<td>per instance</td>
</tr>
<tr>
<td>ssh_import_id</td>
<td>Imports SSH keys</td>
<td>per instance</td>
</tr>
<tr>
<td>ssh</td>
<td>Configures SSH, and host and authorized SSH keys</td>
<td>per instance</td>
</tr>
<tr>
<td>timezone</td>
<td>Sets the system time zone</td>
<td>per instance</td>
</tr>
<tr>
<td>update_etc_hosts</td>
<td>Updates /etc/hosts</td>
<td>per always</td>
</tr>
<tr>
<td>update_hostname</td>
<td>Updates host name and FQDN</td>
<td>per always</td>
</tr>
<tr>
<td>users_groups</td>
<td>Configures users and groups</td>
<td>per instance</td>
</tr>
<tr>
<td>write_files</td>
<td>Writes arbitrary files</td>
<td>per instance</td>
</tr>
<tr>
<td>yum_add_repo</td>
<td>Adds dnf repository configuration to the system</td>
<td>per always</td>
</tr>
</tbody>
</table>

The following table lists modules that Red Hat does not currently support.

**Table 3.3. Modules not supported**
### 3.4. THE DEFAULT CLOUD.CFG FILE

The `/etc/cloud/cloud.cfg` file lists the modules comprising the basic configuration for `cloud-init`.

The modules in the file are the default modules for `cloud-init`. You can configure the modules for your environment or remove modules you do not need. Modules that are included in `cloud.cfg` do not necessarily do anything by being listed in the file. You need to configure them individually if you want them to perform actions during one of the `cloud-init` phases.

The `cloud.cfg` file provides the chronology for running individual modules. You can add additional modules to `cloud.cfg` as long as Red Hat supports the modules you want to add.

The default contents of the file for Red Hat Enterprise Linux (RHEL) are as follows:

#### NOTE

- Modules run in the order given in `cloud.cfg`. You typically do not change this order.
- The `cloud.cfg` directives can be overridden by user data.
- When running `cloud-init` manually, you can override `cloud.cfg` with command line options.
- Each module includes its own configuration options, where you can add specific information.

<table>
<thead>
<tr>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>apt_configure</td>
</tr>
<tr>
<td>apt_pipeline</td>
</tr>
<tr>
<td>byobu</td>
</tr>
<tr>
<td>chef</td>
</tr>
<tr>
<td>emit_upstart</td>
</tr>
<tr>
<td>grub_dpkg</td>
</tr>
<tr>
<td>ubuntu_init_switch</td>
</tr>
</tbody>
</table>

**users:**
- `default`

- `disable_root: 1`
- `ssh_pwauth: 0`

- `mount_default_fields: [~ , ~, 'auto', 'defaults,nofail,x-systemd.requires=cloud-init.service', '0', '2']`
ssh_deletekeys: 1
ssh_genkeytypes: ['rsa', 'ecdsa', 'ed25519']
syslog_fix_perms: ~
disable_vmware_customization: false

cloud_init_modules: 9
- disk_setup
- migrator
- bootcmd
- write-files
- growpart
- resizefs
- set_hostname
- update_hostname
- update_etc_hosts
- rsyslog
- users-groups
- ssh

cloud_config_modules: 10
- mounts
- locale
- set-passwords
- rh_subscription
- dnf-add-repo
- package-update-upgrade-install
- timezone
- puppet
- chef
- salt-minion
- mcollective
- disable-ec2-metadata
- runcmd

cloud_final_modules: 11
- rightscale_userdata
- scripts-per-once
- scripts-per-boot
- scripts-per-instance
- scripts-user
- ssh-authkey-fingerprints
- keys-to-console
- phone-home
- final-message
- power-state-change

system_info:
default_user: 12
  name: cloud-user
  lock_passwd: true
  gecos: Cloud User
  groups: [adm, systemd-journal]
sudo: ["ALL=(ALL) NOPASSWD:ALL"]
shell: /bin/bash
distro: rhel 13
paths:
cloud_dir: /var/lib/cloud
templates_dir: /etc/cloud/templates
ssh_svcname: sshd

# vim:syntax=yaml

1. Specifies the default user for the system. Refer to Users and Groups for more information.
2. Enables or disables root login. Refer to Authorized Keys for more information.
3. Specifies whether ssh is configured to accept password authentication. Refer to Set Passwords for more information.
4. Configures mount points; must be a list containing six values. Refer to Mounts for more information.
5. Specifies whether to remove default host SSH keys. Refer to Host Keys for more information.
6. Specifies key types to generate. Refer to Host Keys for more information. Note that for RHEL 8.4 and earlier, the default value of this line is ~.
7. cloud-init runs at multiple stages of boot. Set this option so that cloud-init can log all stages to its log file. Find more information about this option in the cloud-config.txt file in the /usr/share/doc/cloud-init/examples directory.
8. Enables or disables VMware vSphere customization
9. The modules in this section are services that run when the cloud-init service starts, early in the boot process.
10. These modules run during cloud-init configuration, after initial boot.
11. These modules run in the final phase of cloud-init, after the configuration finishes.
12. Specifies details about the default user. Refer to Users and Groups for more information.
13. Specifies the distribution
14. Specifies the main directory that contains cloud-init-specific subdirectories. Refer to Directory layout for more information.
15. Specifies where templates reside
16. The name of the SSH service

Additional resources
- How to find files
- Modules

3.5. THE CLOUD.CFG.D DIRECTORY
cloud-init acts upon directives that you provide and configure. Typically, those directives are included in the cloud.cfg.d directory.

NOTE

While you can configure modules by adding user data directives within the cloud.cfg file, as a best practice consider leaving cloud.cfg unmodified. Add your directives to the /etc/cloud/cloud.cfg.d directory. Adding directives to this directory can make future modifications and upgrades easier.

There are multiple ways to add directives. You can include directives in a file named *.cfg, which includes the heading #cloud-config. Typically, the directory would contain multiple *.cfg files. There are other options for adding directives, for example, you can add a user data script. Refer to User-Data Formats for more information.

Additional resources

- How to locate configuration files
- Cloud config examples

3.6. THE DEFAULT 05_LOGGING.CFG FILE

The 05_logging.cfg file sets logging information for cloud-init. The /etc/cloud/cloud.cfg.d directory includes this file, along with other cloud-init directives that you add.

cloud-init uses the logging configuration in 05_logging.cfg by default. The default contents of the file for Red Hat Enterprise Linux (RHEL) are as follows:

```yaml
## This yaml formatted config file handles setting
## logger information.  The values that are necessary to be set
## are seen at the bottom. The top '_log' are only used to remove
## redundancy in a syslog and fallback-to-file case.
#
## The 'log_cfgs' entry defines a list of logger configs
## Each entry in the list is tried, and the first one that
## works is used. If a log_cfg list entry is an array, it will
## be joined with '\n'.

_log:
- &log_base |
  [loggers]
  keys=root,cloudinit

  [handlers]
  keys=consoleHandler,cloudLogHandler

  [formatters]
  keys=simpleFormatter,arg0Formatter

  [logger_root]
  level=DEBUG
  handlers=consoleHandler,cloudLogHandler

  [logger_cloudinit]
  level=DEBUG
```
qualname=cloudinit
handlers=
propagate=1

[handler_consoleHandler]
class=StreamHandler
level=WARNING
formatter=arg0Formatter
args=(sys.stderr,)

[formatter_arg0Formatter]
format=%(asctime)s - %(filename)s[%(levelname)s]: %(message)s

[formatter_simpleFormatter]
format=[CLOUDINIT] %(filename)s[%(levelname)s]: %(message)s

- &log_file |
[handler_cloudLogHandler]
class=FileHandler
level=DEBUG
formatter=arg0Formatter
args=('/var/log/cloud-init.log',)
- &log_syslog |
[handler_cloudLogHandler]
class=handlers.SysLogHandler
level=DEBUG
formatter=simpleFormatter
args=('/dev/log', handlers.SysLogHandler.LOG_USER)

log_cfs:
# Array entries in this list will be joined into a string
# that defines the configuration.
#
# If you want logs to go to syslog, uncomment the following line.
# - ['log_base', 'log_syslog']
#
# The default behavior is to just log to a file.
# This mechanism that does not depend on a system service to operate.
- ['log_base', 'log_file']
#
# A file path can also be used.
# - /etc/log.conf

# This tells cloud-init to redirect its stdout and stderr to
# 'tee -a /var/log/cloud-init-output.log' so the user can see output
# there without needing to look on the console.
output: {all: ['| tee -a /var/log/cloud-init-output.log']}

Additional resources

- Logging

3.7. THE CLOUD-INIT /VAR/LIB/CLOUD DIRECTORY LAYOUT

When cloud-init first runs, it creates a directory layout that includes information about your instance and cloud-init configuration.
The directory can include optional directories, such as /scripts/vendor.

The following is a sample directory layout for **cloud-init**.

```
/var/lib/cloud/
  - data/
    - instance-id
    - previous-instance-id
    - previous-datasource
    - previous-hostname
    - result.json
    - set-hostname
    - status.json
  - handlers/
    - instance
      - boot-finished
      - cloud-config.txt
      - datasource
      - handlers/
        - obj.pkl
      - scripts/
        - sem/
      - user-data.txt
      - user-data.txt.i
      - vendor-data.txt
      - vendor-data.txt.i
  - instances/
    f111ee00-0a4a-4eea-9c17-3fa164739c55/
      - boot-finished
      - cloud-config.txt
      - datasource
      - handlers/
        - obj.pkl
      - scripts/
        - sem/
      - user-data.txt
      - user-data.txt.i
      - vendor-data.txt
      - vendor-data.txt.i
    - scripts/
      - per-boot/
      - per-instance/
      - per-once/
      - vendor/
    - seed/
      - sem/
        - config_scripts_per_once.once
```

Additional resources

- Directory layout
CHAPTER 4. CONFIGURING CLOUD-INIT

This chapter includes examples of the most common configuration tasks for cloud-init.

Your cloud-init configuration can require that you add directives to the cloud.cfg file and the cloud.cfg.d directory. Alternatively, your specific data source might require that you add directives to files, such as a user data file and a metadata file. A data source might require that you upload your directives to an HTTP server. Check the requirements of your data source and add directives accordingly.

4.1. CREATING A VIRTUAL MACHINE THAT INCLUDES CLOUD-INIT FOR A NOCLOUD DATASOURCE

To create a new virtual machine (VM) that includes cloud-init, see the following procedure. In this procedure, you create a meta-data and user-data file.

- Your meta-data file includes instance details.
- Your user-data file includes information to create a user and grant access.

Then, you include these files in a new ISO image, and you attach the ISO file to a new VM you create from a KVM Guest Image. In this scenario, the datasource is NoCloud.

Procedure

1. Create a directory named cloudinitiso and move into it.

   $ mkdir cloudinitiso
   $ cd cloudinitiso

2. Create a file named meta-data. Add the following information to the file.

   instance-id: citest
   local-hostname: citest-1

3. Create a file named user-data. Include the following information in the file.

   #cloud-config
   password: cilogon
   chpasswd: {expire: False}
   ssh_pwauth: True
   ssh_authorized_keys:
   - ssh-rsa AAA...fhHQ== sample@redhat.com

   NOTE
   The final line of the user-data file references an SSH public key. Find your SSH public keys in ~/.ssh/id_rsa.pub. When trying this sample procedure, modify the line to include one of your public keys.

4. Use the genisoimage command to create an ISO image that includes user-data and meta-data.
# genisoimage -output ciiso.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 as an attachment to the image.

```
virt-install \\
--memory 4096 \\
--vcpus 4 \\
--name mytestcivm \\
--disk /var/lib/libvirt/images/rhel-8.1-x86_64-kvm.qcow2,device=disk,bus=virtio,format=qcow2 \\
--disk /home/sample/cloudinitiso/ciiso.iso,device=cdrom \\
--os-type Linux \\
--os-variant rhel9.0 \\
--virt-type kvm \\
--graphics none \\
--import
```

7. Log on to your image as `cloud-user`. Your password is `cilogan`.

```
citest-1 login: cloud-user
Password: 
[cloud-user@citest-1 ~]$
```

**Verification**

- Check the `cloud-init` status to see that it has completed its tasks.

```
[cloud-user@citest-1 instance]$ cloud-init status
status: done
```

- `cloud-init` creates the `cloud-init` directory layout under `/var/lib/cloud` when it runs, and it updates or changes certain directory contents based upon the directives you have specified. For example, you can confirm that the datasource is `NoCloud` by checking the datasource file.

```
$ cd /var/lib/cloud/instance
$ cat datasource
DataSourceNoCloud: DataSourceNoCloud [seed=/dev/sr0][dsmode=net]
```

`cloud-init` copies user-data into `/var/lib/cloud/instance/user-data.txt`.

```
$ cat user-data.txt
```
#cloud-config
password: cilogon
chpasswd: {expire: False}
ssh_pwauth: True
ssh_authorized_keys:
- ssh-rsa AAA...fhHQ== sample@redhat.com

These are samples. The cloud-init directory layout includes much more information.

NOTE

For OpenStack, the Creating and managing instances includes information for configuring an instance using cloud-init. See Creating a customized instance for specific procedures.

Additional resources

- Upstream documentation for the NoCloud data source

## 4.2. EXPIRING A CLOUD USER PASSWORD WITH CLOUD-INIT

You can force cloud-user to change the cloud-user password at the first login. Perform the following procedure to expire a password.

### Procedure

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the cloud.cfg.d directory.

   ```plaintext
   #cloud-config
   password: mypassword
   chpasswd: {expire: True}
   ssh_pwauth: True
   ssh_authorized_keys:
   - ssh-rsa AAA...SDvz user1@yourdomain.com
   - ssh-rsa AAB...QTuo user2@yourdomain.com
   
   This works to expire the password because password and chpasswd operate on the default user unless you indicate otherwise.
   
   NOTE
   
   This is a global setting. When you set chpasswd to True, all users you create need to change their passwords when they log in.
4.3. CHANGING A DEFAULT USER NAME WITH CLOUD-INIT

You can change the default user name to something other than `cloud-user`.

**Procedure**

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.

   ```
   #cloud-config
   user: <username>
   password: mypassword
   chpasswd: {expire: False}
   ssh_pwauth: True
   sshAuthorizedKeys:
     - ssh-rsa AAA...SDvz user1@yourdomain.com
     - ssh-rsa AAB...QTuo user2@yourdomain.com
   ```

2. Add the line `user: <username>`, replacing `<username>` with the new default user name.

   ```
   #cloud-config
   user: username
   password: mypassword
   chpasswd: {expire: False}
   ssh_pwauth: True
   sshAuthorizedKeys:
     - ssh-rsa AAA...SDvz user1@yourdomain.com
     - ssh-rsa AAB...QTuo user2@yourdomain.com
   ```

4.4. SETTING A ROOT PASSWORD WITH CLOUD-INIT

To set the root password, create a user list.

**Procedure**

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.

   ```
   #cloud-config
   user: username
   password: mypassword
   chpasswd: {expire: False}
   ssh_pwauth: True
   sshAuthorizedKeys:
     - ssh-rsa AAA...SDvz user1@yourdomain.com
     - ssh-rsa AAB...QTuo user2@yourdomain.com
   ```

2. Create a user list in the `chpasswd` section of the file. The format is shown in the following sample.

   ```
   #cloud-config
   user: username
   password: mypassword
   chpasswd: {expire: False}
   ssh_pwauth: True
   sshAuthorizedKeys:
     - ssh-rsa AAA...SDvz user1@yourdomain.com
     - ssh-rsa AAB...QTuo user2@yourdomain.com
   ```

   ```
   NOTE
   White space is significant. Do not include white space before or after the colon in your user list. If you include white space, the password is set with a space in it.
   ```
ssh_pwauth: True
ssh_authorized_keys:
- ssh-rsa AAA...SDvz user1@yourdomain.com
- ssh-rsa AAB...QTuo user2@yourdomain.com
chpasswd:
  list: |
    root:mypassword
    cloud-user:mypassword
  expire: False

NOTE
If you use this method to set the user password, you must set all passwords in this section.

4.5. MANAGING RED HAT SUBSCRIPTIONS WITH CLOUD-INIT

You can use the rh_subscription directive to register your system. Samples follow. For each subscription, you would edit your user data.

Procedure
The following example uses the auto-attach and service-level options.

- Under rh_subscription, add your username and password, set auto-attach to True, and set service-level to self-support.

  rh_subscription:
  username: sample@redhat.com
  password: 'mypassword'
  auto-attach: True
  service-level: self-support

NOTE
The service-level option requires that you use the auto-attach option.

The following example uses the activation-key and org options.

- Under rh_subscription, add your activation key and org number and set auto-attach to True.

  rh_subscription:
  activation-key: example_key
  org: 12345
  auto-attach: True

The following example adds a subscription pool.

- Under rh_subscription, add your username, password, and pool number.

  rh_subscription:
  username: sample@redhat.com
  password: 'password'
  add-pool: XYZ01234567
NOTE

This sample is the equivalent of the `subscription-manager attach --pool=XYZ01234567` command.

The following example sets a server host name in the `/etc/rhsm/rhsm.conf` file.

- Under `rh_subscription`, add your `username`, `password`, `server-hostname`, and set `auto-attach` to `True`.

```
rh_subscription:
  username: sample@redhat.com
  password: 'password'
  server-hostname: test.example.com
  auto-attach: True
```

### 4.6. ADDING USERS AND USER OPTIONS WITH CLOUD-INIT

You create and describe users in a `users` section. You can modify the section to add more users to your initial system configuration, and you can set additional user options.

If you add the `users` section, you must also set the default user options in this section.

**Procedure**

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.

```
[NOTE]

All user directives include `#cloud-config` at the top of the file so that `cloud-init` recognizes the file as containing user directives. When you include directives in the `cloud.cfg.d` directory, name the file `*.cfg`, and always include `#cloud-config` at the top of the file.
```

2. Add or modify the `users` section to add users.

- If you want `cloud-user` to be the default user created along with the other users you specify, ensure that you add `default` as the first entry in the section. If it is not the first entry, `cloud-user` is not created.

- By default, users are labeled as `unconfined_u` if there is not an `selinux-user` value.

```
#cloud-config
users:
  - default
    name: user2
    gecos: User N. Ame
    selinux-user: staff_u
    groups: users,wheel
    ssh_pwauth: True
    ssh_authorized_keys:
```

4.7. RUNNING FIRST BOOT COMMANDS WITH CLOUD-INIT

You can use the `runcmd` and `bootcmd` sections to execute commands during startup and initialization.

The `bootcmd` section executes early in the initialization process and by default runs on every boot. The `runcmd` section executes near the end of the process and is only executed during the first boot and initialization.

Procedure

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.

   ```yaml
   #cloud-config
   users:
   - default
   - name: user2
gecos: User N. Ame
groups: users
chpasswd:
list: |
  root:password
  fedora:myfedpassword
  user2:mypassword2
expire: False
```

   2. Add the sections for `bootcmd` and `runcmd`; include commands you want `cloud-init` to execute.

   ```bash
   bootcmd:
   - echo New MOTD >> /etc/motd
   runcmd:
   - echo New MOTD2 >> /etc/motd
   ```

4.8. ADDING ADDITIONAL SUDOERS WITH CLOUD-INIT
You can configure a user as a sudoer by adding a `sudo` and `groups` entry to the `users` section.

### Procedure

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.

   ```
   #cloud-config
   users:
   - default
   - name: user2
     gecos: User D. Two
     sudo: ["ALL=(ALL) NOPASSWD:ALL"]
     groups: wheel,adm,systemd-journal
     ssh_pwauth: True
     ssh Authorized_keys:
       - ssh-rsa AA...vz user@domain.com
   cphpasswd:
   list: |
     root:password
     cloud-user:mypassword
     user2:mypassword2
   expire: False
   ```

2. Add a `sudo` entry and specify the user access. For example, `sudo: ALL=(ALL) NOPASSWD:ALL` allows a user unrestricted user access.

3. Add a `groups` entry and specify the groups that include the user.

### 4.9. Setting up a static networking configuration with `cloud-init`

You can set up your network configuration with `cloud-init` by adding a `network-interfaces` section to your metadata.

Red Hat Enterprise Linux provides its default networking service through `NetworkManager`, which is a dynamic network control and configuration daemon that keeps network devices and connections up and active when they are available.

Your datasource might provide a network configuration. Refer to the `cloud-init` documentation section `Network Configuration Sources` for more information.

If you specify no network configuration for `cloud-init` and have not disabled network configuration, `cloud-init` tries to determine if any attached devices have a connection. If it finds a connected device, it generates a network configuration that issues a DHCP request on the interface. Refer to the `cloud-init` documentation section `Fallback Network Configuration` for more information.
Procedure

The following example adds a static networking configuration.

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.

   **NOTE**
   
   All user directives include `#cloud-config` at the top of the file so that `cloud-init` recognizes the file as containing user directives. When you include directives in the `cloud.cfg.d` directory, name the file `*.cfg`, and always include `#cloud-config` at the top of the file.

2. Add a `network-interfaces` section.

   ```yaml
   network:
   version: 1
   config:
   - type: physical
     name: eth0
   subnets:
   - type: static
     address: 192.168.1.10/24
     gateway: 192.168.1.254
   ```

   **NOTE**
   
   You can disable a network configuration by adding the following information to your metadata.

   ```yaml
   network:
   config: disabled
   ```

Additional resources

- Network Configuration
- NoCloud

4.10. CONFIGURING ONLY A ROOT USER WITH CLOUD-INIT

You can configure your user data so that you have a root user and no other users.

Procedure

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the `cloud.cfg.d` directory.
2. Create an entry for the user root in the users section.
   The simple example that follows includes a users section with only the name option.

   ```yaml
   users:
   - name: root
     chpasswd:
       list: |
         root:password
     expire: False
   ```

3. Optionally, set up SSH keys for the root user.

   ```yaml
   users:
   - name: root
     ssh_pwauth: True
     sshAuthorizedKeys:
       - ssh-rsa AA..vz user@domain.com
   ```

4.11. SETTING UP STORAGE WITH CONTAINER-STORAGE-SETUP IN CLOUD-INIT

You can set up storage by referencing the container-storage-setup utility within the write_files module.

Procedure

1. Depending upon the requirements of your datasource, open your user-data file for editing, or otherwise add the following directive to the cloud.cfg.d directory.

   ```yaml
   write_files:
   - path: /etc/sysconfig/docker-storage-setup
     permissions: 0644
   ```

   **NOTE**

   All user directives include #cloud-config at the top of the file so that cloud-init recognizes the file as containing user directives. When you include directives in the cloud.cfg.d directory, name the file *.cfg, and always include #cloud-config at the top of the file.

2. Add or modify the write_files module to include the path to the container-storage-setup utility.
   The following example sets the size of the root logical volume to 6GB rather than the default 3GB.

   ```yaml
   write_files:
   - path: /etc/sysconfig/docker-storage-setup
     permissions: 0644
   ```
NOTE
Prior to RHEL 7.4, container-storage-setup was called docker-storage-setup. If you are using OverlayFS for storage, as of RHEL 7.4 you can now use that type of file system with SELinux in enforcing mode.

4.12. CHANGING THE SYSTEM LOCALE WITH CLOUD-INIT

You can configure the system location with the locale module.

Procedure

1. Depending upon the requirements of your datasource, open your meta-data file for editing, or otherwise add the following directive to the cloud.cfg file or the cloud.cfg.d directory.

2. Add the locale directive, specifying the location. The following sample sets the locale to ja_JP (Japan) with UTF-8 encoding.

   #cloud-config
   locale: ja_JP.UTF-8

Additional resources

- Locale

4.13. CLOUD-INIT AND SHELL SCRIPTS

You can add list values or string values to bootcmd or runcmd. You can also provide a shell script within your userdata.

- If you use a list value for bootcmd or runcmd, each list item is run in turn using execve.
- If you use a string value, then the entire string is run as a shell script.
- If you want to use cloud-init to run a shell script, you can provide a shell script (complete with shebang (#!)) instead of providing cloud-init with a .yaml file.

Refer to Run commands on first boot for examples of how to put shell scripts in bootcmd and runcmd.

4.14. PREVENTING CLOUD-INIT FROM UPDATING CONFIG FILES

When you create or restore an instance from a backup image, the instance ID changes. The change in instance ID can cause cloud-init to update configuration files.

Perform the following procedure to ensure that cloud-init does not update certain configuration files when you create or restore from backup.

Procedure
1. Open the `/etc/cloud/cloud.cfg` file for editing.

2. Comment out or remove the configuration that you do not want `cloud-init` to update when you restore your instance. For example, to avoid updating the SSH key file, remove `-ssh` from the `cloud_init_modules` section.

   ```
   cloud_init_modules:
   - disk_setup
   - migrator
   - bootcmd
   - write-files
   - growpart
   - resizefs
   - set_hostname
   - update_hostname
   - update_etc_hosts
   - rsyslog
   - users-groups
   # - ssh
   ```

Verifications

You can check to see which configuration files `cloud-init` has updated. To do so, examine the `/var/log/cloud/cloud-init.log` file. Updated files are logged during instance startup with messages beginning with `Writing to`. For example:

```
2019-09-03 00:16:07,XXX - util.py[DEBUG]: Writing to /root/.ssh/authorized_keys - wb: [XXX] 554 bytes
2019-09-03 00:16:08,XXX - util.py[DEBUG]: Writing to /etc/ssh/sshd_config - wb: [XXX] 3905 bytes
```

4.15. MODIFYING A VM CREATED FROM A KVM GUEST IMAGE AFTER CLOUD-INIT HAS RUN

To modify your `cloud-init` configuration before rerunning `cloud-init`, use the following procedure. When you launch a VM that includes the `cloud-init` package installed and enabled, `cloud-init` runs in its default state on that initial boot of your VM.

Procedure

1. Log in to your VM.

2. Add or change directives, for example, modify the `cloud.cfg` file in the `/etc/cloud` directory or add directives to the `/etc/cloud/cloud.cfg.d` directory.

3. Run the `cloud-init clean` command to clean directories so that `cloud-init` can rerun. You can also run the following commands as root to clean the VM.

   ````
   `rm -Rf /var/lib/cloud/instances/*`
   `rm -Rf /var/lib/cloud/instance`
   `rm -Rf /var/lib/cloud/data/*`
   ```
You can save the cleaned image as a new image and use that image for multiple VMs. The new VMs run `cloud-init` using your updated `cloud-init` configuration.

4. Rerun `cloud-init` or reboot the VM. `cloud-init` reruns, implementing the configuration changes you made.

### 4.16. MODIFYING A VM FOR A SPECIFIC DATASOURCE AFTER CLOUD-INIT HAS RUN

To modify your `cloud-init` configuration before rerunning `cloud-init`, see the following procedure. This procedure uses OpenStack as an example. Note that the exact steps you need to perform vary based on your datasource.

**Procedure**

1. Create and launch an instance for the OpenStack Platform. For information about creating instances for OpenStack, see Creating an instance. In this example, our virtual machine includes `cloud-init`, which runs upon boot of the virtual machine.

2. Add or change directives. For example, modify the `user-data.file` file that is stored on the OpenStack HTTP server.

3. Clean the virtual machine. Run the following commands as root.

   ```sh
   `rm -rf /etc/resolv.conf /run/cloud-init`
   `userdel -rf cloud-user`
   `hostnamectl set-hostname localhost.localdomain`
   `rm /etc/NetworkManager/conf.d/99-cloud-init.conf`
   ```

   **NOTE**
   You can save the cleaned image as a new image and use that image for multiple virtual machines. The new virtual machines run `cloud-init` using your updated `cloud-init` configuration.

4. Rerun `cloud-init` or reboot the virtual machine. `cloud-init` reruns, implementing the configuration changes you made.

### 4.17. TROUBLESHOOTING CLOUD-INIT

You can troubleshoot your instance after `cloud-init` has run by examining your configuration and log files. Once you have identified the issue, you can rerun `cloud-init` on your instance.

You can run `cloud-init` from the command line using the `cloud-init` command. To view the command syntax, along with a description of the optional arguments and subcommands, run the `cloud-init --help` command. The basic syntax follows.

```
          {init,modules,single,query,dhclient-hook,features,analyze,devel,collect-logs,clean,status}
```
The procedure that follows offers ideas for identifying issues with `cloud-init` and samples for rerunning the program.

**Procedure**

1. Review the `cloud-init` configuration files.
   
a. Examine the `/etc/cloud/cloud.cfg` configuration file. Check which modules are included under `cloud_init_modules`, `cloud_config_modules`, and `cloud_final_modules`.

   b. Check directives (*.cfg files) in the `/etc/cloud/cloud.cfg.d` directory.

2. Review the `/var/log/cloud-init.log` and `/var/log/cloud-init-output.log` files for details on a specific issue. For example, if the issue was that the root partition was not automatically extended, check log messages for `growpart`. If the file system was not extended, check log messages for `resizefs`. For example:

   ```
   # grep resizefs /var/log/cloud-init.log
   ```

   **NOTE**

   `growpart` does not support LVM. If your root partition is based in LVM, the root partition is not automatically extended upon first boot.

   
   - Rerun `cloud-init` with only the init modules.
     ```
     /usr/bin/cloud-init -d init
     ```

   - Rerun `cloud-init` with all modules in your configuration.
     ```
     /usr/bin/cloud-init -d modules
     ```

   - Delete the `cloud-init` cache and force `cloud-init` to run after boot.
     ```
     rm -rf /var/lib/cloud/* && /usr/bin/cloud-init -d init
     ```

   - Run the following commands to clean directories and simulate a clean instance.
     ```
     rm -Rf /var/lib/cloud/instances/*
     rm -Rf /var/lib/cloud/instance
     rm -Rf /var/lib/cloud/data/*
     reboot
     ```

   - Run the following commands to rerun `cloud-init`.
     ```
     cloud-init init --local
     cloud-init init
     ```

**Additional resources**

- **CLI commands**