Red Hat Enterprise Linux 9

Configuring basic system settings

Set up the essential functions of your system and customize your system environment

Last Updated: 2024-07-09

Red Hat Enterprise Linux 9 Configuring basic system settings

Set up the essential functions of your system and customize your system environment

Legal Notice

Abstract

Perform basic system administration tasks, configure the environment settings, register your system, and configure network access and system security. Administer users, groups, and file permissions. Use system roles for managing system configurations interface on multiple RHEL systems. Use systemd for efficient service management. Configure the Network Time Protocol (NTP) with chrony. Backup and restore your system by using ReaR.

Table of Contents

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. CONFIGURING AND MANAGING BASIC NETWORK ACCESS

This section describes only basic options on how to configure network settings in Red Hat Enterprise Linux.

1.1. CONFIGURING THE NETWORK AND HOST NAME IN THE GRAPHICAL INSTALLATION MODE

Follow the steps in this procedure to configure your network and host name.

Procedure

1. From the **Installation Summary** window, click **Network and Host Name**.
2. From the list in the left-hand pane, select an interface. The details are displayed in the right-hand pane.

NOTE

There are several types of network device naming standards used to identify network devices with persistent names, for example, **em1** and **wl3sp0**. For information about these standards, see the *Configuring and managing networking* document.

3. Toggle the **ON**/**OFF** switch to enable or disable the selected interface.

NOTE

The installation program automatically detects locally accessible interfaces, and you cannot add or remove them manually.

4. Click **+** to add a virtual network interface, which can be either: Team (deprecated), Bond, Bridge, or VLAN.
5. Click **-** to remove a virtual interface.
6. Click **Configure** to change settings such as IP addresses, DNS servers, or routing configuration for an existing interface (both virtual and physical).
7. Type a host name for your system in the **Host Name** field.

NOTE

- The host name can either be a fully qualified domain name (FQDN) in the format ***hostname.domainname***, or a short host name without the domain. Many networks have a Dynamic Host Configuration Protocol (DHCP) service that automatically supplies connected systems with a domain name. To allow the DHCP service to assign the domain name to this system, specify only the short host name.
- When using static IP and host name configuration, it depends on the planned system use case whether to use a short name or FQDN. Red Hat Identity Management configures FQDN during provisioning but some 3rd party software products may require short name. In either case, to ensure availability of both forms in all situations, add an entry for the host in **/etc/hosts** in the format **IP FQDN short-alias**.
- The value **localhost** means that no specific static host name for the target system is configured, and the actual host name of the installed system is configured during the processing of the network configuration, for example, by NetworkManager using DHCP or DNS.
- Host names can only contain alphanumeric characters and **-** or **.**. Host name should be equal to or less than 64 characters. Host names cannot start or end with **-** and **.**. To be compliant with DNS, each part of a FQDN should be equal to or less than 63 characters and the FQDN total length, including dots, should not exceed 255 characters.

8. Click **Apply** to apply the host name to the installer environment.
9. Alternatively, in the **Network and Hostname** window, you can choose the Wireless option. Click **Select network** in the right-hand pane to select your wifi connection, enter the password if required, and click **Done**.

Additional resources

- Performing an advanced RHEL 9 installation

1.2. CONFIGURING AN ETHERNET CONNECTION BY USING NMCLI

If you connect a host to the network over Ethernet, you can manage the connection's settings on the command line by using the **nmcli** utility.

Prerequisites

- A physical or virtual Ethernet Network Interface Controller (NIC) exists in the server's configuration.

Procedure

1. List the NetworkManager connection profiles:

```
# nmcli connection show
NAME                UUID                                  TYPE      DEVICE
Wired connection 1  a5eb6490-cc20-3668-81f8-0314a27f3f75  ethernet  enp1s0
```

By default, NetworkManager creates a profile for each NIC in the host. If you plan to connect this NIC only to a specific network, adapt the automatically-created profile. If you plan to connect this NIC to networks with different settings, create individual profiles for each network.

2. If you want to create an additional connection profile, enter:

```
# nmcli connection add con-name <connection-name> ifname <device-name> type ethernet
```

Skip this step to modify an existing profile.

3. Optional: Rename the connection profile:

```
# nmcli connection modify "Wired connection 1" connection.id "Internal-LAN"
```

On hosts with multiple profiles, a meaningful name makes it easier to identify the purpose of a profile.

4. Display the current settings of the connection profile:

```
# nmcli connection show Internal-LAN
...
connection.interface-name:     enp1s0
connection.autoconnect:        yes
ipv4.method:                   auto
ipv6.method:                   auto
...
```

5. Configure the IPv4 settings:

- To use DHCP, enter:

```
# nmcli connection modify Internal-LAN ipv4.method auto
```

Skip this step if **ipv4.method** is already set to **auto** (default).

- To set a static IPv4 address, network mask, default gateway, DNS servers, and search domain, enter:

```
# nmcli connection modify Internal-LAN ipv4.method manual ipv4.addresses 192.0.2.1/24 ipv4.gateway 192.0.2.254 ipv4.dns 192.0.2.200 ipv4.dns-search example.com
```

6. Configure the IPv6 settings:

- To use stateless address autoconfiguration (SLAAC), enter:

```
# nmcli connection modify Internal-LAN ipv6.method auto
```

Skip this step if **ipv6.method** is already set to **auto** (default).

- To set a static IPv6 address, network mask, default gateway, DNS servers, and search domain, enter:

```
# nmcli connection modify Internal-LAN ipv6.method manual ipv6.addresses
2001:db8:1::fffe/64 ipv6.gateway 2001:db8:1::fffe ipv6.dns 2001:db8:1::ffbb
ipv6.dns-search example.com
```

7. To customize other settings in the profile, use the following command:

```
# nmcli connection modify <connection-name> <setting> <value>
```

   Enclose values with spaces or semicolons in quotes.

8. Activate the profile:

```
# nmcli connection up Internal-LAN
```

Verification

1. Display the IP settings of the NIC:

```
# ip address show enp1s0
2: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP
group default qlen 1000
    link/ether 52:54:00:17:b8:b6 brd ff:ff:ff:ff:ff:ff
    inet 192.0.2.1/24 brd 192.0.2.255 scope global noprefixroute enp1s0
       valid_lft forever preferred_lft forever
    inet6 2001:db8:1::fffe/64 scope global noprefixroute
       valid_lft forever preferred_lft forever
```

2. Display the IPv4 default gateway:

```
# ip route show default
default via 192.0.2.254 dev enp1s0 proto static metric 102
```

3. Display the IPv6 default gateway:

```
# ip -6 route show default
default via 2001:db8:1::ffee dev enp1s0 proto static metric 102 pref medium
```

4. Display the DNS settings:

```
# cat /etc/resolv.conf
search example.com
nameserver 192.0.2.200
nameserver 2001:db8:1::ffbb
```

   If multiple connection profiles are active at the same time, the order of **nameserver** entries depend on the DNS priority values in these profile and the connection types.

5. Use the **ping** utility to verify that this host can send packets to other hosts:

```
# ping <host-name-or-IP-address>
```

Troubleshooting

- Verify that the network cable is plugged-in to the host and a switch.
- Check whether the link failure exists only on this host or also on other hosts connected to the same switch.
- Verify that the network cable and the network interface are working as expected. Perform hardware diagnosis steps and replace defect cables and network interface cards.
- If the configuration on the disk does not match the configuration on the device, starting or restarting NetworkManager creates an in-memory connection that reflects the configuration of the device. For further details and how to avoid this problem, see the NetworkManager duplicates a connection after restart of NetworkManager service solution.

Additional resources

- **nm-settings(5)** man page

1.3. CONFIGURING AN ETHERNET CONNECTION BY USING NMTUI

If you connect a host to the network over Ethernet, you can manage the connection's settings in a text-based user interface by using the **nmtui** application. Use **nmtui** to create new profiles and to update existing ones on a host without a graphical interface.

NOTE

In **nmtui**:

- Navigate by using the cursor keys.
- Press a button by selecting it and hitting **Enter**.
- Select and clear checkboxes by using **Space**.

Prerequisites

- A physical or virtual Ethernet Network Interface Controller (NIC) exists in the server's configuration.

Procedure

1. If you do not know the network device name you want to use in the connection, display the available devices:

```
# nmcli device status
DEVICE     TYPE      STATE                CONNECTION
enp1s0     ethernet  unavailable          --
...
```

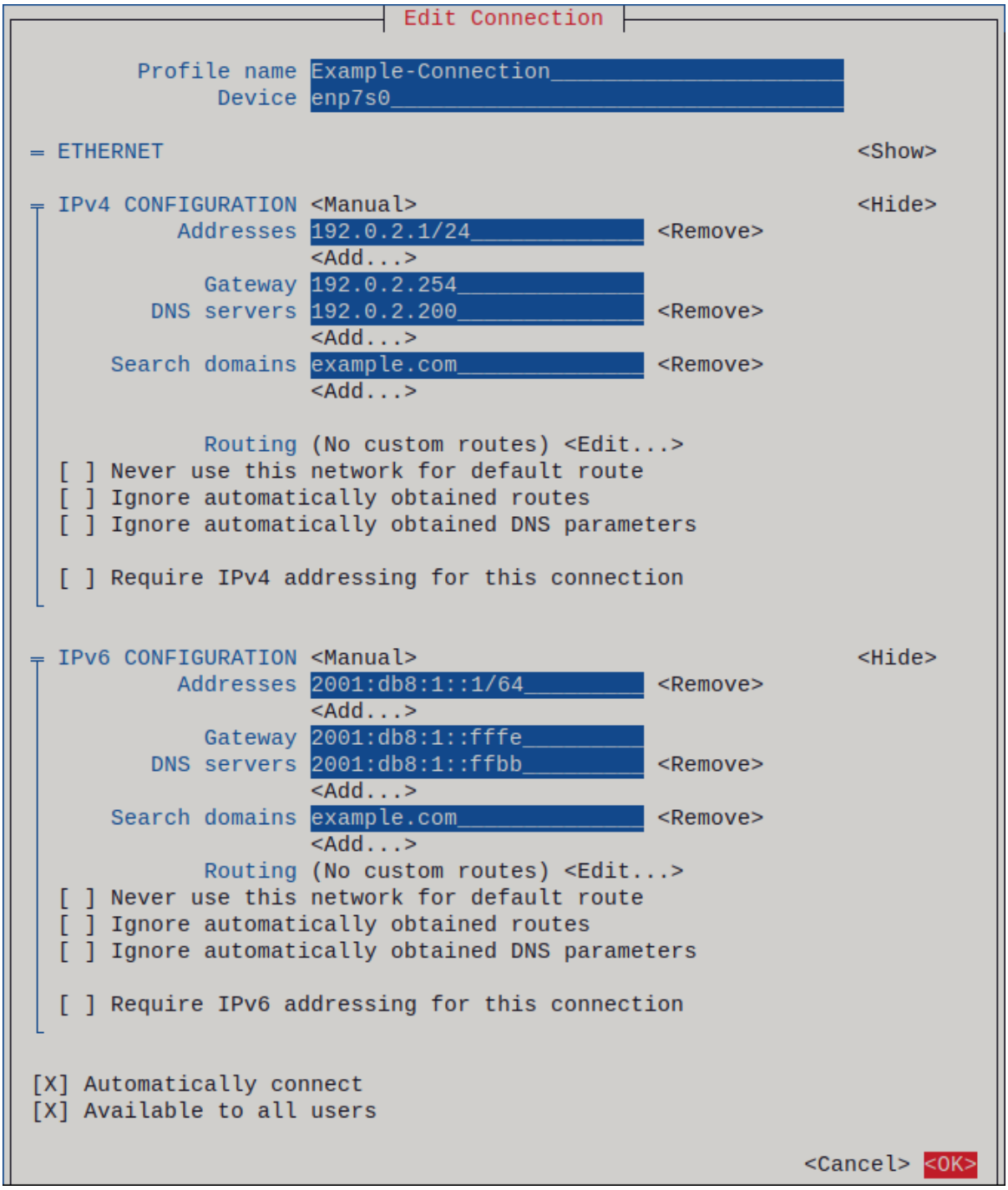
2. Start **nmtui**:

```
# nmtui
```

3. Select **Edit a connection**, and press **Enter**.

4. Choose whether to add a new connection profile or to modify an existing one:
   - To create a new profile:
     i. Press **Add**.
     ii. Select **Ethernet** from the list of network types, and press **Enter**.
   - To modify an existing profile, select the profile from the list, and press **Enter**.
5. Optional: Update the name of the connection profile.
   On hosts with multiple profiles, a meaningful name makes it easier to identify the purpose of a profile.
6. If you create a new connection profile, enter the network device name into the **Device** field.
7. Depending on your environment, configure the IP address settings in the **IPv4 configuration** and **IPv6 configuration** areas accordingly. For this, press the button next to these areas, and select:
   - **Disabled**, if this connection does not require an IP address.
   - **Automatic**, if a DHCP server dynamically assigns an IP address to this NIC.
   - **Manual**, if the network requires static IP address settings. In this case, you must fill further fields:
     i. Press **Show** next to the protocol you want to configure to display additional fields.
     ii. Press **Add** next to **Addresses**, and enter the IP address and the subnet mask in Classless Inter-Domain Routing (CIDR) format.
     If you do not specify a subnet mask, NetworkManager sets a /**32** subnet mask for IPv4 addresses and /**64** for IPv6 addresses.
     iii. Enter the address of the default gateway.
     iv. Press **Add** next to **DNS servers**, and enter the DNS server address.
     v. Press **Add** next to **Search domains**, and enter the DNS search domain.

Figure 1.1. Example of an Ethernet connection with static IP address settings



8. Press **OK** to create and automatically activate the new connection.
9. Press **Back** to return to the main menu.
10. Select **Quit**, and press **Enter** to close the **nmtui** application.

Verification

1. Display the IP settings of the NIC:

```
# ip address show enp1s0
2: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP
group default qlen 1000
    link/ether 52:54:00:17:b8:b6 brd ff:ff:ff:ff:ff:ff
```

```
    inet 192.0.2.1/24 brd 192.0.2.255 scope global noprefixroute enp1s0
       valid_lft forever preferred_lft forever
    inet6 2001:db8:1::fffe/64 scope global noprefixroute
       valid_lft forever preferred_lft forever
```

2. Display the IPv4 default gateway:

```
# ip route show default
default via 192.0.2.254 dev enp1s0 proto static metric 102
```

3. Display the IPv6 default gateway:

```
# ip -6 route show default
default via 2001:db8:1::ffee dev enp1s0 proto static metric 102 pref medium
```

4. Display the DNS settings:

```
# cat /etc/resolv.conf
search example.com
nameserver 192.0.2.200
nameserver 2001:db8:1::ffbb
```

   If multiple connection profiles are active at the same time, the order of **nameserver** entries depend on the DNS priority values in these profile and the connection types.

5. Use the **ping** utility to verify that this host can send packets to other hosts:

```
# ping <host-name-or-IP-address>
```

Troubleshooting

- Verify that the network cable is plugged-in to the host and a switch.
- Check whether the link failure exists only on this host or also on other hosts connected to the same switch.
- Verify that the network cable and the network interface are working as expected. Perform hardware diagnosis steps and replace defect cables and network interface cards.
- If the configuration on the disk does not match the configuration on the device, starting or restarting NetworkManager creates an in-memory connection that reflects the configuration of the device. For further details and how to avoid this problem, see the NetworkManager duplicates a connection after restart of NetworkManager service solution.

Additional resources

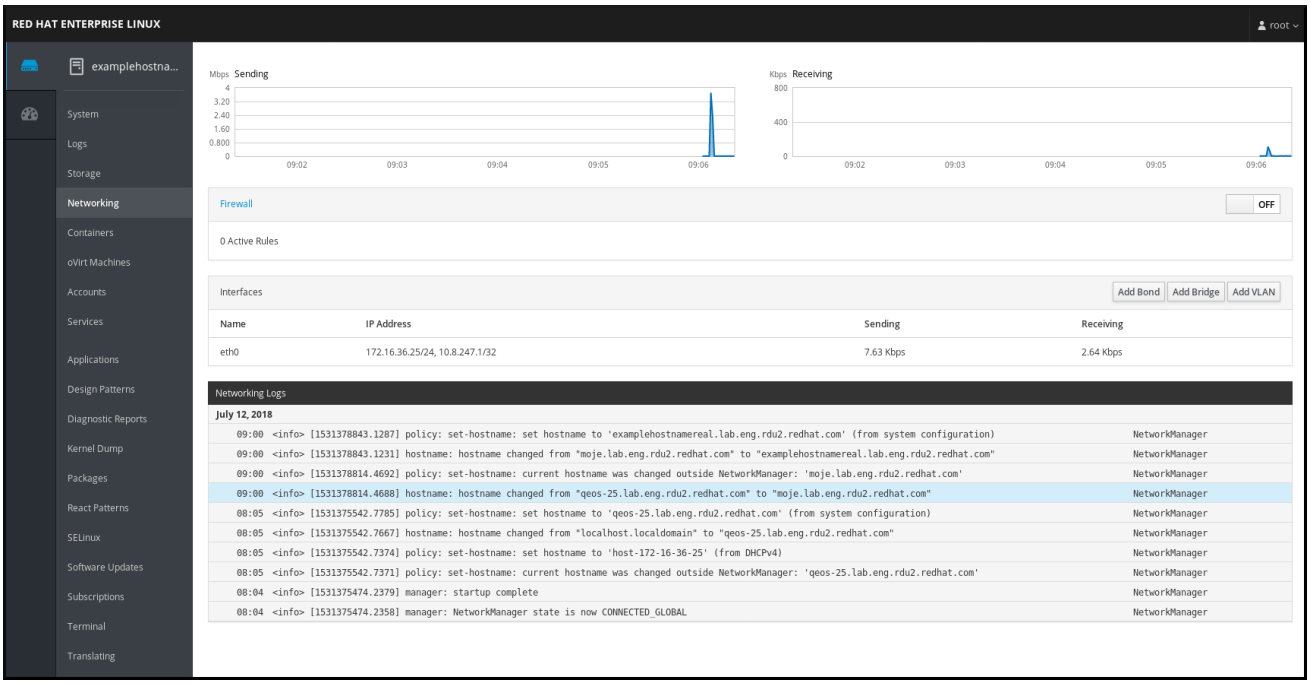
- Configuring NetworkManager to avoid using a specific profile to provide a default gateway
- Configuring the order of DNS servers

1.4. MANAGING NETWORKING IN THE RHEL WEB CONSOLE

In the web console, the **Networking** menu enables you:

- To display currently received and sent packets
- To display the most important characteristics of available network interfaces
- To display content of the networking logs.
- To add various types of network interfaces (bond, team, bridge, VLAN)

Figure 1.2. Managing Networking in the RHEL web console



1.5. MANAGING NETWORKING USING RHEL SYSTEM ROLES

You can configure the networking connections on multiple target machines using the **network** role.

The **network** role allows to configure the following types of interfaces:

- Ethernet
- Bridge
- Bonded
- VLAN
- MacVLAN
- InfiniBand

The required networking connections for each host are provided as a list within the **network_connections** variable.

WARNING

The **network** role updates or creates all connection profiles on the target system exactly as specified in the **network_connections** variable. Therefore, the **network** role removes options from the specified profiles if the options are only present on the system but not in the **network_connections** variable.

The following example shows how to apply the **network** role to ensure that an Ethernet connection with the required parameters exists:

An example playbook applying the network role to set up an Ethernet connection with the required parameters

```
# SPDX-License-Identifier: BSD-3-Clause
---
- hosts: managed-node-01.example.com
  vars:
    network_connections:

      # Create one Ethernet profile and activate it.
      # The profile uses automatic IP addressing
      # and is tied to the interface by MAC address.
      - name: prod1
        state: up
        type: ethernet
        autoconnect: yes
        mac: "00:00:5e:00:53:00"
        mtu: 1450

  roles:
    - rhel-system-roles.network
```

Additional resources

- Preparing a control node and managed nodes to use RHEL system roles

1.6. ADDITIONAL RESOURCES

- Configuring and managing networking

CHAPTER 2. REGISTERING THE SYSTEM AND MANAGING SUBSCRIPTIONS

Subscriptions cover products installed on Red Hat Enterprise Linux, including the operating system itself.

You can use a subscription to Red Hat Content Delivery Network to track:

- Registered systems
- Products installed on your systems
- Subscriptions attached to the installed products

2.1. REGISTERING THE SYSTEM AFTER THE INSTALLATION

Use the following procedure to register your system if you have not registered it during the installation process already.

Prerequisites

- A valid user account in the Red Hat Customer Portal.
- See the Create a Red Hat Login page.
- An active subscription for the RHEL system.
- For more information about the installation process, see Performing a standard RHEL 9 installation.

Procedure

1. Register and automatically subscribe your system in one step:

```
# subscription-manager register --username <username> --password <password> --auto-attach
Registering to: subscription.rhsm.redhat.com:443/subscription
The system has been registered with ID: 37to907c-ece6-49ea-9174-20b87ajk9ee7
The registered system name is: client1.idm.example.com
Installed Product Current Status:
Product Name: Red Hat Enterprise Linux for x86_64
Status:       Subscribed
```

   The command prompts you to enter your Red Hat Customer Portal user name and password.

   If the registration process fails, you can register your system with a specific pool. For guidance on how to do it, proceed with the following steps:

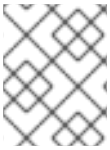
   a. Determine the pool ID of a subscription that you require:

```
# subscription-manager list --available
```

      This command displays all available subscriptions for your Red Hat account. For every subscription, various characteristics are displayed, including the pool ID.

b. Attach the appropriate subscription to your system by replacing *pool_id* with the pool ID determined in the previous step:

```
# subscription-manager attach --pool=pool_id
```



NOTE

To register the system with Red Hat Insights, you can use the **rhc connect** utility. See Setting up remote host configuration .

Additional resources

- Understanding autoattaching subscriptions on the Customer Portal
- Understanding the manual registration and subscription on the Customer Portal

2.2. REGISTERING SUBSCRIPTIONS WITH CREDENTIALS IN THE WEB CONSOLE

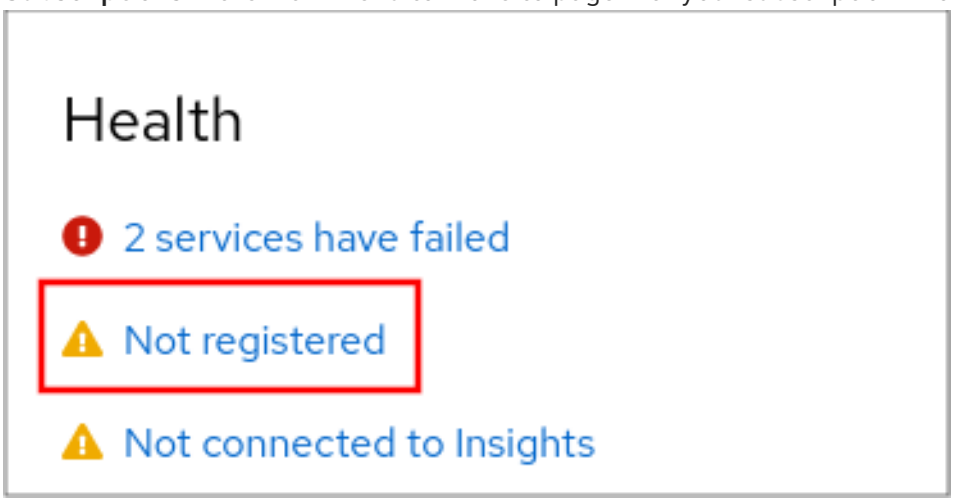
Use the following steps to register a newly installed Red Hat Enterprise Linux with account credentials using the RHEL web console.

Prerequisites

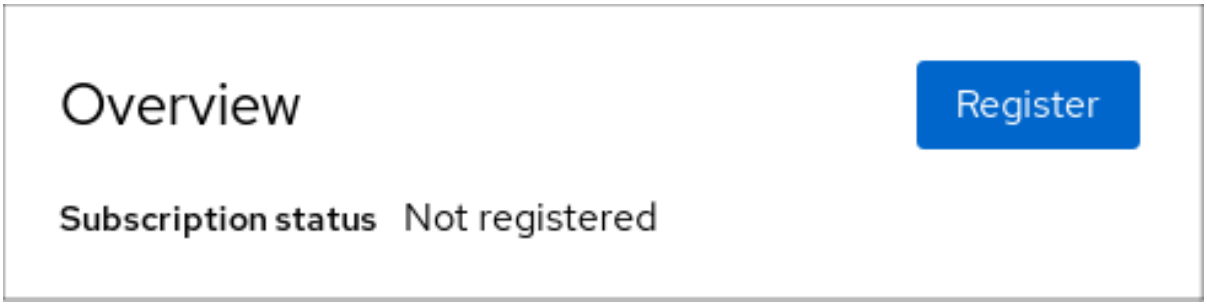
- A valid user account on the Red Hat Customer Portal.
  See the Create a Red Hat Login page.
- Active subscription for your RHEL system.

Procedure

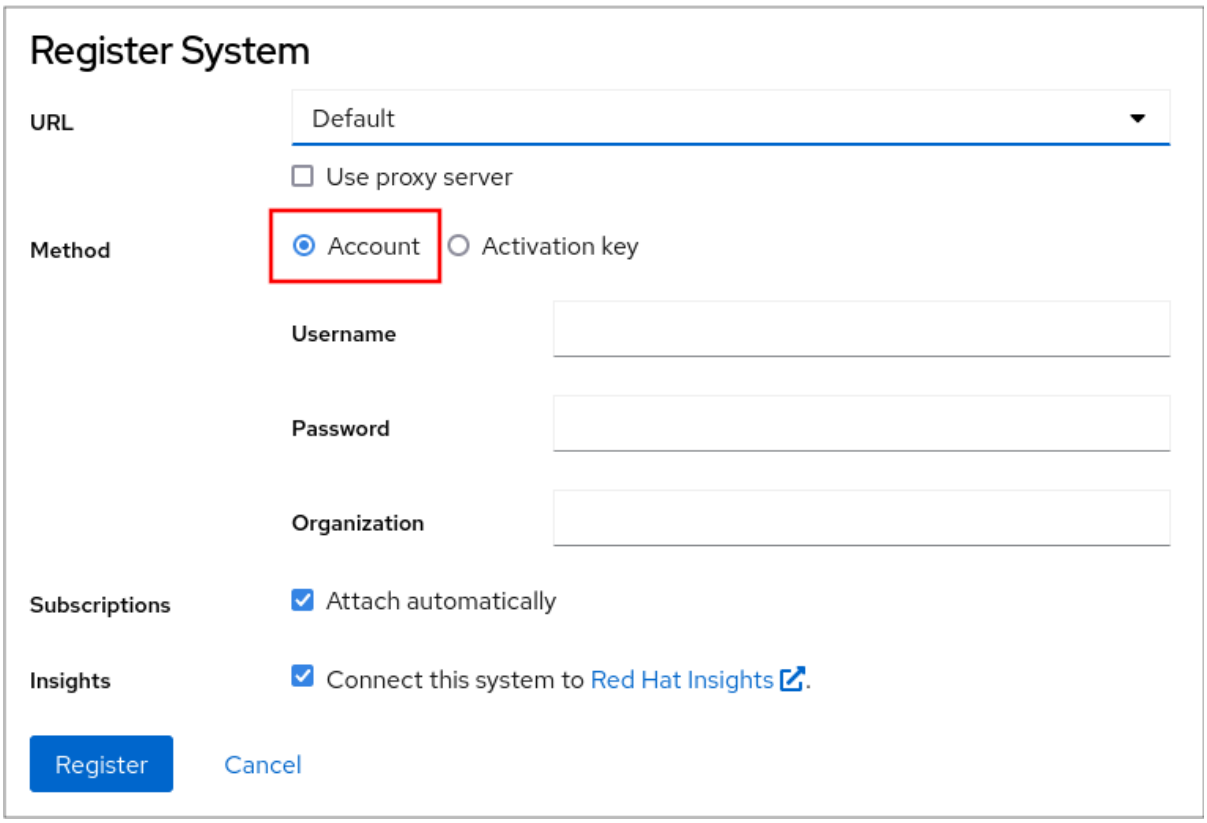
1. Log in to the RHEL web console. For details, see Logging in to the web console .
2. In the **Health** filed in the **Overview** page, click the **Not registered** warning, or click **Subscriptions** in the main menu to move to page with your subscription information.



3. In the **Overview** filed, click **Register**.



4. In the **Register system** dialog box, select that you want to register using your account credentials.



5. Enter your username.
6. Enter your password.
7. Optionally, enter your organization's name or ID.
   If your account belongs to more than one organization on the Red Hat Customer Portal, you have to add the organization name or organization ID. To get the org ID, go to your Red Hat contact point.
   - If you do not want to connect your system to Red Hat Insights, clear the **Insights** check box.
8. Click the **Register** button.

At this point, your Red Hat Enterprise Linux Enterprise Linux system has been successfully registered.

2.3. REGISTERING A SYSTEM USING RED HAT ACCOUNT ON GNOME

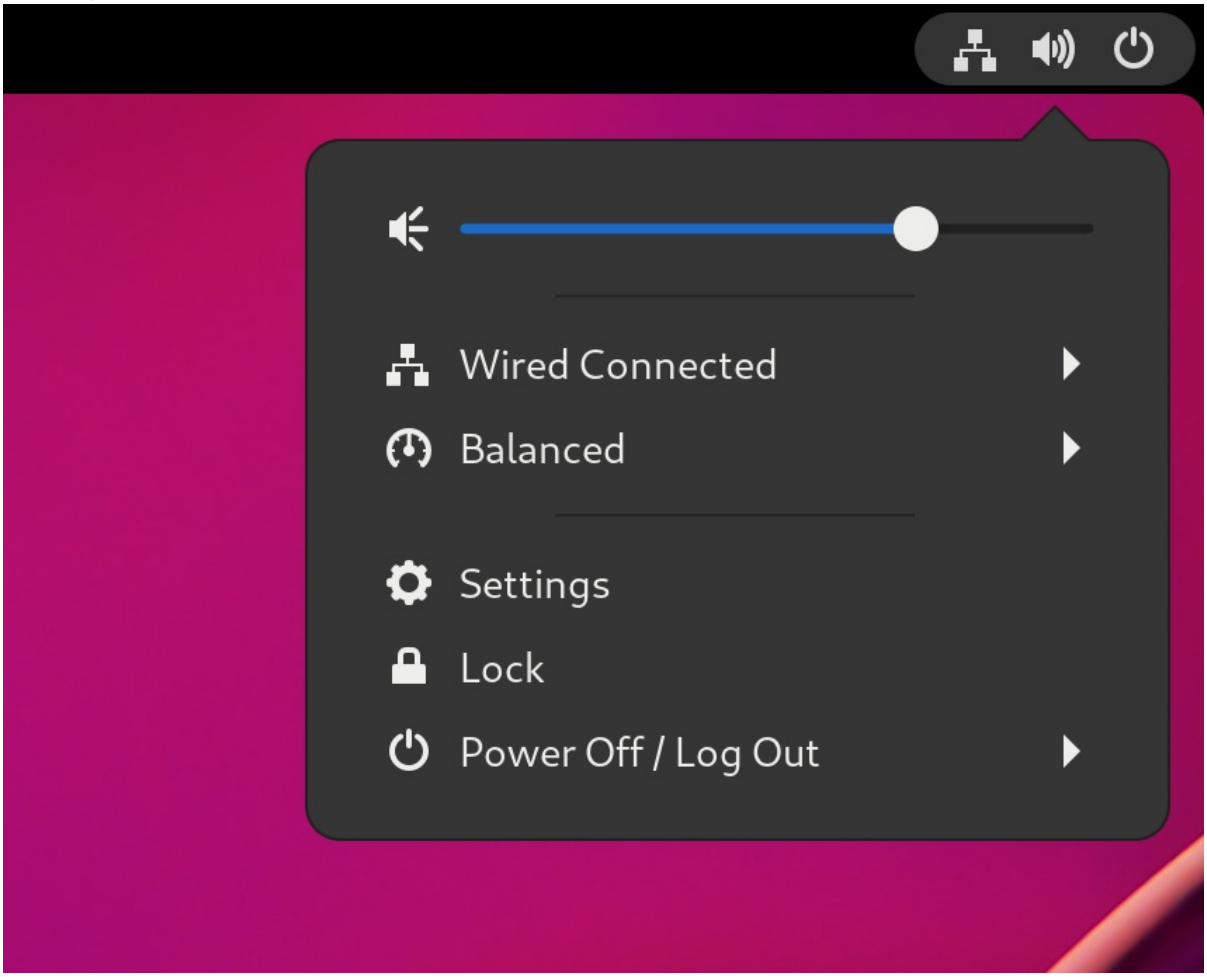
Follow the steps in this procedure to enroll your system with your Red Hat account.

Prerequisites

- A valid account on Red Hat customer portal.
  See the Create a Red Hat Login page for new user registration.

Procedure

1. Open the **system menu**, which is accessible from the upper-right screen corner, and click **Settings**.



2. Go to **About → Subscription**.
3. If you are not using the Red Hat server:
   a. In the **Registration Server** section, select **Custom Address**.
   b. Enter the server address in the **URL** field.
4. In the **Registration Type** section, select **Red Hat Account**.
5. In the **Registration Details** section:
   - Enter your Red Hat account user name in the **Login** field.
   - Enter your Red Hat account password in the **Password** field.
   - Enter the name of your organization in the **Organization** field.
6. Click **Register**.

2.4. REGISTERING A SYSTEM USING AN ACTIVATION KEY ON GNOME

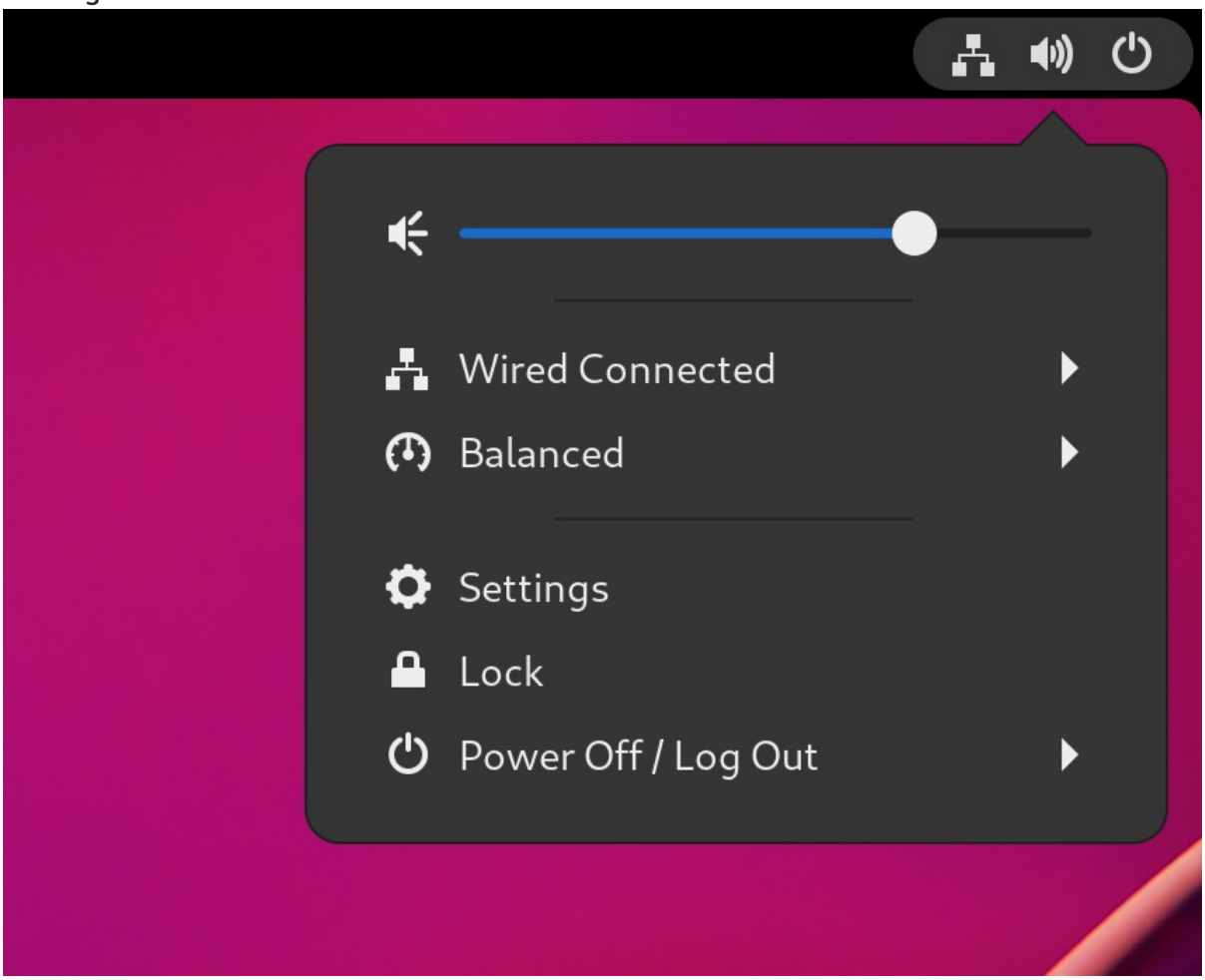
Follow the steps in this procedure to register your system with an activation key. You can get the activation key from your organization administrator.

Prerequisites

- Activation key or keys.
  See the Activation Keys page for creating new activation keys.

Procedure

1. Open the **system menu**, which is accessible from the upper-right screen corner, and click **Settings**.



2. Go to **About → Subscription**.
3. If you are not using the Red Hat server:
   a. In the **Registration Server** section, select **Custom Address**.
   b. Enter the server address in the **URL** field.
4. In the **Registration Type** section, select **Activation Keys**.
5. Under **Registration Details**:
   - Enter your activation keys in the **Activation Keys** field.
     Separate your keys by a comma (**,**).
   - Enter the name or ID of your organization in the **Organization** field.

6. Click **Register**.

CHAPTER 3. ACCESSING THE RED HAT SUPPORT

This section describes how to effectively troubleshoot your problems using Red Hat support and **sosreport**.

To obtain support from Red Hat, use the Red Hat Customer Portal, which provides access to everything available with your subscription.

3.1. OBTAINING RED HAT SUPPORT THROUGH RED HAT CUSTOMER PORTAL

The following section describes how to use the Red Hat Customer Portal to get help.

Prerequisites

- A valid user account on the Red Hat Customer Portal. See Create a Red Hat Login .
- An active subscription for the RHEL system.

Procedure

1. Access Red Hat support:
   a. Open a new support case.
   b. Initiate a live chat with a Red Hat expert.
   c. Contact a Red Hat expert by making a call or sending an email.

3.2. TROUBLESHOOTING PROBLEMS USING SOSREPORT

The **sosreport** command collects configuration details, system information and diagnostic information from a Red Hat Enterprise Linux system.

The following section describes how to use the **sosreport** command to produce reports for your support cases.

Prerequisites

- A valid user account on the Red Hat Customer Portal. See Create a Red Hat Login .
- An active subscription for the RHEL system.
- A support-case number.

Procedure

1. Install the **sos** package:

```
# dnf install sos
```

NOTE

The default minimal installation of Red Hat Enterprise Linux does not include the **sos** package, which provides the **sosreport** command.

2. Generate a report:

```
# sosreport
```

3. Attach the report to your support case.
   See the How can I attach a file to a Red Hat support case? Red Hat Knowledgebase article for more information.

   Note that when attaching the report, you are prompted to enter the number of the relevant support case.

Additional resources

- What is an sosreport and how to create one in Red Hat Enterprise Linux?

CHAPTER 4. CHANGING BASIC ENVIRONMENT SETTINGS

Configuration of basic environment settings is a part of the installation process. The following sections guide you when you change them later. The basic configuration of the environment includes:

- Date and time
- System locales
- Keyboard layout
- Language

4.1. CONFIGURING THE DATE AND TIME

Accurate timekeeping is important for several reasons. In Red Hat Enterprise Linux, timekeeping is ensured by the **NTP** protocol, which is implemented by a daemon running in user space. The user-space daemon updates the system clock running in the kernel. The system clock can keep time by using various clock sources.

Red Hat Enterprise Linux 9 and later versions use the **chronyd** daemon to implement **NTP**. **chronyd** is available from the **chrony** package. For more information, see Using the chrony suite to configure NTP .

4.1.1. Displaying the current date and time

To display the current date and time, use either of these steps.

Procedure

1. Enter the **date** command:

```
$ date
Mon Mar 30 16:02:59 CEST 2020
```

2. To see more details, use the **timedatectl** command:

```
$ timedatectl
Local time: Mon 2020-03-30 16:04:42 CEST
Universal time: Mon 2020-03-30 14:04:42 UTC
  RTC time: Mon 2020-03-30 14:04:41
 Time zone: Europe/Prague (CEST, +0200)
System clock synchronized: yes
NTP service: active
RTC in local TZ: no
```

Additional resources

- Configuring time settings using the web console
- **man date(1)** and **man timedatectl(1)**

4.2. CONFIGURING THE SYSTEM LOCALE

System-wide locale settings are stored in the **/etc/locale.conf** file that is read at early boot by the **systemd** daemon. Every service or user inherits the locale settings configured in **/etc/locale.conf**, unless individual programs or individual users override them.

Procedure

- To list available system locale settings:

```
$ localectl list-locales
C.utf8
aa_DJ
aa_DJ.iso88591
aa_DJ.utf8
...
```

- To display the current status of the system locales settings:

```
$ localectl status
```

- To set or change the default system locale settings, use a **localectl set-locale** sub-command as the **root** user. For example:

```
# localectl set-locale LANG=en_US
```

Additional resources

- **man localectl(1)**, **man locale(7)**, and **man locale.conf(5)**

4.3. CONFIGURING THE KEYBOARD LAYOUT

The keyboard layout settings control the layout used on the text console and graphical user interfaces.

Procedure

- To list available keymaps:

```
$ localectl list-keymaps
ANSI-dvorak
al
al-plisi
amiga-de
amiga-us
...
```

- To display the current status of keymaps settings:

```
$ localectl status
...
VC Keymap: us
...
```

- To set or change the default system keymap. For example:

```
# localectl set-keymap us
```

Additional resources

- **man localectl(1)**, **man locale(7)**, and **man locale.conf(5)**

4.4. CHANGING THE FONT SIZE IN TEXT CONSOLE MODE

You can change the font size in the virtual console by using the **setfont** command.

- Enter the **setfont** command with the name of the font, for example:

```
# setfont /usr/lib/kbd/consolefonts/LatArCyrHeb-19.psfu.gz
```

NOTE

The **setfont** command searches for multiple hard-coded paths by default. Therefore, **setfont** does not require the full name and path to the font.

- To double the size of the font horizontally and vertically, enter the **setfont** command with **-d** parameter:

```
# setfont -d LatArCyrHeb-16
```

NOTE

The maximum font size that you can double is 16x16 pixel.

- To preserve the selected font during the reboot of the system, use the **FONT** variable in the **/etc/vconsole.conf** file, for example:

```
# cat /etc/vconsole.conf
KEYMAP="us"
FONT="eurlatgr"
```

- You can find various fonts in the **kbd-misc** package, which is installed with the `kbd` package. For example, the font **LatArCyrHeb** has many variants:

```
# rpm -ql kbd-misc | grep LatAr

/usr/lib/kbd/consolefonts/LatArCyrHeb-08.psfu.gz
/usr/lib/kbd/consolefonts/LatArCyrHeb-14.psfu.gz
/usr/lib/kbd/consolefonts/LatArCyrHeb-16+.psfu.gz
/usr/lib/kbd/consolefonts/LatArCyrHeb-16.psfu.gz
/usr/lib/kbd/consolefonts/LatArCyrHeb-19.psfu.gz
```

NOTE

The maximum supported font size by the virtual console is 32 pixels. You can reduce the font readability problem by using smaller resolution for the console.

4.5. ADDITIONAL RESOURCES

- Performing a standard RHEL 9 installation

CHAPTER 5. USING SECURE COMMUNICATIONS BETWEEN TWO SYSTEMS WITH OPENSSH

SSH (Secure Shell) is a protocol which provides secure communications between two systems using a client-server architecture and allows users to log in to server host systems remotely. Unlike other remote communication protocols, such as FTP or Telnet, SSH encrypts the login session, which prevents intruders to collect unencrypted passwords from the connection.

Red Hat Enterprise Linux includes the basic **OpenSSH** packages: the general **openssh** package, the **openssh-server** package and the **openssh-clients** package. Note that the **OpenSSH** packages require the **OpenSSL** package **openssl-libs**, which installs several important cryptographic libraries that enable **OpenSSH** to provide encrypted communications.

5.1. SSH AND OPENSSH

SSH (Secure Shell) is a program for logging into a remote machine and executing commands on that machine. The SSH protocol provides secure encrypted communications between two untrusted hosts over an insecure network. You can also forward X11 connections and arbitrary TCP/IP ports over the secure channel.

The SSH protocol mitigates security threats, such as interception of communication between two systems and impersonation of a particular host, when you use it for remote shell login or file copying. This is because the SSH client and server use digital signatures to verify their identities. Additionally, all communication between the client and server systems is encrypted.

A host key authenticates hosts in the SSH protocol. Host keys are cryptographic keys that are generated automatically when OpenSSH is first installed, or when the host boots for the first time.

OpenSSH is an implementation of the SSH protocol supported by Linux, UNIX, and similar operating systems. It includes the core files necessary for both the OpenSSH client and server. The OpenSSH suite consists of the following user-space tools:

- **ssh** is a remote login program (SSH client).
- **sshd** is an OpenSSH SSH daemon.
- **scp** is a secure remote file copy program.
- **sftp** is a secure file transfer program.
- **ssh-agent** is an authentication agent for caching private keys.
- **ssh-add** adds private key identities to **ssh-agent**.
- **ssh-keygen** generates, manages, and converts authentication keys for **ssh**.
- **ssh-copy-id** is a script that adds local public keys to the **authorized_keys** file on a remote SSH server.
- **ssh-keyscan** gathers SSH public host keys.

NOTE

In RHEL 9, the Secure copy protocol (SCP) is replaced with the SSH File Transfer Protocol (SFTP) by default. This is because SCP has already caused security issues, for example CVE-2020-15778.

If SFTP is unavailable or incompatible in your scenario, you can use the **-O** option to force use of the original SCP/RCP protocol.

For additional information, see the OpenSSH SCP protocol deprecation in Red Hat Enterprise Linux 9 article.

The OpenSSH suite in RHEL supports only SSH version 2. It has an enhanced key-exchange algorithm that is not vulnerable to exploits known in the older version 1.

OpenSSH, as one of core cryptographic subsystems of RHEL, uses system-wide crypto policies. This ensures that weak cipher suites and cryptographic algorithms are disabled in the default configuration. To modify the policy, the administrator must either use the **update-crypto-policies** command to adjust the settings or manually opt out of the system-wide crypto policies.

The OpenSSH suite uses two sets of configuration files: one for client programs (that is, **ssh**, **scp**, and **sftp**), and another for the server (the **sshd** daemon).

System-wide SSH configuration information is stored in the **/etc/ssh/** directory. User-specific SSH configuration information is stored in **~/.ssh/** in the user's home directory. For a detailed list of OpenSSH configuration files, see the **FILES** section in the **sshd(8)** man page.

Additional resources

- Man pages listed by using the **man -k ssh** command
- Using system-wide cryptographic policies

5.2. CONFIGURING AND STARTING AN OPENSSH SERVER

You can change the welcome banner and the IP address of your OpenSSH server. You can also switch to a slower dynamic network configuration.

Note that after the default RHEL installation, the **sshd** daemon is already started, and server host keys are automatically created.

Prerequisites

- The **openssh-server** package is installed.

Procedure

1. If the **sshd** service is not already running, start it in the current session and set it to start automatically at boot time:

```
# systemctl enable --now sshd
```

2. To specify different addresses than the default **0.0.0.0** (IPv4) or **::** (IPv6) for the **ListenAddress** directive in the **/etc/ssh/sshd_config** configuration file and to use a slower dynamic network configuration, add the dependency on the **network-online.target** target unit

to the **sshd.service** unit file. To achieve this, create the **/etc/systemd/system/sshd.service.d/local.conf** file with the following content:

```
[Unit]
Wants=network-online.target
After=network-online.target
```

3. Review if OpenSSH server settings in the **/etc/ssh/sshd_config** configuration file meet the requirements of your scenario.

4. Optionally, change the welcome message that your OpenSSH server displays before a client authenticates by editing the **/etc/issue** file, for example:

```
Welcome to ssh-server.example.com
Warning: By accessing this server, you agree to the referenced terms and conditions.
```

Ensure that the **Banner** option is not commented out in **/etc/ssh/sshd_config** and its value contains **/etc/issue**:

```
# less /etc/ssh/sshd_config | grep Banner
Banner /etc/issue
```

Note that to change the message displayed after a successful login you have to edit the **/etc/motd** file on the server. See the **pam_motd** man page for more information.

5. Reload the **systemd** configuration and restart **sshd** to apply the changes:

```
# systemctl daemon-reload
# systemctl restart sshd
```

Verification

1. Check that the **sshd** daemon is running:

```
# systemctl status sshd
● sshd.service - OpenSSH server daemon
   Loaded: loaded (/usr/lib/systemd/system/sshd.service; enabled; vendor preset: enabled)
   Active: active (running) since Mon 2019-11-18 14:59:58 CET; 6min ago
     Docs: man:sshd(8)
           man:sshd_config(5)
 Main PID: 1149 (sshd)
    Tasks: 1 (limit: 11491)
   Memory: 1.9M
   CGroup: /system.slice/sshd.service
           └─1149 /usr/sbin/sshd -D -oCiphers=aes128-ctr,aes256-ctr,aes128-cbc,aes256-cbc -
oMACs=hmac-sha2-256,>

Nov 18 14:59:58 ssh-server-example.com systemd[1]: Starting OpenSSH server daemon...
Nov 18 14:59:58 ssh-server-example.com sshd[1149]: Server listening on 0.0.0.0 port 22.
Nov 18 14:59:58 ssh-server-example.com sshd[1149]: Server listening on :: port 22.
Nov 18 14:59:58 ssh-server-example.com systemd[1]: Started OpenSSH server daemon.
```

2. Connect to the SSH server with an SSH client.

```
# ssh user@ssh-server-example.com
ECDSA key fingerprint is SHA256:dXbaS0RG/UzlTTku8GtXSz0S1++lPegSy31v3L/FAEc.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'ssh-server-example.com' (ECDSA) to the list of known hosts.

user@ssh-server-example.com's password:
```

Additional resources

- **sshd(8)** and **sshd_config(5)** man pages.

5.3. SETTING AN OPENSSH SERVER FOR KEY-BASED AUTHENTICATION

To improve system security, enforce key-based authentication by disabling password authentication on your OpenSSH server.

Prerequisites

- The **openssh-server** package is installed.
- The **sshd** daemon is running on the server.

Procedure

1. Open the **/etc/ssh/sshd_config** configuration in a text editor, for example:

```
# vi /etc/ssh/sshd_config
```

2. Change the **PasswordAuthentication** option to **no**:

```
PasswordAuthentication no
```

On a system other than a new default installation, check that **PubkeyAuthentication no** has not been set and the **KbdInteractiveAuthentication** directive is set to **no**. If you are connected remotely, not using console or out-of-band access, test the key-based login process before disabling password authentication.

3. To use key-based authentication with NFS-mounted home directories, enable the **use_nfs_home_dirs** SELinux boolean:

```
# setsebool -P use_nfs_home_dirs 1
```

4. Reload the **sshd** daemon to apply the changes:

```
# systemctl reload sshd
```

Additional resources

- **sshd(8)**, **sshd_config(5)**, and **setsebool(8)** man pages.

5.4. GENERATING SSH KEY PAIRS

You can log in to an OpenSSH server without providing a password by generating an SSH key pair on a local system and copying the generated public key to the OpenSSH server. The server must be configured to allow this option.

Prerequisites

- You are logged in as the Linux user that will connect to the OpenSSH server. If you complete the following steps as **root**, only **root** can use the keys.

Procedure

1. Generate an ECDSA key pair for version 2 of the SSH protocol:

```
$ ssh-keygen -t ecdsa
Generating public/private ecdsa key pair.
Enter file in which to save the key (/home/<username>/.ssh/id_ecdsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/<username>/.ssh/id_ecdsa.
Your public key has been saved in /home/<username>/.ssh/id_ecdsa.pub.
The key fingerprint is:
SHA256:Q/x+qms4j7PCQ0qFd09iZEFHA+SqwBKRNaU72oZfaCI
<username>@<localhost.example.com>
The key's randomart image is:
+---[ECDSA 256]---+
|.oo..o=++        |
|.. o .oo .       |
|. .. o. o        |
|....o.+...       |
|o.oo.o +S .      |
|.=.+.   .o       |
|E.*+.  .  . .    |
|.=..+ +..  o     |
|  .  oo*+o.      |
+----[SHA256]-----+
```

   You can also generate an RSA key pair by using the **-t rsa** option with the **ssh-keygen** command or an Ed25519 key pair by entering the **ssh-keygen -t ed25519** command.

2. Copy the public key to a remote machine:

```
$ ssh-copy-id <username>@<ssh-server-example.com>
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that are already installed
<username>@<ssh-server-example.com>'s password:
...
Number of key(s) added: 1

Now try logging into the machine, with: "ssh '<username>@<ssh-server-example.com>'" and check to make sure that only the key(s) you wanted were added.
```

   Replace ***<username>@<ssh-server-example.com>*** with your credentials.

If you do not use the **ssh-agent** program in your session, the previous command copies the most recently modified **~/.ssh/id*.pub** public key if it is not yet installed. To specify another public-key file or to prioritize keys in files over keys cached in memory by **ssh-agent**, use the **ssh-copy-id** command with the **-i** option.

3. Optional: To keep previously generated key pairs between reinstalls of the system, back up the **~/.ssh/** directory. After reinstalling, copy it back to your home directory. You can do this for all users on your system, including **root**.

Verification

1. Log in to the OpenSSH server without providing any password:

```
$ ssh <username>@<ssh-server-example.com>
Welcome message.
...
Last login: Mon Nov 18 18:28:42 2019 from ::1
```

Additional resources

- **ssh-keygen(1)** and **ssh-copy-id(1)** man pages.

5.5. USING SSH KEYS STORED ON A SMART CARD

You can use RSA and ECDSA keys stored on a smart card on OpenSSH clients. Authentication by using a smart card replaces the default password authentication.

Prerequisites

- On the client side, the **opensc** package is installed and the **pcscd** service is running.

Procedure

1. List all keys provided by the OpenSC PKCS #11 module including their PKCS #11 URIs and save the output to the *keys.pub* file:

```
$ ssh-keygen -D pkcs11: > keys.pub
$ ssh-keygen -D pkcs11:
ssh-rsa AAAAB3NzaC1yc2E...KKZMzcQZzx
pkcs11:id=%02;object=SIGN%20pubkey;token=SSH%20key;manufacturer=piv_II?module-
path=/usr/lib64/pkcs11/opensc-pkcs11.so
ecdsa-sha2-nistp256 AAA...J0hkYnnsM=
pkcs11:id=%01;object=PIV%20AUTH%20pubkey;token=SSH%20key;manufacturer=piv_II?
module-path=/usr/lib64/pkcs11/opensc-pkcs11.so
```

2. To enable authentication using a smart card on a remote server (*example.com*), transfer the public key to the remote server. Use the **ssh-copy-id** command with *keys.pub* created in the previous step:

```
$ ssh-copy-id -f -i keys.pub username@example.com
```

3. To connect to *example.com* using the ECDSA key from the output of the **ssh-keygen -D** command in step 1, you can use just a subset of the URI, which uniquely references your key, for example:

```
$ ssh -i "pkcs11:id=%01?module-path=/usr/lib64/pkcs11/opensc-pkcs11.so" example.com
Enter PIN for 'SSH key':
[example.com] $
```

4. You can use the same URI string in the **~/.ssh/config** file to make the configuration permanent:

```
$ cat ~/.ssh/config
IdentityFile "pkcs11:id=%01?module-path=/usr/lib64/pkcs11/opensc-pkcs11.so"
$ ssh example.com
Enter PIN for 'SSH key':
[example.com] $
```

Because OpenSSH uses the **p11-kit-proxy** wrapper and the OpenSC PKCS #11 module is registered to PKCS#11 Kit, you can simplify the previous commands:

```
$ ssh -i "pkcs11:id=%01" example.com
Enter PIN for 'SSH key':
[example.com] $
```

If you skip the **id=** part of a PKCS #11 URI, OpenSSH loads all keys that are available in the proxy module. This can reduce the amount of typing required:

```
$ ssh -i pkcs11: example.com
Enter PIN for 'SSH key':
[example.com] $
```

Additional resources

- Fedora 28: Better smart card support in OpenSSH
- **p11-kit(8)**, **opensc.conf(5)**, **pcscd(8)**, **ssh(1)**, and **ssh-keygen(1)** man pages on your system

5.6. MAKING OPENSSH MORE SECURE

You can tweak the system to increase security when using OpenSSH.

Note that changes in the **/etc/ssh/sshd_config** OpenSSH configuration file require reloading the **sshd** daemon to take effect:

```
# systemctl reload sshd
```

WARNING

The majority of security hardening configuration changes reduce compatibility with clients that do not support up-to-date algorithms or cipher suites.

Disabling insecure connection protocols

- To make SSH truly effective, prevent the use of insecure connection protocols that are replaced by the OpenSSH suite. Otherwise, a user's password might be protected using SSH for one session only to be captured later when logging in using Telnet. For this reason, consider disabling insecure protocols, such as telnet, rsh, rlogin, and ftp.

Enabling key-based authentication and disabling password-based authentication

- Disabling passwords for authentication and allowing only key pairs reduces the attack surface and it also might save users' time. On clients, generate key pairs using the **ssh-keygen** tool and use the **ssh-copy-id** utility to copy public keys from clients on the OpenSSH server. To disable password-based authentication on your OpenSSH server, edit **/etc/ssh/sshd_config** and change the **PasswordAuthentication** option to **no**:

```
PasswordAuthentication no
```

Key types

- Although the **ssh-keygen** command generates a pair of RSA keys by default, you can instruct it to generate ECDSA or Ed25519 keys by using the **-t** option. The ECDSA (Elliptic Curve Digital Signature Algorithm) offers better performance than RSA at the equivalent symmetric key strength. It also generates shorter keys. The Ed25519 public-key algorithm is an implementation of twisted Edwards curves that is more secure and also faster than RSA, DSA, and ECDSA. OpenSSH creates RSA, ECDSA, and Ed25519 server host keys automatically if they are missing. To configure the host key creation in RHEL, use the **sshd-keygen@.service** instantiated service. For example, to disable the automatic creation of the RSA key type:

```
# systemctl mask sshd-keygen@rsa.service
```

NOTE

In images with **cloud-init** enabled, the **ssh-keygen** units are automatically disabled. This is because the **ssh-keygen template** service can interfere with the **cloud-init** tool and cause problems with host key generation. To prevent these problems the **etc/systemd/system/sshd-keygen@.service.d/disable-sshd-keygen-if-cloud-init-active.conf** drop-in configuration file disables the **ssh-keygen** units if **cloud-init** is running.

- To exclude particular key types for SSH connections, comment out the relevant lines in **/etc/ssh/sshd_config**, and reload the **sshd** service. For example, to allow only Ed25519 host keys:

```
# HostKey /etc/ssh/ssh_host_rsa_key
# HostKey /etc/ssh/ssh_host_ecdsa_key
HostKey /etc/ssh/ssh_host_ed25519_key
```

IMPORTANT

The Ed25519 algorithm is not FIPS-140-compliant, and OpenSSH does not work with Ed25519 keys in FIPS mode.

Non-default port

- By default, the **sshd** daemon listens on TCP port 22. Changing the port reduces the exposure of the system to attacks based on automated network scanning and therefore increase security through obscurity. You can specify the port using the **Port** directive in the **/etc/ssh/sshd_config** configuration file.
  You also have to update the default SELinux policy to allow the use of a non-default port. To do so, use the **semanage** tool from the **policycoreutils-python-utils** package:

  ```
  # semanage port -a -t ssh_port_t -p tcp <port_number>
  ```

  Furthermore, update **firewalld** configuration:

  ```
  # firewall-cmd --add-port <port_number>/tcp
  # firewall-cmd --remove-port=22/tcp
  # firewall-cmd --runtime-to-permanent
  ```

  In the previous commands, replace *<port_number>* with the new port number specified using the **Port** directive.

Root login

- **PermitRootLogin** is set to **prohibit-password** by default. This enforces the use of key-based authentication instead of the use of passwords for logging in as root and reduces risks by preventing brute-force attacks.

WARNING

Enabling logging in as the root user is not a secure practice because the administrator cannot audit which users run which privileged commands. For using administrative commands, log in and use **sudo** instead.

Using the X Security extension

- The X server in Red Hat Enterprise Linux clients does not provide the X Security extension. Therefore, clients cannot request another security layer when connecting to untrusted SSH servers with X11 forwarding. Most applications are not able to run with this extension enabled anyway.

By default, the **ForwardX11Trusted** option in the **/etc/ssh/ssh_config.d/50-redhat.conf** file is set to **yes**, and there is no difference between the **ssh -X remote_machine** (untrusted host) and **ssh -Y remote_machine** (trusted host) command.

If your scenario does not require the X11 forwarding feature at all, set the **X11Forwarding** directive in the **/etc/ssh/sshd_config** configuration file to **no**.

Restricting access to specific users, groups, or domains

- The **AllowUsers** and **AllowGroups** directives in the **/etc/ssh/sshd_config** configuration file server enable you to permit only certain users, domains, or groups to connect to your OpenSSH server. You can combine **AllowUsers** and **AllowGroups** to restrict access more precisely, for example:

```
AllowUsers *@192.168.1.* *@10.0.0.* !*@192.168.1.2
AllowGroups example-group
```

The previous configuration lines accept connections from all users from systems in 192.168.1.* and 10.0.0.* subnets except from the system with the 192.168.1.2 address. All users must be in the **example-group** group. The OpenSSH server denies all other connections.

The OpenSSH server permits only connections that pass all Allow and Deny directives in **/etc/ssh/sshd_config**. For example, if the **AllowUsers** directive lists a user that is not part of a group listed in the **AllowGroups** directive, then the user cannot log in.

Note that using allowlists (directives starting with Allow) is more secure than using blocklists (options starting with Deny) because allowlists block also new unauthorized users or groups.

Changing system-wide cryptographic policies

- OpenSSH uses RHEL system-wide cryptographic policies, and the default system-wide cryptographic policy level offers secure settings for current threat models. To make your cryptographic settings more strict, change the current policy level:

```
# update-crypto-policies --set FUTURE
Setting system policy to FUTURE
```

WARNING

If your system communicates on the internet, you might face interoperability problems due to the strict setting of the **FUTURE** policy.

You can also disable only specific ciphers for the SSH protocol through the system-wide cryptographic policies. See the Customizing system-wide cryptographic policies with subpolicies section in the Security hardening document for more information.

To opt out of the system-wide cryptographic policies for your OpenSSH server, specify the cryptographic policy in a drop-in configuration file located in the **/etc/ssh/sshd_config.d/** directory, with a two-digit number prefix smaller than 50, so that it lexicographically precedes the **50-redhat.conf** file, and with a **.conf** suffix, for example, **49-crypto-policy-override.conf**.

See the **sshd_config(5)** man page for more information.

To opt out of system-wide cryptographic policies for your OpenSSH client, perform one of the following tasks:

- For a given user, override the global **ssh_config** with a user-specific configuration in the **~/.ssh/config** file.
- For the entire system, specify the cryptographic policy in a drop-in configuration file located in the **/etc/ssh/ssh_config.d/** directory, with a two-digit number prefix smaller than 50, so that it lexicographically precedes the **50-redhat.conf** file, and with a **.conf** suffix, for example, **49-crypto-policy-override.conf**.

Additional resources

- **sshd_config(5)**, **ssh-keygen(1)**, **crypto-policies(7)**, and **update-crypto-policies(8)** man pages.
- Using system-wide cryptographic policies in the Security hardening document.
- How to disable specific algorithms and ciphers for ssh service only article.

5.7. CONNECTING TO A REMOTE SERVER USING AN SSH JUMP HOST

You can connect your local system to a remote server through an intermediary server, also called jump host.

Prerequisites

- A jump host accepts SSH connections from your local system.
- A remote server accepts SSH connections only from the jump host.

Procedure

1. Define the jump host by editing the **~/.ssh/config** file on your local system, for example:

```
Host jump-server1
  HostName jump1.example.com
```

   - The **Host** parameter defines a name or alias for the host you can use in **ssh** commands. The value can match the real host name, but can also be any string.
   - The **HostName** parameter sets the actual host name or IP address of the jump host.

2. Add the remote server jump configuration with the **ProxyJump** directive to **~/.ssh/config** file on your local system, for example:

```
Host remote-server
  HostName remote1.example.com
  ProxyJump jump-server1
```

3. Use your local system to connect to the remote server through the jump server:

```
$ ssh remote-server
```

The previous command is equivalent to the **ssh -J jump-server1 remote-server** command if you omit the configuration steps 1 and 2.

4. You can specify more jump servers and you can also skip adding host definitions to the configurations file when you provide their complete host names, for example:

```
$ ssh -J jump1.example.com,jump2.example.com,jump3.example.com remote1.example.com
```

Change the host name-only notation in the previous command if the user names or SSH ports on the jump servers differ from the names and ports on the remote server, for example:

```
$ ssh -J
johndoe@jump1.example.com:75,johndoe@jump2.example.com:75,johndoe@jump3.example
.com:75 joesec@remote1.example.com:220
```

Additional resources

- **ssh_config(5)** and **ssh(1)** man pages.

5.8. CONNECTING TO REMOTE MACHINES WITH SSH KEYS USING SSH-AGENT

To avoid entering a passphrase each time you initiate an SSH connection, you can use the **ssh-agent** utility to cache the private SSH key. The private key and the passphrase remain secure.

Prerequisites

- You have a remote host with SSH daemon running and reachable through the network.
- You know the IP address or hostname and credentials to log in to the remote host.
- You have generated an SSH key pair with a passphrase and transferred the public key to the remote machine.

For more information, see Generating SSH key pairs.

Procedure

1. Optional: Verify you can use the key to authenticate to the remote host:
   a. Connect to the remote host using SSH:

```
$ ssh example.user1@198.51.100.1 hostname
```

   b. Enter the passphrase you set while creating the key to grant access to the private key.

```
$ ssh example.user1@198.51.100.1 hostname
 host.example.com
```

2. Start the **ssh-agent**.

```
$ eval $(ssh-agent)
Agent pid 20062
```

3. Add the key to **ssh-agent**.

```
$ ssh-add ~/.ssh/id_rsa
Enter passphrase for ~/.ssh/id_rsa:
Identity added: ~/.ssh/id_rsa (example.user0@198.51.100.12)
```

Verification

- Optional: Log in to the host machine using SSH.

```
$ ssh example.user1@198.51.100.1

Last login: Mon Sep 14 12:56:37 2020
```

Note that you did not have to enter the passphrase.

5.9. CONFIGURING SECURE COMMUNICATION WITH THE SSH SYSTEM ROLES

As an administrator, you can use the **sshd** system role to configure SSH servers and the **ssh** system role to configure SSH clients consistently on any number of RHEL systems at the same time using the Ansible Core package.

5.9.1. Variables of the sshd RHEL system role

In an **sshd** system role playbook, you can define the parameters for the SSH configuration file according to your preferences and limitations.

If you do not configure these variables, the system role produces an **sshd_config** file that matches the RHEL defaults.

In all cases, Booleans correctly render as **yes** and **no** in **sshd** configuration. You can define multi-line configuration items using lists. For example:

```
sshd_ListenAddress:
  - 0.0.0.0
  - '::'
```

renders as:

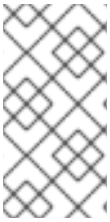
```
ListenAddress 0.0.0.0
ListenAddress ::
```

Additional resources

- **/usr/share/ansible/roles/rhel-system-roles.sshd/README.md** file
- **/usr/share/doc/rhel-system-roles/sshd/** directory

5.9.2. Configuring OpenSSH servers by using the sshd RHEL system role

You can use the **sshd** RHEL system role to configure multiple SSH servers by running an Ansible playbook.



NOTE

You can use the **sshd** RHEL system role with other RHEL system roles that change SSH and SSHD configuration, for example the Identity Management RHEL system roles. To prevent the configuration from being overwritten, make sure that the **sshd** role uses namespaces (RHEL 8 and earlier versions) or a drop-in directory (RHEL 9).

Prerequisites

- You have prepared the control node and the managed nodes
- You are logged in to the control node as a user who can run playbooks on the managed nodes.
- The account you use to connect to the managed nodes has **sudo** permissions on them.

Procedure

1. Create a playbook file, for example ~/**playbook.yml**, with the following content:

```
---
- name: SSH server configuration
  hosts: managed-node-01.example.com
  tasks:
    - name: Configure sshd to prevent root and password login except from particular subnet
      ansible.builtin.include_role:
        name: rhel-system-roles.sshd
      vars:
        sshd:
          PermitRootLogin: no
          PasswordAuthentication: no
          Match:
            - Condition: "Address 192.0.2.0/24"
              PermitRootLogin: yes
              PasswordAuthentication: yes
```

   The playbook configures the managed node as an SSH server configured so that:

   - password and **root** user login is disabled
   - password and **root** user login is enabled only from the subnet **192.0.2.0/24**

2. Validate the playbook syntax:

```
$ ansible-playbook --syntax-check ~/playbook.yml
```

   Note that this command only validates the syntax and does not protect against a wrong but valid configuration.

3. Run the playbook:

```
$ ansible-playbook ~/playbook.yml
```

Verification

1. Log in to the SSH server:

```
$ ssh <username>@<ssh_server>
```

2. Verify the contents of the **sshd_config** file on the SSH server:

```
$ cat /etc/ssh/sshd_config.d/00-ansible_system_role.conf
#
# Ansible managed
#
PasswordAuthentication no
PermitRootLogin no
Match Address 192.0.2.0/24
  PasswordAuthentication yes
  PermitRootLogin yes
```

3. Check that you can connect to the server as root from the **192.0.2.0/24** subnet:

   a. Determine your IP address:

```
$ hostname -I
192.0.2.1
```

   If the IP address is within the **192.0.2.1** - **192.0.2.254** range, you can connect to the server.

   b. Connect to the server as **root**:

```
$ ssh root@<ssh_server>
```

Additional resources

- **/usr/share/ansible/roles/rhel-system-roles.sshd/README.md** file
- **/usr/share/doc/rhel-system-roles/sshd/** directory

5.9.3. Variables of the ssh RHEL system role

In an **ssh** system role playbook, you can define the parameters for the client SSH configuration file according to your preferences and limitations.

If you do not configure these variables, the system role produces a global **ssh_config** file that matches the RHEL defaults.

In all cases, booleans correctly render as **yes** or **no** in **ssh** configuration. You can define multi-line configuration items using lists. For example:

```
LocalForward:
  - 22 localhost:2222
  - 403 localhost:4003
```

renders as:

```
LocalForward 22 localhost:2222
LocalForward 403 localhost:4003
```

NOTE

The configuration options are case sensitive.

Additional resources

- **/usr/share/ansible/roles/rhel-system-roles.ssh/README.md** file
- **/usr/share/doc/rhel-system-roles/ssh/** directory

5.9.4. Configuring OpenSSH clients by using the ssh RHEL system role

You can use the **ssh** RHEL system role to configure multiple SSH clients by running an Ansible playbook.

NOTE

You can use the **ssh** RHEL system role with other system roles that change SSH and SSHD configuration, for example the Identity Management RHEL system roles. To prevent the configuration from being overwritten, make sure that the **ssh** role uses a drop-in directory (default in RHEL 8 and later).

Prerequisites

- You have prepared the control node and the managed nodes
- You are logged in to the control node as a user who can run playbooks on the managed nodes.
- The account you use to connect to the managed nodes has **sudo** permissions on them.

Procedure

1. Create a playbook file, for example ~/**playbook.yml**, with the following content:

```
---
- name: SSH client configuration
  hosts: managed-node-01.example.com
  tasks:
    - name: "Configure ssh clients"
      ansible.builtin.include_role:
        name: rhel-system-roles.ssh
      vars:
        ssh_user: root
        ssh:
          Compression: true
          GSSAPIAuthentication: no
          ControlMaster: auto
          ControlPath: ~/.ssh/.cm%C
          Host:
            - Condition: example
```

```
        Hostname: server.example.com
        User: user1
    ssh_ForwardX11: no
```

This playbook configures the **root** user's SSH client preferences on the managed nodes with the following configurations:

- Compression is enabled.
- ControlMaster multiplexing is set to **auto**.
- The **example** alias for connecting to the **server.example.com** host is **user1**.
- The **example** host alias is created, which represents a connection to the **server.example.com** host the with the **user1** user name.
- X11 forwarding is disabled.

2. Validate the playbook syntax:

```
$ ansible-playbook --syntax-check ~/playbook.yml
```

Note that this command only validates the syntax and does not protect against a wrong but valid configuration.

3. Run the playbook:

```
$ ansible-playbook ~/playbook.yml
```

Verification

- Verify that the managed node has the correct configuration by displaying the SSH configuration file:

```
# cat ~/root/.ssh/config
# Ansible managed
Compression yes
ControlMaster auto
ControlPath ~/.ssh/.cm%C
ForwardX11 no
GSSAPIAuthentication no
Host example
  Hostname example.com
  User user1
```

Additional resources

- **/usr/share/ansible/roles/rhel-system-roles.ssh/README.md** file
- **/usr/share/doc/rhel-system-roles/ssh/** directory

5.9.5. Using the sshd RHEL system role for non-exclusive configuration

Normally, applying the **sshd** system role overwrites the entire configuration. This may be problematic if

you have previously adjusted the configuration, for example, with a different system role or playbook. To apply the **sshd** system role for only selected configuration options while keeping other options in place, you can use the non-exclusive configuration.

You can apply a non-exclusive configuration:

- In RHEL 8 and earlier by using a configuration snippet.
- In RHEL 9 and later by using files in a drop-in directory. The default configuration file is already placed in the drop-in directory as **/etc/ssh/sshd_config.d/00-ansible_system_role.conf**.

Prerequisites

- You have prepared the control node and the managed nodes
- You are logged in to the control node as a user who can run playbooks on the managed nodes.
- The account you use to connect to the managed nodes has **sudo** permissions on them.

Procedure

1. Create a playbook file, for example ~/**playbook.yml**, with the following content:
   - For managed nodes that run RHEL 8 or earlier:

```
---
- name: Non-exclusive sshd configuration
  hosts: managed-node-01.example.com
  tasks:
    - name: <Configure SSHD to accept some useful environment variables>
      ansible.builtin.include_role:
        name: rhel-system-roles.sshd
      vars:
        sshd_config_namespace: <my-application>
        sshd:
          # Environment variables to accept
          AcceptEnv:
            LANG
            LS_COLORS
            EDITOR
```

   - For managed nodes that run RHEL 9 or later:

```
- name: Non-exclusive sshd configuration
  hosts: managed-node-01.example.com
  tasks:
    - name: <Configure sshd to accept some useful environment variables>
      ansible.builtin.include_role:
        name: rhel-system-roles.sshd
      vars:
        sshd_config_file: /etc/ssh/sshd_config.d/<42-my-application>.conf
        sshd:
          # Environment variables to accept
          AcceptEnv:
```

```
LANG
LS_COLORS
EDITOR
```

In the **sshd_config_file** variable, define the **.conf** file into which the **sshd** system role writes the configuration options. Use a two-digit prefix, for example ***42-*** to specify the order in which the configuration files will be applied.

2. Validate the playbook syntax:

```
$ ansible-playbook --syntax-check ~/playbook.yml
```

Note that this command only validates the syntax and does not protect against a wrong but valid configuration.

3. Run the playbook:

```
$ ansible-playbook ~/playbook.yml
```

Verification

- Verify the configuration on the SSH server:
  - For managed nodes that run RHEL 8 or earlier:

```
# cat /etc/ssh/sshd_config.d/42-my-application.conf
# Ansible managed
#
AcceptEnv LANG LS_COLORS EDITOR
```

  - For managed nodes that run RHEL 9 or later:

```
# cat /etc/ssh/sshd_config
...
# BEGIN sshd system role managed block: namespace <my-application>
Match all
  AcceptEnv LANG LS_COLORS EDITOR
# END sshd system role managed block: namespace <my-application>
```

Additional resources

- **/usr/share/ansible/roles/rhel-system-roles.sshd/README.md** file
- **/usr/share/doc/rhel-system-roles/sshd/** directory

5.10. ADDITIONAL RESOURCES

- **sshd(8)**, **ssh(1)**, **scp(1)**, **sftp(1)**, **ssh-keygen(1)**, **ssh-copy-id(1)**, **ssh_config(5)**, **sshd_config(5)**, **update-crypto-policies(8)**, and **crypto-policies(7)** man pages.
- Configuring SELinux for applications and services with non-standard configurations
- Controlling network traffic using firewalld

CHAPTER 6. CONFIGURING BASIC SYSTEM SECURITY

Computer security is the protection of computer systems and their hardware, software, information, and services from theft, damage, disruption, and misdirection. Ensuring computer security is an essential task, in particular in enterprises that process sensitive data and handle business transactions.

This section covers only the basic security features that you can configure after installation of the operating system.

6.1. ENABLING THE FIREWALLD SERVICE

A firewall is a network security system that monitors and controls incoming and outgoing network traffic according to configured security rules. A firewall typically establishes a barrier between a trusted secure internal network and another outside network.

The **firewalld** service, which provides a firewall in Red Hat Enterprise Linux, is automatically enabled during installation.

To enable the **firewalld** service, follow this procedure.

Procedure

- Display the current status of **firewalld**:

```
$ systemctl status firewalld
● firewalld.service - firewalld - dynamic firewall daemon
   Loaded: loaded (/usr/lib/systemd/system/firewalld.service; disabled; vendor preset:
enabled)
   Active: inactive (dead)
...
```

- If **firewalld** is not enabled and running, switch to the **root** user, and start the **firewalld** service and enable to start it automatically after the system restarts:

```
# systemctl enable --now firewalld
```

Verification steps

- Check that **firewalld** is running and enabled:

```
$ systemctl status firewalld
● firewalld.service - firewalld - dynamic firewall daemon
   Loaded: loaded (/usr/lib/systemd/system/firewalld.service; enabled; vendor preset:
enabled)
   Active: active (running)
...
```

Additional resources

- Using and configuring firewalld
- **man firewalld(1)**

6.2. MANAGING BASIC SELINUX SETTINGS

Security-Enhanced Linux (SELinux) is an additional layer of system security that determines which processes can access which files, directories, and ports. These permissions are defined in SELinux policies. A policy is a set of rules that guide the SELinux security engine.

SELinux has two possible states:

- Disabled
- Enabled

When SELinux is enabled, it runs in one of the following modes:

- Enabled
  - Enforcing
  - Permissive

In **enforcing mode**, SELinux enforces the loaded policies. SELinux denies access based on SELinux policy rules and enables only the interactions that are explicitly allowed. Enforcing mode is the safest SELinux mode and is the default mode after installation.

In **permissive mode**, SELinux does not enforce the loaded policies. SELinux does not deny access, but reports actions that break the rules to the **/var/log/audit/audit.log** log. Permissive mode is the default mode during installation. Permissive mode is also useful in some specific cases, for example when troubleshooting problems.

Additional resources

- Using SELinux

6.3. ADDITIONAL RESOURCES

- Generating SSH key pairs
- Setting an OpenSSH server for key-based authentication
- Security hardening
- Using SELinux
- Securing networks

CHAPTER 7. INTRODUCTION TO RHEL SYSTEM ROLES

By using RHEL system roles, you can remotely manage the system configurations of multiple RHEL systems across major versions of RHEL.

Important terms and concepts

The following describes important terms and concepts in an Ansible environment:

Control node

A control node is the system from which you run Ansible commands and playbooks. Your control node can be an Ansible Automation Platform, Red Hat Satellite, or a RHEL 9, 8, or 7 host. For more information, see Preparing a control node on RHEL 9 .

Managed node

Managed nodes are the servers and network devices that you manage with Ansible. Managed nodes are also sometimes called hosts. Ansible does not have to be installed on managed nodes. For more information, see Preparing a managed node .

Ansible playbook

In a playbook, you define the configuration you want to achieve on your managed nodes or a set of steps for the system on the managed node to perform. Playbooks are Ansible's configuration, deployment, and orchestration language.

Inventory

In an inventory file, you list the managed nodes and specify information such as IP address for each managed node. In the inventory, you can also organize the managed nodes by creating and nesting groups for easier scaling. An inventory file is also sometimes called a hostfile.

Available roles on a Red Hat Enterprise Linux 9 control node

On a Red Hat Enterprise Linux 9 control node, the **rhel-system-roles** package provides the following roles:

Role name	Role description	Chapter title
certificate	Certificate Issuance and Renewal	Requesting certificates by using RHEL system roles
cockpit	Web console	Installing and configuring web console with the cockpit RHEL system role
crypto_policies	System-wide cryptographic policies	Setting a custom cryptographic policy across systems
firewall	Firewalld	Configuring firewalld by using system roles
ha_cluster	HA Cluster	Configuring a high-availability cluster by using system roles
kdump	Kernel Dumps	Configuring kdump by using RHEL system roles

Role name	Role description	Chapter title
kernel_settings	Kernel Settings	Using Ansible roles to permanently configure kernel parameters
logging	Logging	Using the logging system role
metrics	Metrics (PCP)	Monitoring performance by using RHEL system roles
network	Networking	Using the network RHEL system role to manage InfiniBand connections
nbde_client	Network Bound Disk Encryption client	Using the nbde_client and nbde_server system roles
nbde_server	Network Bound Disk Encryption server	Using the nbde_client and nbde_server system roles
postfix	Postfix	Variables of the postfix role in system roles
postgresql	PostgreSQL	Installing and configuring PostgreSQL by using the postgresql RHEL system role
selinux	SELinux	Configuring SELinux by using system roles
ssh	SSH client	Configuring secure communication with the ssh system roles
sshd	SSH server	Configuring secure communication with the ssh system roles
storage	Storage	Managing local storage by using RHEL system roles
tlog	Terminal Session Recording	Configuring a system for session recording by using the tlog RHEL system role
timesync	Time Synchronization	Configuring time synchronization by using RHEL system roles
vpn	VPN	Configuring VPN connections with IPsec by using the vpn RHEL system role

Additional resources

- Automating system administration by using RHEL system roles
- Red Hat Enterprise Linux (RHEL) system roles
- **/usr/share/ansible/roles/rhel-system-roles.*<role_name>*/README.md** file

- **/usr/share/doc/rhel-system-roles/*<role_name>*/** directory

CHAPTER 8. TROUBLESHOOTING PROBLEMS BY USING LOG FILES

Log files contain messages about the system, including the kernel, services, and applications running on it. These contain information that helps troubleshoot issues or monitor system functions. The logging system in Red Hat Enterprise Linux is based on the built-in **syslog** protocol. Particular programs use this system to record events and organize them into log files, which are useful when auditing the operating system and troubleshooting various problems.

8.1. SERVICES HANDLING SYSLOG MESSAGES

The following two services handle **syslog** messages:

- The **systemd-journald** daemon
- The **Rsyslog** service

The **systemd-journald** daemon collects messages from various sources and forwards them to **Rsyslog** for further processing. The **systemd-journald** daemon collects messages from the following sources:

- Kernel
- Early stages of the boot process
- Standard and error output of daemons as they start up and run
- **Syslog**

The **Rsyslog** service sorts the **syslog** messages by type and priority and writes them to the files in the **/var/log** directory. The **/var/log** directory persistently stores the log messages.

8.2. SUBDIRECTORIES STORING SYSLOG MESSAGES

The following subdirectories under the **/var/log** directory store **syslog** messages.

- **/var/log/messages** - all **syslog** messages except the following
- **/var/log/secure** - security and authentication-related messages and errors
- **/var/log/maillog** - mail server-related messages and errors
- **/var/log/cron** - log files related to periodically executed tasks
- **/var/log/boot.log** - log files related to system startup

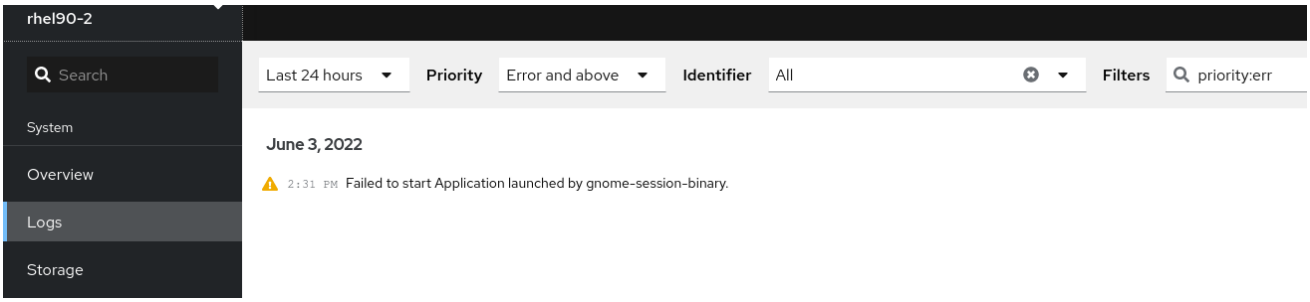
8.3. INSPECTING LOG FILES USING THE WEB CONSOLE

Follow the steps in this procedure to inspect the log files using the RHEL web console.

Procedure

1. Log into the RHEL web console. For details see Logging in to the web console .
2. Click **Logs**.

Figure 8.1. Inspecting the log files in the RHEL 9 web console



8.4. VIEWING LOGS USING THE COMMAND LINE

The Journal is a component of systemd that helps to view and manage log files. It addresses problems connected with traditional logging, closely integrated with the rest of the system, and supports various logging technologies and access management for the log files.

You can use the **journalctl** command to view messages in the system journal using the command line, for example:

```
$ journalctl -b | grep kvm
May 15 11:31:41 localhost.localdomain kernel: kvm-clock: Using msrs 4b564d01 and 4b564d00
May 15 11:31:41 localhost.localdomain kernel: kvm-clock: cpu 0, msr 76401001, primary cpu clock
...
```

Table 8.1. Viewing system information

Command	Description
journalctl	Shows all collected journal entries.
journalctl FILEPATH	Shows logs related to a specific file. For example, the **journalctl /dev/sda** command displays logs related to the **/dev/sda** file system.
journalctl -b	Shows logs for the current boot.
journalctl -k -b -1	Shows kernel logs for the current boot.

Table 8.2. Viewing information about specific services

Command	Description
journalctl -b _SYSTEMD_UNIT=*<name.service>*	Filters log to show entries matching the **systemd** service.
journalctl -b _SYSTEMD_UNIT=*<name.service>* _PID=*<number>*	Combines matches. For example, this command shows logs for **systemd-units** that match ***<name.service>*** and the PID ***<number>***.

Command	Description
journalctl -b _SYSTEMD_UNIT=*<name.service>* _PID=*<number>* + _SYSTEMD_UNIT=*<name2.service>*	The plus sign (+) separator combines two expressions in a logical OR. For example, this command shows all messages from the ***<name.service>*** service process with the **PID** plus all messages from the ***<name2.service>*** service (from any of its processes).
journalctl -b _SYSTEMD_UNIT=*<name.service>* _SYSTEMD_UNIT=*<name2.service>*	This command shows all entries matching either expression, referring to the same field. Here, this command shows logs matching a systemd-unit ***<name.service>*** or a systemd-unit ***<name2.service>***.

Table 8.3. Viewing logs related to specific boots

Command	Description
journalctl --list-boots	Shows a tabular list of boot numbers, their IDs, and the timestamps of the first and last message pertaining to the boot. You can use the ID in the next command to view detailed information.
journalctl --boot=ID _SYSTEMD_UNIT=*<name.service>*	Shows information about the specified boot ID.

8.5. ADDITIONAL RESOURCES

- **man journalctl(1)**
- Configuring a remote logging solution

CHAPTER 9. MANAGING USERS AND GROUPS

Preventing unauthorized access to files and processes requires an accurate user and group management. If you do not manage accounts centrally or you require a user account or group only on a specific system, you can create them locally on this host.

9.1. INTRODUCTION TO MANAGING USER AND GROUP ACCOUNTS

The control of users and groups is a core element of Red Hat Enterprise Linux (RHEL) system administration. Each RHEL user has distinct login credentials and can be assigned to various groups to customize their system privileges.

9.1.1. Introduction to users and groups

A user who creates a file is the owner of that file *and* the group owner of that file. The file is assigned separate read, write, and execute permissions for the owner, the group, and those outside that group. The file owner can be changed only by the **root** user. Access permissions to the file can be changed by both the **root** user and the file owner. A regular user can change group ownership of a file they own to a group of which they are a member of.

Each user is associated with a unique numerical identification number called *user ID* (**UID**). Each group is associated with a *group ID* (**GID**). Users within a group share the same permissions to read, write, and execute files owned by that group.

9.1.2. Configuring reserved user and group IDs

RHEL reserves user and group IDs below 1000 for system users and groups. You can find the reserved user and group IDs in the **setup** package. To view reserved user and group IDs, use:

```
cat /usr/share/doc/setup*/uidgid
```

It is recommended to assign IDs to the new users and groups starting at 5000, as the reserved range can increase in the future.

To make the IDs assigned to new users start at 5000 by default, modify the **UID_MIN** and **GID_MIN** parameters in the **/etc/login.defs** file.

Procedure

To modify and make the IDs assigned to new users start at 5000 by default:

1. Open the **/etc/login.defs** file in an editor of your choice.
2. Find the lines that define the minimum value for automatic UID selection.

```
# Min/max values for automatic uid selection in useradd
#
UID_MIN                  1000
```

3. Modify the **UID_MIN** value to start at 5000.

```
# Min/max values for automatic uid selection in useradd
#
UID_MIN                  5000
```

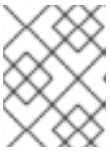
4. Find the lines that define the minimum value for automatic GID selection.

```
# Min/max values for automatic gid selection in groupadd
#
GID_MIN                  1000
```

5. Modify the **GID_MIN** value to start at 5000.

```
# Min/max values for automatic gid selection in groupadd
#
GID_MIN                  5000
```

The dynamically assigned UIDs and GIDs for the regular users now start at 5000.



NOTE

The UID's and GID's of users and groups created before you changed the UID_MIN and GID_MIN values do not change.

This will allow new user's group to have same 5000+ ID as UID and GID.

WARNING

Do not raise IDs reserved by the system above 1000 by changing **SYS_UID_MAX** to avoid conflict with systems that retain the 1000 limit.

9.1.3. User private groups

RHEL uses the *user private group* (**UPG**) system configuration, which makes UNIX groups easier to manage. A user private group is created whenever a new user is added to the system. The user private group has the same name as the user for which it was created and that user is the only member of the user private group.

UPGs simplify the collaboration on a project between multiple users. In addition, UPG system configuration makes it safe to set default permissions for a newly created file or directory, as it allows both the user, and the group this user is a part of, to make modifications to the file or directory.

A list of all groups is stored in the **/etc/group** configuration file.

9.2. GETTING STARTED WITH MANAGING USER ACCOUNTS

Red Hat Enterprise Linux is a multi-user operating system, which enables multiple users on different computers to access a single system installed on one machine. Every user operates under its own account, and managing user accounts thus represents a core element of Red Hat Enterprise Linux system administration.

The following are the different types of user accounts:

- **Normal user accounts:**

Normal accounts are created for users of a particular system. Such accounts can be added, removed, and modified during normal system administration.

- **System user accounts:**
  System user accounts represent a particular applications identifier on a system. Such accounts are generally added or manipulated only at software installation time, and they are not modified later.

WARNING

System accounts are presumed to be available locally on a system. If these accounts are configured and provided remotely, such as in the instance of an LDAP configuration, system breakage and service start failures can occur.

For system accounts, user IDs below 1000 are reserved. For normal accounts, you can use IDs starting at 1000. However, the recommended practice is to assign IDs starting at 5000. For assigning IDs, see the **/etc/login.defs** file.

- **Group:**
  A group is an entity which ties together multiple user accounts for a common purpose, such as granting access to particular files.

9.2.1. Managing accounts and groups using command line tools

Use the following basic command-line tools to manage user accounts and groups.

- To display user and group IDs:

```
$ id
uid=1000(example.user) gid=1000(example.user) groups=1000(example.user),10(wheel)
context=unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023
```

- To create a new user account:

```
# useradd example.user
```

- To assign a new password to a user account belonging to *example.user*:

```
# passwd example.user
```

- To add a user to a group:

```
# usermod -a -G example.group example.user
```

Additional resources

- **man useradd(8)**, **man passwd(1)**, and **man usermod(8)**

9.2.2. System user accounts managed in the web console

With user accounts displayed in the RHEL web console you can:

- Authenticate users when accessing the system.
- Set the access rights to the system.

The RHEL web console displays all user accounts located in the system. Therefore, you can see at least one user account just after the first login to the web console.

After logging into the RHEL web console, you can perform the following operations:

- Create new users accounts.
- Change their parameters.
- Lock accounts.
- Terminate user sessions.

9.2.3. Adding new accounts using the web console

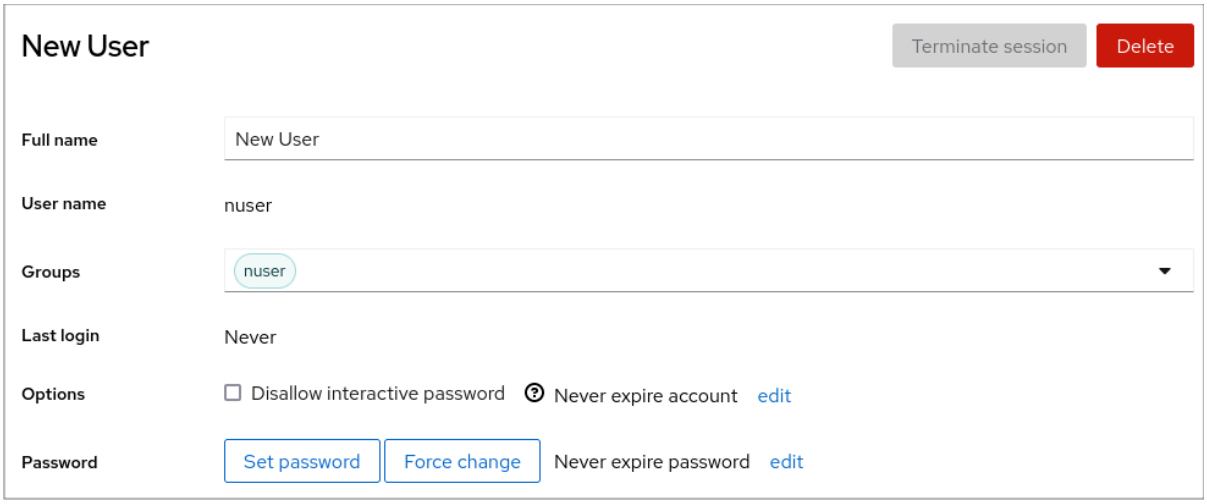
You can add user accounts to the system and set administration rights to the accounts through the RHEL web console.

Prerequisites

- The RHEL web console must be installed and accessible. For details, see Installing the web console.

Procedure

1. Log in to the RHEL web console.
2. Click **Accounts**.
3. Click **Create New Account**.
4. In the **Full Name** field, enter the full name of the user.
   The RHEL web console automatically suggests a user name from the full name and fills it in the **User Name** field. If you do not want to use the original naming convention consisting of the first letter of the first name and the whole surname, update the suggestion.
5. In the **Password/Confirm** fields, enter the password and retype it for verification that your password is correct.
   The color bar below the fields shows you the security level of the entered password, which does not allow you to create a user with a weak password.
6. Click **Create** to save the settings and close the dialog box.
7. Select the newly created account.
8. In the **Groups** drop-down menu, select the groups that you want to add to the new account.



Now you can see the new account in the **Accounts** settings and you can use its credentials to connect to the system.

9.3. MANAGING USERS FROM THE COMMAND LINE

You can manage users and groups using the command-line interface (**CLI**). This enables you to add, remove, and modify users and user groups in Red Hat Enterprise Linux environment.

9.3.1. Adding a new user from the command line

You can use the **useradd** utility to add a new user.

Prerequisites

- **Root** access

Procedure

- To add a new user, use:

```
# useradd options username
```

Replace *options* with the command-line options for the **useradd** command, and replace *username* with the name of the user.

Example 9.1. Adding a new user

To add the user **sarah** with user ID **5000**, use:

```
# useradd -u 5000 sarah
```

Verification steps

- To verify the new user is added, use the **id** utility.

```
# id sarah
```

The output returns:

```
uid=5000(sarah) gid=5000(sarah) groups=5000(sarah)
```

Additional resources

- **useradd** man page

9.3.2. Adding a new group from the command line

You can use the **groupadd** utility to add a new group.

Prerequisites

- **Root** access

Procedure

- To add a new group, use:

```
# groupadd options group-name
```

Replace *options* with the command-line options for the **groupadd** command, and replace *group-name* with the name of the group.

Example 9.2. Adding a new group

To add the group **sysadmins** with group ID **5000**, use:

```
# groupadd -g 5000 sysadmins
```

Verification steps

- To verify the new group is added, use the **tail** utility.

```
# tail /etc/group
```

The output returns:

```
sysadmins:x:5000:
```

Additional resources

- **groupadd** man page

9.3.3. Adding a user to a supplementary group from the command line

You can add a user to a supplementary group to manage permissions or enable access to certain files or devices.

Prerequisites

- **root** access

Procedure

- To add a group to the supplementary groups of the user, use:

```
# usermod --append -G group-name username
```

Replace *group-name* with the name of the group, and replace *username* with the name of the user.

Example 9.3. Adding a user to a supplementary group

To add the user **sysadmin** to the group **system-administrators**, use:

```
# usermod --append -G system-administrators sysadmin
```

Verification steps

- To verify the new groups is added to the supplementary groups of the user **sysadmin**, use:

```
# groups sysadmin
```

The output displays:

```
sysadmin : sysadmin system-administrators
```

9.3.4. Creating a group directory

Under the UPG system configuration, you can apply the *set-group identification permission* (**setgid** bit) to a directory. The **setgid** bit makes managing group projects that share a directory simpler. When you apply the **setgid** bit to a directory, files created within that directory are automatically assigned to a group that owns the directory. Any user that has the permission to write and execute within this group can now create, modify, and delete files in the directory.

The following section describes how to create group directories.

Prerequisites

- **Root** access

Procedure

1. Create a directory:

```
# mkdir directory-name
```

Replace *directory-name* with the name of the directory.

2. Create a group:

```
# groupadd group-name
```

Replace *group-name* with the name of the group.

3. Add users to the group:

```
# usermod --append -G group-name username
```

Replace *group-name* with the name of the group, and replace *username* with the name of the user.

4. Associate the user and group ownership of the directory with the *group-name* group:

```
# chgrp group-name directory-name
```

Replace *group-name* with the name of the group, and replace *directory-name* with the name of the directory.

5. Set the write permissions to allow the users to create and modify files and directories and set the **setgid** bit to make this permission be applied within the *directory-name* directory:

```
# chmod g+rwxs directory-name
```

Replace *directory-name* with the name of the directory.

Now all members of the ***group-name*** group can create and edit files in the ***directory-name*** directory. Newly created files retain the group ownership of ***group-name*** group.

Verification steps

- To verify the correctness of set permissions, use:

```
# ls -ld directory-name
```

Replace *directory-name* with the name of the directory.

The output returns:

```
drwxrwsr-x. 2 root group-name 6 Nov 25 08:45 directory-name
```

9.3.5. Removing a user on the command line

You can remove a user account using the command line. In addition to removing the user account, you can optionally remove the user data and metadata, such as their home directory and configuration files.

Prerequisites

- You have **root** access.
- The user currently exists.
- Ensure that the user is logged out:

```
# loginctl terminate-user user-name
```

Procedure

- To only remove the user account, and not the user data:

```
# userdel user-name
```

- To remove the user, the data, and the metadata:

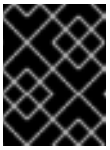
  a. Remove the user, their home directory, their mail spool, and their SELinux user mapping:

```
# userdel --remove --selinux-user user-name
```

  b. Remove additional user metadata:

```
# rm -rf /var/lib/AccountsService/users/user-name
```

  This directory stores information that the system needs about the user before the home directory is available. Depending on the system configuration, the home directory might not be available until the user authenticates at the login screen.



IMPORTANT

If you do not remove this directory and you later recreate the same user, the recreated user will still use certain settings inherited from the removed user.

Additional resources

- The **userdel(8)** man page.

9.4. MANAGING USER ACCOUNTS IN THE WEB CONSOLE

The RHEL web console offers a graphical interface that enables you to execute a wide range of administrative tasks without accessing your terminal directly. For example, you can add, edit or remove system user accounts.

After reading this section, you will know:

- From where the existing accounts come from.
- How to add new accounts.
- How to set password expiration.
- How and when to terminate user sessions.

Prerequisites

- Set up the RHEL web console. For details, see Getting started using the RHEL web console .
- Log in to the RHEL web console with an account that has administrator permissions assigned. For details, see Logging in to the RHEL web console .

9.4.1. System user accounts managed in the web console

With user accounts displayed in the RHEL web console you can:

- Authenticate users when accessing the system.
- Set the access rights to the system.

The RHEL web console displays all user accounts located in the system. Therefore, you can see at least one user account just after the first login to the web console.

After logging into the RHEL web console, you can perform the following operations:

- Create new users accounts.
- Change their parameters.
- Lock accounts.
- Terminate user sessions.

9.4.2. Adding new accounts using the web console

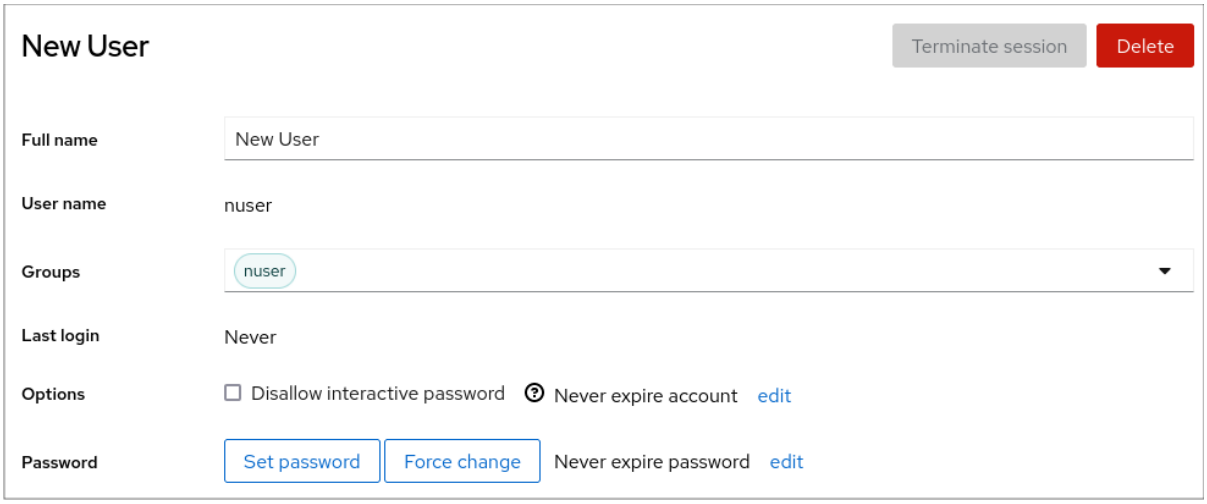
You can add user accounts to the system and set administration rights to the accounts through the RHEL web console.

Prerequisites

- The RHEL web console must be installed and accessible. For details, see Installing the web console.

Procedure

1. Log in to the RHEL web console.
2. Click **Accounts**.
3. Click **Create New Account**.
4. In the **Full Name** field, enter the full name of the user.
   The RHEL web console automatically suggests a user name from the full name and fills it in the **User Name** field. If you do not want to use the original naming convention consisting of the first letter of the first name and the whole surname, update the suggestion.
5. In the **Password/Confirm** fields, enter the password and retype it for verification that your password is correct.
   The color bar below the fields shows you the security level of the entered password, which does not allow you to create a user with a weak password.
6. Click **Create** to save the settings and close the dialog box.
7. Select the newly created account.
8. In the **Groups** drop-down menu, select the groups that you want to add to the new account.



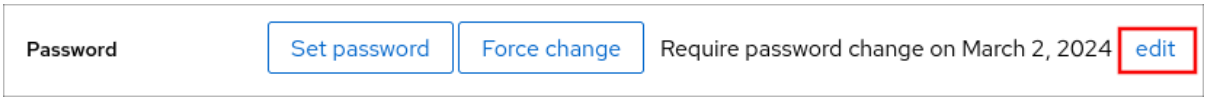
Now you can see the new account in the **Accounts** settings and you can use its credentials to connect to the system.

9.4.3. Enforcing password expiration in the web console

By default, user accounts have set passwords to never expire. You can set system passwords to expire after a defined number of days. When the password expires, the next login attempt will prompt for a password change.

Procedure

1. Log in to the RHEL 9 web console.
2. Click **Accounts**.
3. Select the user account for which you want to enforce password expiration.
4. Click **edit** on the **Password** line.



5. In the **Password expiration** dialog box, select **Require password change every ... days** and enter a positive whole number representing the number of days after which the password expires.
6. Click **Change**.
   The web console immediately shows the date of the future password change request on the **Password** line.

9.4.4. Terminating user sessions in the web console

A user creates user sessions when logging into the system. Terminating user sessions means to log the user out from the system. It can be helpful if you need to perform administrative tasks sensitive to configuration changes, for example, system upgrades.

In each user account in the RHEL 9web console, you can terminate all sessions for the account except for the web console session you are currently using. This prevents you from loosing access to your system.

Procedure

1. Log in to the RHEL 9 web console.
2. Click **Accounts**.
3. Click the user account for which you want to terminate the session.
4. Click **Terminate Session**.
   If the **Terminate Session** button is inactive, the user is not logged in to the system.

   The RHEL web console terminates the sessions.

9.5. EDITING USER GROUPS USING THE COMMAND LINE

A user belongs to a certain set of groups that allow a logical collection of users with a similar access to files and folders. You can edit the primary and supplementary user groups from the command line to change the user's permissions.

9.5.1. Primary and supplementary user groups

A group is an entity which ties together multiple user accounts for a common purpose, such as granting access to particular files.

On Linux, user groups can act as primary or supplementary. Primary and supplementary groups have the following properties:

Primary group

- Every user has just one primary group at all times.
- You can change the user's primary group.

Supplementary groups

- You can add an existing user to an existing supplementary group to manage users with the same security and access privileges within the group.
- Users can be members of zero or multiple supplementary groups.

9.5.2. Listing the primary and supplementary groups of a user

You can list the groups of users to see which primary and supplementary groups they belong to.

Procedure

- Display the names of the primary and any supplementary group of a user:

  ```
  $ groups user-name
  ```

  Replace *user-name* with the name of the user. If you do not provide a user name, the command displays the group membership for the current user. The first group is the primary group followed by the optional supplementary groups.

Example 9.4. Listing of groups for user sarah:

```
$ groups sarah
```

The output displays:

```
sarah : sarah wheel developer
```

User **sarah** has a primary group **sarah** and is a member of supplementary groups **wheel** and **developer**.

Example 9.5. Listing of groups for user marc:

```
$ groups marc
```

The output displays:

```
marc : marc
```

User **marc** has only a primary group **marc** and no supplementary groups.

9.5.3. Changing the primary group of a user

You can change the primary group of an existing user to a new group.

Prerequisites:

1. **root** access
2. The new group must exist

Procedure

- Change the primary group of a user:

```
# usermod -g group-name user-name
```

Replace *group-name* with the name of the new primary group, and replace *user-name* with the name of the user.

NOTE

When you change a user's primary group, the command also automatically changes the group ownership of all files in the user's home directory to the new primary group. You must fix the group ownership of files outside of the user's home directory manually.

Example 9.6. Example of changing the primary group of a user:

If the user **sarah** belongs to the primary group **sarah1**, and you want to change the primary group of the user to **sarah2**, use:

```
# usermod -g sarah2 sarah
```

Verification steps

- Verify that you changed the primary group of the user:

```
$ groups sarah
```

The output displays:

```
sarah : sarah2
```

9.5.4. Adding a user to a supplementary group from the command line

You can add a user to a supplementary group to manage permissions or enable access to certain files or devices.

Prerequisites

- **root** access

Procedure

- To add a group to the supplementary groups of the user, use:

```
# usermod --append -G group-name username
```

Replace *group-name* with the name of the group, and replace *username* with the name of the user.

Example 9.7. Adding a user to a supplementary group

To add the user **sysadmin** to the group **system-administrators**, use:

```
# usermod --append -G system-administrators sysadmin
```

Verification steps

- To verify the new groups is added to the supplementary groups of the user **sysadmin**, use:

```
# groups sysadmin
```

The output displays:

```
sysadmin : sysadmin system-administrators
```

9.5.5. Removing a user from a supplementary group

You can remove an existing user from a supplementary group to limit their permissions or access to files and devices.

Prerequisites

- **root** access

Procedure

- Remove a user from a supplementary group:

```
# gpasswd -d user-name group-name
```

Replace *user-name* with the name of the user, and replace *group-name* with the name of the supplementary group.

Example 9.8. Removing user from a supplementary group

If the user sarah has a primary group **sarah2**, and belongs to the secondary groups **wheel** and **developers**, and you want to remove that user from the group **developers**, use:

```
# gpasswd -d sarah developers
```

Verification steps

- Verify that you removed the user sarah from the secondary group developers:

```
$ groups sarah
```

The output displays:

```
sarah : sarah2 wheel
```

9.5.6. Changing all of the supplementary groups of a user

You can overwrite the list of supplementary groups that you want the user to remain a member of.

Prerequisites

- **root** access
- The supplementary groups must exist

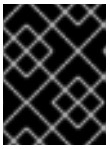
Procedure

- Overwrite a list of user's supplementary groups:

```
# usermod -G group-names username
```

Replace *group-names* with the name of one or more supplementary groups. To add the user to several supplementary groups at once, separate the group names using commas and no intervening spaces. For example: **wheel,developer**.

Replace *user-name* with the name of the user.



IMPORTANT

If the user is currently a member of a group that you do not specify, the command removes the user from the group.

Example 9.9. Changing the list of supplementary groups of a user

If the user **sarah** has a primary group **sarah2**, and belongs to the supplementary group **wheel**, and you want the user to belong to three more supplementary groups **developer**, **sysadmin**, and **security**, use:

```
# usermod -G wheel,developer,sysadmin,security sarah
```

Verification steps

- Verify that you set the list of the supplementary groups correct:

```
# groups sarah
```

The output displays:

```
sarah : sarah2 wheel developer sysadmin security
```

9.6. CHANGING AND RESETTING THE ROOT PASSWORD

If the existing root password is no longer satisfactory or is forgotten, you can change or reset it both as the **root** user and a non-root user.

9.6.1. Changing the root password as the root user

You can use the **passwd** command to change the **root** password as the **root** user.

Prerequisites

- **Root** access

Procedure

- To change the **root** password, use:

```
# passwd
```

You are prompted to enter your current password before you can change it.

9.6.2. Changing or resetting the forgotten root password as a non-root user

You can use the **passwd** command to change or reset the forgotten **root** password as a non-root user.

Prerequisites

- You are able to log in as a non-root user.
- You are a member of the administrative **wheel** group.

Procedure

- To change or reset the **root** password as a non-root user that belongs to the **wheel** group, use:

```
$ sudo passwd root
```

  You are prompted to enter your current non-root password before you can change the **root** password.

9.6.3. Resetting the root password on boot

If you are unable to log in as a non-root user or do not belong to the administrative **wheel** group, you can reset the root password on boot by switching into a specialized **chroot jail** environment.

Procedure

1. Reboot the system and, on the GRUB 2 boot screen, press the **e** key to interrupt the boot process.
   The kernel boot parameters appear.

```
load_video
set gfx_payload=keep
insmod gzio
linux ($root)/vmlinuz-5.14.0-70.22.1.e19_0.x86_64 root=/dev/mapper/rhel-root ro crash\
kernel=auto resume=/dev/mapper/rhel-swap rd.lvm.lv/swap rhgb quiet
initrd ($root)/initramfs-5.14.0-70.22.1.e19_0.x86_64.img $tuned_initrd
```

2. Go to the end of the line that starts with **linux**.

```
linux ($root)/vmlinuz-5.14.0-70.22.1.e19_0.x86_64 root=/dev/mapper/rhel-root ro crash\
kernel=auto resume=/dev/mapper/rhel-swap rd.lvm.lv/swap rhgb quiet
```

   Press **Ctrl+e** to jump to the end of the line.

3. Add **rd.break** to the end of the line that starts with **linux**.

```
linux ($root)/vmlinuz-5.14.0-70.22.1.e19_0.x86_64 root=/dev/mapper/rhel-root ro crash\
kernel=auto resume=/dev/mapper/rhel-swap rd.lvm.lv/swap rhgb quiet rd.break
```

4. Press **Ctrl+x** to start the system with the changed parameters.
   The **switch_root** prompt appears.

5. Remount the file system as writable:

```
mount -o remount,rw /sysroot
```

The file system is mounted as read-only in the /**sysroot** directory. Remounting the file system as writable allows you to change the password.

6. Enter the **chroot** environment:

```
chroot /sysroot
```

The **sh-4.4#** prompt appears.

7. Reset the **root** password:

```
passwd
```

Follow the instructions displayed by the command line to finalize the change of the **root** password.

8. Enable the SELinux relabeling process on the next system boot:

```
touch /.autorelabel
```

9. Exit the **chroot** environment:

```
exit
```

10. Exit the **switch_root** prompt:

```
exit
```

11. Wait until the SELinux relabeling process is finished. Note that relabeling a large disk might take a long time. The system reboots automatically when the process is complete.

Verification steps

1. To verify that the **root** password is successfully changed, log in as a normal user and open the Terminal.
2. Run the interactive shell as root:

```
$ su
```

3. Enter your new **root** password.
4. Print the user name associated with the current effective user ID:

```
# whoami
```

The output returns:

```
root
```

CHAPTER 10. MANAGING SUDO ACCESS

System administrators can grant **sudo** access to allow non-root users to execute administrative commands that are normally reserved for the root user. As a result, non-root users can execute such commands without logging in to the root user account.

10.1. USER AUTHORIZATIONS IN SUDOERS

The **/etc/sudoers** file specifies which users can use the **sudo** command to execute other commands. The rules can apply to individual users and user groups. You can also define rules for groups of hosts, commands, and even users more easily by using aliases. Default aliases are defined in the first part of the **/etc/sudoers** file.

When a user enters a command with **sudo** for which the user does not have authorization, the system records a message that contains the string ***<username>* : user NOT in sudoers** to the journal log.

The default **/etc/sudoers** file provides information and examples of authorizations. You can activate a specific example rule by uncommenting the corresponding line. The section with user authorizations is marked with the following introduction:

```
## Next comes the main part: which users can run what software on
## which machines  (the sudoers file can be shared between multiple
## systems).
```

You can create new **sudoers** authorizations and modify existing authorizations by using the following format:

```
<username> <hostname.example.com>=(<run_as_user>:<run_as_group>) <path/to/command>
```

Where:

- ***<username>*** is the user that enters the command, for example, **user1**. If the value starts with **%**, it defines a group, for example, **%group1**.
- ***<hostname.example.com>*** is the name of the host on which the rule applies.
- The section **(*<run_as_user>*:*<run_as_group>*)** defines the user or group as which the command is executed. If you omit this section, ***<username>*** can execute the command as root.
- ***<path/to/command>*** is the complete absolute path to the command. You can also limit the user to only performing a command with specific options and arguments by adding those options after the command path. If you do not specify any options, the user can use the command with all options.

You can apply the rule to all users, hosts, or commands by replacing any of these variables with **ALL**.

WARNING

With overly permissive rules, such as **ALL ALL=(ALL) ALL**, all users can run all commands as all users on all hosts. This presents serious security risks.

You can specify the arguments negatively by using the **!** operator. For example, **!root** specifies all users except root. Note that allowing specific users, groups, and commands is more secure than disallowing specific users, groups, and commands. This is because allow rules also block new unauthorized users or groups.

WARNING

Avoid using negative rules for commands because users can overcome such rules by renaming commands with the **alias** command.

The system reads the **/etc/sudoers** file from beginning to end. Therefore, if the file contains multiple entries for a user, the entries are applied in order. In case of conflicting values, the system uses the last match, even if it is not the most specific match.

To preserve the rules during system updates and for easier fixing of errors, enter new rules by creating new files in the **/etc/sudoers.d/** directory instead of entering rules directly to the **/etc/sudoers** file. The system reads the files in the **/etc/sudoers.d** directory when it reaches the following line in the **/etc/sudoers** file:

```
#includedir /etc/sudoers.d
```

Note that the number sign (**#**) at the beginning of this line is part of the syntax and does not mean the line is a comment. The names of files in that directory must not contain a period and must not end with a tilde (**~**).

Additional resources

- **sudo(8)** and **sudoers(5)** man pages

10.2. GRANTING SUDO ACCESS TO A USER

System administrators can allow non-root users to execute administrative commands by granting them **sudo** access. The **sudo** command provides users with administrative access without using the password of the root user.

When users need to perform an administrative command, they can precede that command with **sudo**. If the user has authorization for the command, the command is executed as if they were root.

Be aware of the following limitations:

- Only users listed in the **/etc/sudoers** configuration file can use the **sudo** command.
- The command is executed in the shell of the user, not in the root shell.

Prerequisites

- You have root access to the system.

Procedure

1. As root, open the **/etc/sudoers** file.

```
# visudo
```

   The **/etc/sudoers** file defines the policies applied by the **sudo** command.

2. In the **/etc/sudoers** file, find the lines that grant **sudo** access to users in the administrative **wheel** group.

```
## Allows people in group wheel to run all commands
%wheel        ALL=(ALL)       ALL
```

3. Make sure the line that starts with **%wheel** is not commented out with the number sign (**#**).

4. Save any changes, and exit the editor.

5. Add users you want to grant **sudo** access to into the administrative **wheel** group.

```
# usermod --append -G wheel <username>
```

   Replace ***<username>*** with the name of the user.

Verification steps

- Verify that the user is in the administrative **wheel** group:

```
# id <username>
uid=5000(<username>) gid=5000(<username>) groups=5000(<username>),10(wheel)
```

Additional resources

- **sudo(8)**, **visudo(8)**, and **sudoers(5)** man pages

10.3. ENABLING UNPRIVILEGED USERS TO RUN CERTAIN COMMANDS

As an administrator, you can allow unprivileged users to enter certain commands on specific workstations by configuring a policy in the **/etc/sudoers.d/** directory.

Prerequisites

- You have root access to the system.

Procedure

1. As root, create a new **sudoers.d** directory under **/etc/**:

```
# mkdir -p /etc/sudoers.d/
```

2. Create a new file in the **/etc/sudoers.d** directory:

```
# visudo -f /etc/sudoers.d/<filename>
```

   The file opens automatically.

3. Add the following line to the **/etc/sudoers.d/*<filename>*** file:

```
<username> <hostname.example.com> = (<run_as_user>:<run_as_group>)
<path/to/command>
```

   - Replace ***<username>*** with the name of the user.
   - Replace ***<hostname.example.com>*** with the URL of the host.
   - Replace **(*<run_as_user>*:*<run_as_group>*)** with the user or group as which the command can be executed. If you omit this section, ***<username>*** can execute the command as root.
   - Replace ***<path/to/command>*** with the complete absolute path to the command. You can also limit the user to only performing a command with specific options and arguments by adding those options after the command path. If you do not specify any options, the user can use the command with all options.
   - To allow two and more commands on the same host on one line, you can list them separated by a comma followed by a space.
     For example, to allow **user1** to execute the **dnf** and **reboot** commands on **host1.example.com**, enter **user1 host1.example.com = /bin/dnf, /sbin/reboot**.

4. Optional: To receive email notifications every time the user attempts to use **sudo** privileges, add the following lines to the file:

```
Defaults    mail_always
Defaults    mailto="<email@example.com>"
```

5. Save the changes, and exit the editor.

Verification

1. To verify if a user can run a command with **sudo** privileges, switch the account:

```
# su <username> -
```

2. As the user, enter the command with the **sudo** command:

```
$ sudo <command>
[sudo] password for <username>:
```

   Enter the user's **sudo** password.

3. If the privileges are configured correctly, the system displays the list of commands and options. For example, with the **dnf** command, it shows the following output:

```
...
usage: dnf [options] COMMAND
...
```

   If the system returns the error message ***<username>* is not in the sudoers file. This incident will be reported**, the file for ***<username>*** in **/etc/sudoers.d/** does not exist.

If the system returns the error message ***<username>* is not allowed to run sudo on *<host.example.com>***, the configuration was not completed correctly. Ensure that you are logged in as root and that the configuration was performed correctly.

If the system returns the error message **Sorry, user *<username>* is not allowed to execute '*<path/to/command>*' as root on *<host.example.com>*.**, the command is not correctly defined in the rule for the user.

Additional resources

- **sudo(8)**, **visudo(8)**, and **sudoers(5)** man pages

CHAPTER 11. MANAGING FILE SYSTEM PERMISSIONS

File system permissions control the ability of user and group accounts to read, modify, and execute the contents of the files and to enter directories. Set permissions carefully to protect your data against unauthorized access.

11.1. MANAGING FILE PERMISSIONS

Every file or directory has three levels of ownership:

- User owner (**u**).
- Group owner (**g**).
- Others (**o**).

Each level of ownership can be assigned the following permissions:

- Read (**r**).
- Write (**w**).
- Execute (**x**).

Note that the execute permission for a file allows you to execute that file. The execute permission for a directory allows you to access the contents of the directory, but not execute it.

When a new file or directory is created, the default set of permissions are automatically assigned to it. The default permissions for a file or directory are based on two factors:

- Base permission.
- The *user file-creation mode mask* (**umask**).

11.1.1. Base file permissions

Whenever a new file or directory is created, a base permission is automatically assigned to it. Base permissions for a file or directory can be expressed in *symbolic* or *octal* values.

Permission	Symbolic value	Octal value
No permission	---	0
Execute	--x	1
Write	-w-	2
Write and execute	-wx	3
Read	r--	4
Read and execute	r-x	5

Read and write	rw-	6
Read, write, execute	rwx	7

The base permission for a directory is **777** (**drwxrwxrwx**), which grants everyone the permissions to read, write, and execute. This means that the directory owner, the group, and others can list the contents of the directory, create, delete, and edit items within the directory, and descend into it.

Note that individual files within a directory can have their own permission that might prevent you from editing them, despite having unrestricted access to the directory.

The base permission for a file is **666** (**-rw-rw-rw-**), which grants everyone the permissions to read and write. This means that the file owner, the group, and others can read and edit the file.

Example 11.1. Permissions for a file

If a file has the following permissions:

```
$ ls -l
-rwxrw----. 1 sysadmins sysadmins 2 Mar 2 08:43 file
```

- **-** indicates it is a file.
- **rwx** indicates that the file owner has permissions to read, write, and execute the file.
- **rw-** indicates that the group has permissions to read and write, but not execute the file.
- **---** indicates that other users have no permission to read, write, or execute the file.
- **.** indicates that the SELinux security context is set for the file.

Example 11.2. Permissions for a directory

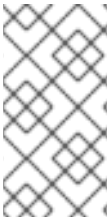
If a directory has the following permissions:

```
$ ls -dl directory
drwxr-----. 1 sysadmins sysadmins 2 Mar 2 08:43 directory
```

- **d** indicates it is a directory.
- **rwx** indicates that the directory owner has the permissions to read, write, and access the contents of the directory.
  As a directory owner, you can list the items (files, subdirectories) within the directory, access the content of those items, and modify them.
- **r-x** indicates that the group has permissions to read the content of the directory, but not write - create new entries or delete files. The **x** permission means that you can also access the directory using the **cd** command.
- **---** indicates that other users have no permission to read, write, or access the contents of the directory.

As someone who is not a user owner, or as group owner of the directory, you cannot list the items within the directory, access information about those items, or modify them.

- **.** indicates that the SELinux security context is set for the directory.



NOTE

The base permission that is automatically assigned to a file or directory is **not** the default permission the file or directory ends up with. When you create a file or directory, the base permission is altered by the *umask*. The combination of the base permission and the *umask* creates the default permission for files and directories.

11.1.2. User file-creation mode mask

The user file-creation mode mask (*umask*) is variable that controls how file permissions are set for newly created files and directories. The *umask* automatically removes permissions from the base permission value to increase the overall security of a Linux system. The *umask* can be expressed in *symbolic* or *octal* values.

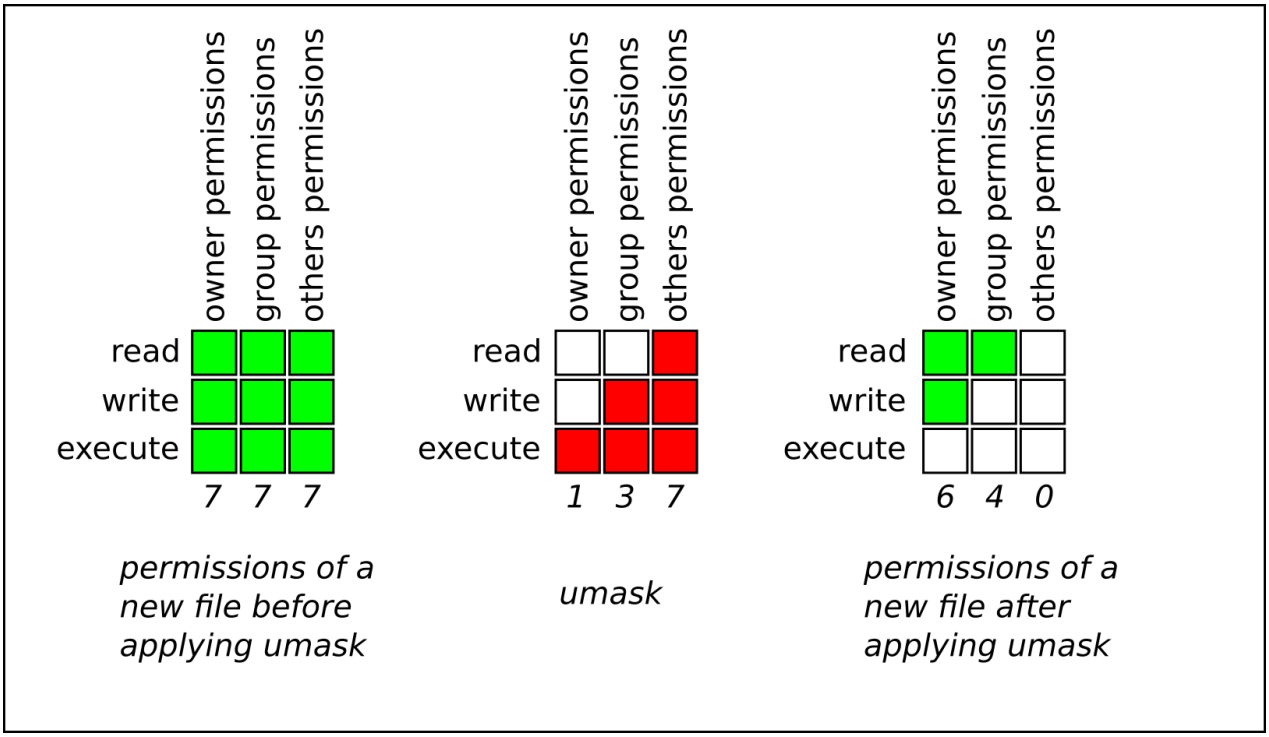
Permission	Symbolic value	Octal value
Read, write, and execute	rwx	0
Read and write	rw-	1
Read and execute	r-x	2
Read	r--	3
Write and execute	-wx	4
Write	-w-	5
Execute	--x	6
No permissions	---	7

The default *umask* for both a standard user and for a **root** user is **0022**.

The first digit of the *umask* represents special permissions (sticky bit,). The last three digits of the *umask* represent the permissions that are removed from the user owner (**u**), group owner (**g**), and others (**o**) respectively.

Example 11.3. Applying the umask when creating a file

The following example illustrates how the *umask* with an octal value of **0137** is applied to the file with the base permission of **777**, to create the file with the default permission of **640**.



11.1.3. Default file permissions

The default permissions are set automatically for all newly created files and directories. The value of the default permissions is determined by applying the *umask* to the base permission.

Example 11.4. Default permissions for a directory

When a **standard user** or a **root user** creates a new **directory**, the *umask* is set to **022** (**rwxr-xr-x**), and the base permissions for a directory are set to **777** (**rwxrwxrwx**). This brings the default permissions to **755** (**rwxr-xr-x**).

	Symbolic value	Octal value
Base permission	rwxrwxrwx	777
Umask	rwxr-xr-x	022
Default permission	rwxr-xr-x	755

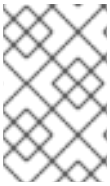
This means that the directory owner can list the contents of the directory, create, delete, and edit items within the directory, and descend into it. The group and others can only list the contents of the directory and descend into it.

Example 11.5. Default permissions for a file

When a **standard user** or a **root user** creates a new **file**, the *umask* is set to **022** (**rwxr-xr-x**), and the base permissions for a file are set to **666** (**rw-rw-rw-**). This brings the default permissions to **644** (**-rw-r—r--**).

	Symbolic value	Octal value
Base permission	rw-rw-rw-	666
Umask	rwxr-xr-x	022
Default permission	rw-r—r--	644

This means that the file owner can read and edit the file, while the group and others can only read the file.



NOTE

For security reasons, regular files cannot have execute permissions by default, even if the *umask* is set to **000** (**rwxrwxrwx**). However, directories can be created with execute permissions.

11.1.4. Changing file permissions using symbolic values

You can use the **chmod** utility with symbolic values (a combination letters and signs) to change file permissions for a file or directory.

You can assign the following *permissions*:

- Read (**r**)
- Write (**w**)
- Execute (**x**)

Permissions can be assigned to the following *levels of ownership*:

- User owner (**u**)
- Group owner (**g**)
- Other (**o**)
- All (**a**)

To add or remove permissions you can use the following *signs*:

- **+** to add the permissions on top of the existing permissions
- **-** to remove the permissions from the existing permission
- **=** to remove the existing permissions and explicitly define the new ones

Procedure

- To change the permissions for a file or directory, use:

```
$ chmod <level><operation><permission> file-name
```

Replace ***<level>*** with the level of ownership you want to set the permissions for. Replace ***<operation>*** with one of the signs. Replace ***<permission>*** with the permissions you want to assign. Replace *file-name* with the name of the file or directory. For example, to grant everyone the permissions to read, write, and execute (**rwx**) **my-script.sh**, use the **chmod a=rwx my-script.sh** command.

See Base file permissions for more details.

Verification steps

- To see the permissions for a particular file, use:

```
$ ls -l file-name
```

Replace *file-name* with the name of the file.

- To see the permissions for a particular directory, use:

```
$ ls -dl directory-name
```

Replace *directory-name* with the name of the directory.

- To see the permissions for all the files within a particular directory, use:

```
$ ls -l directory-name
```

Replace *directory-name* with the name of the directory.

Example 11.6. Changing permissions for files and directories

- To change file permissions for **my-file.txt** from **-rw-rw-r--** to **-rw------**, use:
  1. Display the current permissions for **my-file.txt**:

```
$ ls -l my-file.txt
-rw-rw-r--. 1 username username 0 Feb 24 17:56 my-file.txt
```

  2. Remove the permissions to read, write, and execute (**rwx**) the file from group owner (**g**) and others (**o**):

```
$ chmod go= my-file.txt
```

Note that any permission that is not specified after the equals sign (**=**) is automatically prohibited.

  3. Verify that the permissions for **my-file.txt** were set correctly:

```
$ ls -l my-file.txt
-rw-------. 1 username username 0 Feb 24 17:56 my-file.txt
```

- To change file permissions for **my-directory** from **drwxrwx---** to **drwxrwxr-x**, use:
  1. Display the current permissions for **my-directory**:

1. Display the current permissions for **my-directory**:

```
$ ls -dl my-directory
drwxrwx---. 2 username username 4096 Feb 24 18:12 my-directory
```

2. Add the read and execute (**r-x**) access for all users (**a**):

```
$ chmod o+rx my-directory
```

3. Verify that the permissions for **my-directory** and its content were set correctly:

```
$ ls -dl my-directory
drwxrwxr-x. 2 username username 4096 Feb 24 18:12 my-directory
```

11.1.5. Changing file permissions using octal values

You can use the **chmod** utility with octal values (numbers) to change file permissions for a file or directory.

Procedure

- To change the file permissions for an existing file or directory, use:

```
$ chmod octal_value file-name
```

Replace *file-name* with the name of the file or directory. Replace *octal_value* with an octal value. See Base file permissions for more details.

11.2. MANAGING THE ACCESS CONTROL LIST

Each file and directory can only have one user owner and one group owner at a time. If you want to grant a user permissions to access specific files or directories that belong to a different user or group while keeping other files and directories private, you can utilize Linux Access Control Lists (ACLs).

11.2.1. Displaying the current Access Control List

You can use the **getfacl** utility to display the current ACL.

Procedure

- To display the current ACL for a particular file or directory, use:

```
$ getfacl file-name
```

Replace *file-name* with the name of the file or directory.

11.2.2. Setting the Access Control List

You can use the **setfacl** utility to set the ACL for a file or directory.

Prerequisites

- **root** access.

Procedure

- To set the ACL for a file or directory, use:

```
# setfacl -m u:username:symbolic_value file-name
```

Replace *username* with the name of the user, *symbolic_value* with a symbolic value, and *file-name* with the name of the file or directory. For more information see the **setfacl** man page.

Example 11.7. Modifying permissions for a group project

The following example describes how to modify permissions for the **group-project** file owned by the **root** user that belongs to the **root** group so that this file is:

- Not executable by anyone.
- The user **andrew** has the **rw-** permissions.
- The user **susan** has the **---** permissions.
- Other users have the **r--** permissions.

Procedure

```
# setfacl -m u:andrew:rw- group-project
# setfacl -m u:susan:--- group-project
```

Verification steps

- To verify that the user **andrew** has the **rw-** permission, the user **susan** has the **---** permission, and other users have the **r--** permission, use:

```
$ getfacl group-project
```

The output returns:

```
# file: group-project
# owner: root
# group: root
user:andrew:rw-
user:susan:---
group::r--
mask::rw-
other::r--
```

11.3. MANAGING THE UMASK

You can use the **umask** utility to display, set, or change the current or default value of the *umask*.

11.3.1. Displaying the current value of the umask

You can use the **umask** utility to display the current value of the *umask* in symbolic or octal mode.

Procedure

- To display the current value of the *umask* in symbolic mode, use:

```
$ umask -S
```

- To display the current value of the *umask* in the octal mode, use:

```
$ umask
```

NOTE

When displaying the *umask* in octal mode, you may notice it displayed as a four digit number (**0002** or **0022**). The first digit of the *umask* represents a special bit (sticky bit, SGID bit, or SUID bit). If the first digit is set to **0**, the special bit is not set.

11.3.2. Displaying the default bash umask

There are a number of shells you can use, such as **bash**, **ksh**, **zsh** and **tcsh**. Those shells can behave as login or non-login shells. You can invoke the login shell by opening a native or a GUI terminal.

To determine whether you are executing a command in a login or a non-login shell, use the **echo $0** command.

Example 11.8. Determining if you are working in a login or a non-login bash shell

- If the output of the **echo $0** command returns **bash**, you are executing the command in a non-login shell.

```
$ echo $0
bash
```

  The default *umask* for the non-login shell is set in the **/etc/bashrc** configuration file.

- If the output of the **echo $0** command returns **-bash**, you are executing the command in a login shell.

```
# echo $0
-bash
```

  The default *umask* for the login shell is set in the **/etc/login.defs** configuration file.

Procedure

- To display the default **bash** *umask* for the non-login shell, use:

```
$ grep umask /etc/bashrc
```

  The output returns:

```
# By default, we want umask to get set. This sets it for non-login shell.
      umask 002
      umask 022
```

- To display the default **bash** *umask* for the login shell, use:

```
$ grep "UMASK" /etc/login.defs
```

The output returns:

```
# UMASK is also used by useradd(8) and newusers(8) to set the mode for new
UMASK        022
# If HOME_MODE is not set, the value of UMASK is used to create the mode.
```

11.3.3. Setting the umask using symbolic values

You can use the **umask** utility with symbolic values (a combination letters and signs) to set the *umask* for the current shell session

You can assign the following *permissions*:

- Read (**r**)
- Write (**w**)
- Execute (**x**)

Permissions can be assigned to the following *levels of ownership*:

- User owner (**u**)
- Group owner (**g**)
- Other (**o**)
- All (**a**)

To add or remove permissions you can use the following *signs*:

- **+** to add the permissions on top of the existing permissions
- **-** to remove the permissions from the existing permission
- **=** to remove the existing permissions and explicitly define the new ones

NOTE

Any permission that is not specified after the equals sign (**=**) is automatically prohibited.

Procedure

- To set the *umask* for the current shell session, use:

```
$ umask -S <level><operation><permission>
```

Replace ***<level>*** with the level of ownership you want to set the umask for. Replace ***<operation>*** with one of the signs. Replace ***<permission>*** with the permissions you want to assign. For example, to set the *umask* to **u=rwx,g=rwx,o=rwx**, use **umask -S a=rwx**.

See User file-creation mode for more details.

NOTE

The *umask* is only valid for the current shell session.

11.3.4. Setting the umask using octal values

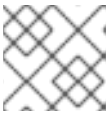
You can use the **umask** utility with octal values (numbers) to set the *umask* for the current shell session.

Procedure

- To set the *umask* for the current shell session, use:

```
$ umask octal_value
```

Replace *octal_value* with an octal value. See User file-creation mode mask for more details.



NOTE

The *umask* is only valid for the current shell session.

11.3.5. Changing the default umask for the non-login shell

You can change the default **bash** *umask* for standard users by modifying the **/etc/bashrc** file.

Prerequisites

- **root** access

Procedure

1. As **root**, open the **/etc/bashrc** file in the editor.
2. Modify the following sections to set a new default **bash** *umask*:

```
if [ $UID -gt 199 ] && [ “id -gn” = “id -un” ]; then
   umask 002
else
   umask 022
fi
```

Replace the default octal value of the *umask* (**002**) with another octal value. See User file-creation mode mask for more details.

3. Save the changes and exit the editor.

11.3.6. Changing the default umask for the login shell

You can change the default **bash** *umask* for the **root** user by modifying the **/etc/login.defs** file.

Prerequisites

- **root** access

Procedure

1. As **root**, open the **/etc/login.defs** file in the editor.
2. Modify the following sections to set a new default **bash** *umask*:

```
# Default initial "umask" value used by login(1) on non-PAM enabled systems.
# Default "umask" value for pam_umask(8) on PAM enabled systems.
# UMASK is also used by useradd(8) and newusers(8) to set the mode for new
# home directories if HOME_MODE is not set.
# 022 is the default value, but 027, or even 077, could be considered
# for increased privacy. There is no One True Answer here: each sysadmin
# must make up their mind.

UMASK           022
```

   Replace the default octal value of the *umask* (**022**) with another octal value. See User file-creation mode mask for more details.

3. Save the changes and exit the editor.

11.3.7. Changing the default umask for a specific user

You can change the default *umask* for a specific user by modifying the **.bashrc** for that user.

Procedure

- Append the line that specifies the octal value of the *umask* into the **.bashrc** file for the particular user.

```
$ echo 'umask octal_value' >> /home/username/.bashrc
```

  Replace *octal_value* with an octal value and replace *username* with the name of the user. See User file-creation mode mask for more details.

11.3.8. Setting default permissions for newly created home directories

You can change the permission modes for home directories of newly created users by modifying the **/etc/login.defs** file.

Procedure

1. As **root**, open the **/etc/login.defs** file in the editor.
2. Modify the following section to set a new default *HOME_MODE*:

```
# HOME_MODE is used by useradd(8) and newusers(8) to set the mode for new
# home directories.
# If HOME_MODE is not set, the value of UMASK is used to create the mode.
HOME_MODE       0700
```

Replace the default octal value (**0700**) with another octal value. The selected mode will be used to create the permissions for the home directory.

3. If *HOME_MODE* is set, save the changes and exit the editor.

4. If *HOME_MODE* is not set, modify the *UMASK* to set the mode for the newly created home directories:

```
# Default initial "umask" value used by login(1) on non-PAM enabled systems.
# Default "umask" value for pam_umask(8) on PAM enabled systems.
# UMASK is also used by useradd(8) and newusers(8) to set the mode for new
# home directories if HOME_MODE is not set.
# 022 is the default value, but 027, or even 077, could be considered
# for increased privacy. There is no One True Answer here: each sysadmin
# must make up their mind.

UMASK           022
```

Replace the default octal value (**022**) with another octal value. See User file-creation mode mask for more details.

5. Save the changes and exit the editor.

CHAPTER 12. MANAGING SYSTEMD

As a system administrator, you can manage critical aspects of your system with **systemd**. Serving as a system and service manager for Linux operating systems, **systemd** software suite provides tools and services for controlling, reporting, and system initialization. Key features of **systemd** include:

- Parallel start of system services during boot
- On-demand activation of daemons
- Dependency-based service control logic

The basic object that **systemd** manages is a *systemd unit*, a representation of system resources and services. A **systemd** unit consists of a name, type and a configuration file that defines and manages a particular task. You can use unit files to configure system behavior. See the following examples of various systemd unit types:

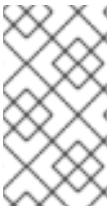
Service
: Controls and manages individual system services.

Target
: Represents a group of units that define system states.

Device
: Manages hardware devices and their availability.

Mount
: Handles file system mounting.

Timer
: Schedules tasks to run at specific intervals.



NOTE

To display all available unit types:

```
# systemctl -t help
```

12.1. SYSTEMD UNIT FILES LOCATIONS

You can find the unit configuration files in one of the following directories:

Table 12.1. systemd unit files locations

Directory	Description
/usr/lib/systemd/system/	**systemd** unit files distributed with installed RPM packages.
/run/systemd/system/	**systemd** unit files created at run time. This directory takes precedence over the directory with installed service unit files.

Directory	Description
/etc/systemd/system/	**systemd** unit files created by using the **systemctl enable** command as well as unit files added for extending a service. This directory takes precedence over the directory with runtime unit files.

The default configuration of **systemd** is defined during the compilation and you can find the configuration in the **/etc/systemd/system.conf** file. By editing this file, you can modify the default configuration by overriding values for **systemd** units globally.

For example, to override the default value of the timeout limit, which is set to 90 seconds, use the **DefaultTimeoutStartSec** parameter to input the required value in seconds.

```
DefaultTimeoutStartSec=required value
```

12.2. MANAGING SYSTEM SERVICES WITH SYSTEMCTL

As a system administrator, you can manage system services by using the **systemctl** utility. You can perform various tasks, such as starting, stopping, restarting running services, enabling and disabling services to start at boot, listing available services, and displaying system services statuses.

12.2.1. Listing system services

You can list all currently loaded service units and display the status of all available service units.

Procedure

Use the **systemctl** command to perform any of the following tasks:

- List all currently loaded service units:

```
$ systemctl list-units --type service
UNIT                    LOAD   ACTIVE SUB     DESCRIPTION
abrt-ccpp.service       loaded active exited  Install ABRT coredump hook
abrt-oops.service       loaded active running ABRT kernel log watcher
abrtd.service           loaded active running ABRT Automated Bug Reporting Tool
...
systemd-vconsole-setup.service loaded active exited  Setup Virtual Console
tog-pegasus.service            loaded active running OpenPegasus CIM Server

LOAD   = Reflects whether the unit definition was properly loaded.
ACTIVE = The high-level unit activation state, or a generalization of SUB.
SUB    = The low-level unit activation state, values depend on unit type.

46 loaded units listed. Pass --all to see loaded but inactive units, too.
To show all installed unit files use 'systemctl list-unit-files'
```

  By default, the **systemctl list-units** command displays only active units. For each service unit file, the command provides an overview of the following parameters:

UNIT

The full name of the service unit

LOAD

The load state of the configuration file

ACTIVE or **SUB**

The current high-level and low-level unit file activation state

DESCRIPTION

A short description of the unit's purpose and functionality

- List **all loaded units regardless of their state** by using the following command with the **--all** or **-a** command line option:

```
$ systemctl list-units --type service --all
```

- List the status (**enabled** or **disabled**) of all available service units:

```
$ systemctl list-unit-files --type service
UNIT FILE                              STATE
abrt-ccpp.service                      enabled
abrt-oops.service                      enabled
abrtd.service                          enabled
...
wpa_supplicant.service                 disabled
ypbind.service                         disabled

208 unit files listed.
```

For each service unit, this command displays:

UNIT FILE

The full name of the service unit

STATE

The information whether the service unit is enabled or disabled to start automatically during boot

Additional resources

- Displaying system service status

12.2.2. Displaying system service status

You can inspect any service unit to get detailed information and verify the state of the service, whether it is enabled to start during boot or currently running. You can also view services that are ordered to start after or before a particular service unit.

Procedure

Use the **systemctl** command to perform any of the following tasks:

- Display detailed information about a service unit that corresponds to a system service:

```
$ systemctl status <name>.service
```

Replace ***<name>*** with the name of the service unit you want to inspect (for example, **gdm**).

This command displays the following information:

- The name of the selected service unit followed by a short description
- One or more fields described in Available service unit information
- The execution of the service unit: if the unit is executed by the **root** user
- The most recent log entries

Table 12.2. Available service unit information

Field	Description
Loaded	Information whether the service unit has been loaded, the absolute path to the unit file, and a note whether the unit is enabled to start during boot.
Active	Information whether the service unit is running followed by a time stamp.
Main PID	The process ID and the name of the corresponding system service.
Status	Additional information about the corresponding system service.
Process	Additional information about related processes.
CGroup	Additional information about related control groups (**cgroups**).

Example 12.1. Displaying service status

The service unit for the GNOME Display Manager is named **gdm.service**. To determine the current status of this service unit, type the following at a shell prompt:

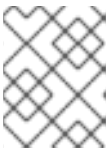
```
# systemctl status gdm.service
gdm.service - GNOME Display Manager
   Loaded: loaded (/usr/lib/systemd/system/gdm.service; enabled)
   Active: active (running) since Thu 2013-10-17 17:31:23 CEST; 5min ago
 Main PID: 1029 (gdm)
   CGroup: /system.slice/gdm.service
           ├─1029 /usr/sbin/gdm
           └─1047 /usr/bin/Xorg :0 -background none -verbose -auth /r...

Oct 17 17:31:23 localhost systemd[1]: Started GNOME Display Manager.
```

- Verify that a particular service unit is running:

```
$ systemctl is-active <name>.service
```

- Determine whether a particular service unit is enabled to start during boot:

```
$ systemctl is-enabled <name>.service
```



NOTE

Both **systemctl is-active** and **systemctl is-enabled** commands return an exit status of **0** if the specified service unit is running or enabled.

- Check what services **systemd** orders to start before the specified service unit

```
# systemctl list-dependencies --after <name>.service
```

For example, to view the list of services ordered to start before **gdm**, enter:

```
# systemctl list-dependencies --after gdm.service
gdm.service
├─dbus.socket
├─getty@tty1.service
├─livesys.service
├─plymouth-quit.service
├─system.slice
├─systemd-journald.socket
├─systemd-user-sessions.service
└─basic.target
[output truncated]
```

- Check what services **systemd** orders to start after the specified service unit:

```
# systemctl list-dependencies --before <name>.service
```

For example, to view the list of services **systemd** orders to start after **gdm**, enter:

```
# systemctl list-dependencies --before gdm.service
gdm.service
├─dracut-shutdown.service
├─graphical.target
│ ├─systemd-readahead-done.service
│ ├─systemd-readahead-done.timer
│ └─systemd-update-utmp-runlevel.service
└─shutdown.target
  ├─systemd-reboot.service
  └─final.target
    └─systemd-reboot.service
```

Additional resources

- Listing system services

12.2.3. Starting a system service

You can start system service in the current session by using the **start** command.

Prerequisites

- Root access

Procedure

- Start a system service in the current session:

```
# systemctl start <name>.service
```

Replace ***<name>*** with the name of the service unit you want to start (for example, **httpd.service**).

NOTE

In **systemd**, positive and negative dependencies between services exist. Starting a particular service may require starting one or more other services (**positive dependency**) or stopping one or more services (**negative dependency**).

When you attempt to start a new service, **systemd** resolves all dependencies automatically, without explicit notification to the user. This means that if you are already running a service, and you attempt to start another service with a negative dependency, the first service is automatically stopped.

For example, if you are running the **postfix** service, and you attempt to start the **sendmail** service, **systemd** first automatically stops **postfix**, because these two services are conflicting and cannot run on the same port.

Additional resources

- **systemctl(1)** man page
- Enabling a system service to start at boot
- Displaying system service status

12.2.4. Stopping a system service

If you want to stop a system service in the current session, use the **stop** command.

Prerequisites

- Root access

Procedure

- Stop a system service:

```
# systemctl stop <name>.service
```

Replace ***<name>*** with the name of the service unit you want to stop (for example, **bluetooth**).

Additional resources

- **systemctl(1)** man page
- Disabling a system service to start at boot
- Displaying system service status

12.2.5. Restarting a system service

You can restart system service in the current session using the **restart** command to perform the following actions:

- Stop the selected service unit in the current session and immediately start it again.
- Restart a service unit only if the corresponding service is already running.
- Reload configuration of a system service without interrupting its execution.

Prerequisites

- Root access

Procedure

- Restart a system service:

```
# systemctl restart <name>.service
```

Replace ***<name>*** with the name of the service unit you want to restart (for example, **httpd**).

NOTE

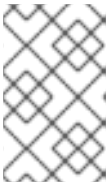
If the selected service unit is not running, this command starts it too.

- Optional: Restart a service unit only if the corresponding service is already running:

```
# systemctl try-restart <name>.service
```

- Optional: Reload the configuration without interrupting service execution:

```
# systemctl reload <name>.service
```



NOTE

System services that do not support this feature, ignore this command. To restart such services, use the **reload-or-restart** and **reload-or-try-restart** commands instead.

Additional resources

- **systemctl** man page
- Displaying system service status

12.2.6. Enabling a system service to start at boot

You can enable a service to start automatically at boot, these changes apply with the next reboot.

Prerequisites

- Root access
- The service you want to enable must not be masked. If you have a masked service, unmask it first:

```
# systemctl unmask <name>.service
```

Procedure

- Enable a service to start at boot:

```
# systemctl enable <name>.service
```

  Replace ***<name>*** with the name of the service unit you want to enable (for example, **httpd**).

- Optional: You can also enable and start a service by using a single command:

```
# systemctl enable --now <name>.service
```

Additional resources

- **systemctl (1)** man page
- Displaying system service status
- Starting a system service

12.2.7. Disabling a system service to start at boot

You can prevent a service unit from starting automatically at boot time. If you disable a service, it will not start at boot, but you can start it manually. You can also mask a service, so that it cannot be started manually. Masking is a way of disabling a service that makes the service permanently unusable until it is unmasked again.

Prerequisites

- Root access

Procedure

- Disable a service to start at boot:

```
# systemctl disable <name>.service
```

Replace ***<name>*** with the name of the service unit you want to disable (for example, **bluetooth**).

- Optional: If you want to make a service permanently unusable, mask the service:

```
# systemctl mask <name>.service
```

This command replaces the **/etc/systemd/system/*name*.service** file with a symbolic link to **/dev/null**, rendering the actual unit file inaccessible to **systemd**.

Additional resources

- **systemctl (1)** man page
- Displaying system service status
- Stopping a system service

12.3. BOOTING INTO A TARGET SYSTEM STATE

As a system administrator, you can control the boot process of your system, and define the state you want your system to boot into. This is called a **systemd** target, and it is a set of **systemd** units that your system starts to reach a certain level of functionality. While working with systemd targets, you can view the default target, select a target at runtime, change the default boot target, boot into emergency or rescue target.

12.3.1. Target unit files

Targets in **systemd** are groups of related units that act as synchronization points during the start of your system. Target unit files, which end with the **.target** file extension, represent the **systemd** targets. The purpose of target units is to group together various **systemd** units through a chain of dependencies.

Consider the following examples:

- The **graphical.target unit** for starting a graphical session, starts system services such as the GNOME Display Manager (**gdm.service**) or Accounts Service (**accounts-daemon.service**), and also activates the **multi-user.target unit**.
- Similarly, the **multi-user.target** unit starts other essential system services such as NetworkManager (**NetworkManager.service**) or D-Bus (**dbus.service**) and activates another target unit named **basic.target**.

You can set the following **systemd** targets as default or current targets:

Table 12.3. Common systemd targets

rescue	unit target that pulls in the base system and spawns a rescue shell
multi-user	unit target for setting up a multi-user system
graphical	unit target for setting up a graphical login screen
emergency	unit target that starts an emergency shell on the main console

Additional resources

- **systemd.special(7)** man page
- **systemd.target(5)** man page

12.3.2. Changing the default target to boot into

When a system starts, **systemd** activates the **default.target** symbolic link, which points to the true target unit. You can find the currently selected default target unit in the **/etc/systemd/system/default.target** file. Each target represents a certain level of functionality and is used for grouping other units. Additionally, target units serve as synchronization points during boot. You can change the default target your system boots into. When you set a default target unit, the current target remains unchanged until the next reboot.

Prerequisites

- Root access

Procedure

1. Determine the current default target unit **systemd** uses to start the system:

```
# systemctl get-default
graphical.target
```

2. List the currently loaded targets:

```
# systemctl list-units --type target
```

3. Configure the system to use a different target unit by default:

```
# systemctl set-default <name>.target
```

Replace ***<name>*** with the name of the target unit you want to use by default.

```
Example:
# systemctl set-default multi-user.target
Removed /etc/systemd/system/default.target
Created symlink /etc/systemd/system/default.target -> /usr/lib/systemd/system/multi-user.target
```

4. Verify the default target unit:

```
# systemctl get-default
multi-user.target
```

5. Apply the changes by rebooting:

```
# reboot
```

Additional resources

- **systemctl(1)** man page
- **systemd.special(7)** man page
- **bootup(7)** man page

12.3.3. Changing the current target

On a running system, you can change the target unit in the current boot without reboot. If you switch to a different target, **systemd** starts all services and their dependencies that this target requires, and stops all services that the new target does not enable. Isolating a different target affects only the current boot.

Procedure

1. Optional: Determine the current target:

```
# systemctl get-default
graphical.target
```

2. Optional: Display the list of targets you can select:

```
# systemctl list-units --type target
```

NOTE

You can only isolate targets that have the **AllowIsolate=yes** option set in the unit files.

3. Change to a different target unit in the current boot:

```
# systemctl isolate <name>.target
```

Replace *<name>* with the name of the target unit you want to use in the current boot.

```
Example:
# systemctl isolate multi-user.target
```

This command starts the target unit named **multi-user** and all dependent units, and immediately stops all other unit.

Additional resources

- **systemctl(1)** man page

12.3.4. Booting to rescue mode

You can boot to the *rescue mode* that provides a single-user environment for troubleshooting or repair if the system cannot get to a later target, and the regular booting process fails. In rescue mode, the system attempts to mount all local file systems and start certain important system services, but it does not activate network interfaces.

Prerequisites

- Root access

Procedure

- To enter the rescue mode, change the current target in the current session:

```
# systemctl rescue

Broadcast message from root@localhost on pts/0 (Fri 2023-03-24 18:23:15 CEST):

The system is going down to rescue mode NOW!
```

NOTE

This command is similar to **systemctl isolate rescue.target**, but it also sends an informative message to all users that are currently logged into the system.

To prevent **systemd** from sending a message, enter the following command with the **--no-wall** command-line option:

```
# systemctl --no-wall rescue
```

Troubleshooting steps

If your system is not able to enter the rescue mode, you can boot to *emergency mode*, which provides the most minimal environment possible. In emergency mode, the system mounts the root file system only for reading, does not attempt to mount any other local file systems, does not activate network interfaces, and only starts a few essential services.

12.3.5. Troubleshooting the boot process

As a system administrator, you can select a non-default target at boot time to troubleshoot the boot process. Changing the target at boot time affects only a single boot. You can boot to *emergency mode*, which provides the most minimal environment possible.

Procedure

1. Reboot the system, and interrupt the boot loader menu countdown by pressing any key except the Enter key, which would initiate a normal boot.
2. Move the cursor to the kernel entry that you want to start.
3. Press the E key to edit the current entry.
4. Move to the end of the line that starts with **linux** and press Ctrl+E to jump to the end of the line:

```
linux ($root)/vmlinuz-5.14.0-70.22.1.e19_0.x86_64 root=/dev/mapper/rhel-root ro crash\
kernel=auto resume=/dev/mapper/rhel-swap rd.lvm.lv/swap rhgb quiet
```

5. To choose an alternate boot target, append the **systemd.unit=** parameter to the end of the line that starts with **linux**:

```
linux ($root)/vmlinuz-5.14.0-70.22.1.e19_0.x86_64 root=/dev/mapper/rhel-root ro crash\
kernel=auto resume=/dev/mapper/rhel-swap rd.lvm.lv/swap rhgb quiet
systemd.unit=<name>.target
```

Replace ***<name>*** with the name of the target unit you want to use. For example, **systemd.unit=emergency.target**

6. Press Ctrl+X to boot with these settings.

12.4. SHUTTING DOWN, SUSPENDING, AND HIBERNATING THE SYSTEM

As a system administrator, you can use different power management options to manage power consumption, perform a proper shutdown to ensure that all data is saved, or restart the system to apply changes and updates.

12.4.1. System shutdown

To shut down the system, you can either use the **systemctl** utility directly, or call this utility through the **shutdown** command.

Using the **shutdown** has the following advantages:

- You can schedule a shutdown by using the **time** argument. This also gives users warning that a system shutdown has been scheduled.
- You can cancel the shutdown.

Additional resources

- Overview of the power management commands with systemctl

12.4.2. Scheduling a system shutdown

As a system administrator, you can schedule a delayed shutdown to give users time to save their work and log off the system. Use the **shutdown** command to perform the following operations:

- Shut down the system and power off the machine at a certain time
- Shut down and halt the system without powering off the machine
- Cancel a pending shutdown

Prerequisites

- Root access

Procedure

Use the **shutdown** command to perform any of the following tasks:

- Specify the time at which you want to shut down the system and power off the machine:

```
# shutdown --poweroff hh:mm
```

Where ***hh:mm*** is the time in the 24-hour time notation. To prevent new logins, the **/run/nologin** file is created 5 minutes before system shutdown.

When you use the time argument, you can notify users logged in to the system of the planned shutdown by specifying an optional *wall message*, for example **shutdown --poweroff 13:59 "Attention. The system will shut down at 13:59"**.

- Shut down and halt the system after a delay, without powering off the machine:

```
# shutdown --halt +m
```

Where ***+m*** is the delay time in minutes. You can use the **now** keyword as an alias for **+0**.

- Cancel a pending shutdown:

```
# shutdown -c
```

Additional resources

- **shutdown(8)** manual page
- Shutting down the system using the systemctl command

12.4.3. Shutting down the system using the systemctl command

As a system administrator, you can shut down the system and power off the machine or shut down and halt the system without powering off the machine by using the **systemctl** command.

Prerequisites

- Root access

Procedure

Use the **systemctl** command to perform any of the following tasks:

- Shut down the system and power off the machine:

```
# systemctl poweroff
```

- Shut down and halt the system without powering off the machine:

```
# systemctl halt
```

NOTE

By default, running either of these commands causes **systemd** to send an informative message to all users that are currently logged into the system. To prevent **systemd** from sending this message, run the selected command with the **--no-wall** command line option.

12.4.4. Restarting the system

When you restart the system, **systemd** stops all running programs and services, the system shuts down, and then immediately starts again. Restarting the system can be helpful in the following situations:

- After installing new software or updates
- After making changes to system settings
- When troubleshooting system issues

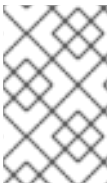
Prerequisites

- Root access

Procedure

- Restart the system:

```
# systemctl reboot
```



NOTE

By default, when you use this command, **systemd** sends an informative message to all users that are currently logged into the system. To prevent **systemd** from sending this message, run this command with the **--no-wall** option.

12.4.5. Optimizing power consumption by suspending and hibernating the system

As a system administrator, you can manage power consumption, save energy on your systems, and preserve the current state of your system. To do so, apply one of the following modes:

Suspend

Suspending saves the system state in RAM and with the exception of the RAM module, powers off most of the devices in the machine. When you turn the machine back on, the system then restores its state from RAM without having to boot again. Because the system state is saved in RAM and not on the hard disk, restoring the system from suspend mode is significantly faster than from hibernation. However, the suspended system state is also vulnerable to power outages.

Hibernate

Hibernating saves the system state on the hard disk drive and powers off the machine. When you turn the machine back on, the system then restores its state from the saved data without having to boot again. Because the system state is saved on the hard disk and not in RAM, the machine does not have to maintain electrical power to the RAM module. However, as a consequence, restoring the system from hibernation is significantly slower than restoring it from suspend mode.

Hybrid sleep

This combines elements of both hibernation and suspending. The system first saves the current state on the the hard disk drive, and enters a low-power state similar to suspending, which allows the system to resume more quickly. The benefit of hybrid sleep is that if the system loses power during the sleep state, it can still recover the previous state from the saved image on the hard disk, similar to hibernation.

Suspend-then-hibernate

This mode first suspends the system, which results in saving the current system state to RAM and putting the system in a low-power mode. The system hibernates if it remains suspended for a specific period of time that you can define in the **HibernateDelaySec** parameter. Hibernation saves

the system state to the hard disk drive and shuts down the system completely. The suspend-then-hibernate mode provides the benefit of conserving battery power while you are still able to quickly resume work. Additionally, this mode ensures that your data is saved in case of a power failure.

Prerequisites

- Root access

Procedure

Choose the appropriate method for power saving:

- Suspend the system:

```
# systemctl suspend
```

- Hibernate the system:

```
# systemctl hibernate
```

- Hibernate and suspend the system:

```
# systemctl hybrid-sleep
```

- Suspend and then hibernate the system:

```
# systemctl suspend-then-hibernate
```

12.4.6. Overview of the power management commands with systemctl

You can use the following list of the **systemctl** commands to control the power management of your system.

Table 12.4. Overview of the systemctl power management commands

systemctl command	Description
systemctl halt	Halts the system.
systemctl poweroff	Powers off the system.
systemctl reboot	Restarts the system.
systemctl suspend	Suspends the system.
systemctl hibernate	Hibernates the system.
systemctl hybrid-sleep	Hibernates and suspends the system.

12.4.7. Changing the power button behavior

When you press the power button on your computer, it suspends or shuts down the system by default. You can customize this behavior according to your preferences.

12.4.7.1. Changing the power button behavior in systemd

When you press the power button in a non-graphical **systemd** target, it shuts down the system by default. You can customize this behavior according to your preferences.

Prerequisites

- Administrative access.

Procedure

1. Open the **/etc/systemd/logind.conf** configuration file.
2. Look for the line that says **HandlePowerKey=poweroff**.
3. If the line starts with the **#** symbol, remove it to enable the setting.
4. Replace **poweroff** with one of the following options:

   poweroff
   Shut down the computer.

   reboot
   Reboot the system.

   halt
   Initiate a system halt.

   kexec
   Initiate a **kexec** reboot.

   suspend
   Suspend the system.

   hibernate
   Initiate system hibernation.

   ignore
   Do nothing.

   For example, to reboot the system upon pressing the power button, use this setting:

   ```
   HandlePowerKey=reboot
   ```

5. Save your changes and close the editor.

Next steps

- If you use the graphical session, also configure the power button in GNOME. See Section 12.4.7.2, “Changing the power button behavior in GNOME” .

12.4.7.2. Changing the power button behavior in GNOME

On the graphical login screen or in the graphical user session, pressing the power button suspends the machine by default. This happens both in cases when the user presses the power button physically or when pressing a virtual power button from a remote console. You can select a different power button behavior.

Prerequisites

- You have configured the power button behavior in **systemd**. See Section 12.4.7.1, "Changing the power button behavior in systemd".

Procedure

1. Create a local database for system-wide settings in the **/etc/dconf/db/local.d/01-power** file. Enter the following content:

```
[org/gnome/settings-daemon/plugins/power]
power-button-action='suspend'
```

   Replace ***suspend*** with any of the following power button actions:

   nothing

   Does nothing .

   suspend

   Suspends the system.

   hibernate

   Hibernates the system.

   interactive

   Shows a pop-up query asking the user what to do.
   With interactive mode, the system powers off automatically after 60 seconds when pressing the power button. However, you can choose a different behavior from the pop-up query.

2. Optional: Override the user's setting, and prevent the user from changing it. Enter the following configuration in the **/etc/dconf/db/local.d/locks/01-power** file:

```
/org/gnome/settings-daemon/plugins/power/power-button-action
```

3. Update the system databases:

```
# dconf update
```

4. Log out and back in again for the system-wide settings to take effect.

CHAPTER 13. CONFIGURING TIME SYNCHRONIZATION

Accurate timekeeping in an IT environment is important. A consistent time across all network devices improves the traceability of log files and certain protocols rely on synchronized clocks. For example, Kerberos uses time stamps to prevent replay attacks.

13.1. USING THE CHRONY SUITE TO CONFIGURE NTP

Accurate timekeeping is important for several reasons in IT. In networking for example, accurate time stamps in packets and logs are required. In Linux systems, the **NTP** protocol is implemented by a daemon running in user space.

The user space daemon updates the system clock running in the kernel. The system clock can keep time by using various clock sources. Usually, the *Time Stamp Counter* (**TSC**) is used. The TSC is a CPU register which counts the number of cycles since it was last reset. It is very fast, has a high resolution, and there are no interruptions.

Starting with Red Hat Enterprise Linux 8, the **NTP** protocol is implemented by the **chronyd** daemon, available from the repositories in the **chrony** package.

The following sections describe how to use the **chrony** suite to configure NTP.

13.1.1. Introduction to chrony suite

chrony is an implementation of the **Network Time Protocol (NTP)**. You can use **chrony**:

- To synchronize the system clock with **NTP** servers
- To synchronize the system clock with a reference clock, for example a GPS receiver
- To synchronize the system clock with a manual time input
- As an **NTPv4(RFC 5905)** server or peer to provide a time service to other computers in the network

chrony performs well in a wide range of conditions, including intermittent network connections, heavily congested networks, changing temperatures (ordinary computer clocks are sensitive to temperature), and systems that do not run continuously, or run on a virtual machine.

Typical accuracy between two machines synchronized over the Internet is within a few milliseconds, and for machines on a LAN within tens of microseconds. Hardware timestamping or a hardware reference clock may improve accuracy between two machines synchronized to a sub-microsecond level.

chrony consists of **chronyd**, a daemon that runs in user space, and **chronyc**, a command line program which can be used to monitor the performance of **chronyd** and to change various operating parameters when it is running.

The **chrony** daemon, **chronyd**, can be monitored and controlled by the command line utility **chronyc**. This utility provides a command prompt which allows entering a number of commands to query the current state of **chronyd** and make changes to its configuration. By default, **chronyd** accepts only commands from a local instance of **chronyc**, but it can be configured to accept monitoring commands also from remote hosts. The remote access should be restricted.

13.1.2. Using chronyc to control chronyd

You can control **chronyd** by using the **chronyc** command line utility.

Procedure

1. To make changes to the local instance of **chronyd** using the command line utility **chronyc** in interactive mode, enter the following command as **root**:

```
# chronyc
```

chronyc must run as **root** if some of the restricted commands are to be used.

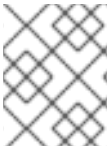
The **chronyc** command prompt will be displayed as follows:

```
chronyc>
```

2. To list all of the commands, type **help**.

3. Alternatively, the utility can also be invoked in non-interactive command mode if called together with a command as follows:

```
chronyc command
```



NOTE

Changes made using **chronyc** are not permanent, they will be lost after a **chronyd** restart. For permanent changes, modify **/etc/chrony.conf**.

13.2. USING CHRONY

The following sections describe how to install, start, and stop **chronyd**, and how to check if **chrony** is synchronized. Sections also describe how to manually adjust System Clock.

13.2.1. Managing chrony

The following procedure describes how to install, start, stop, and check the status of **chronyd**.

Procedure

1. The **chrony** suite is installed by default on Red Hat Enterprise Linux. To ensure that it is, run the following command as **root**:

```
# dnf install chrony
```

The default location for the **chrony** daemon is **/usr/sbin/chronyd**. The command line utility will be installed to **/usr/bin/chronyc**.

2. To check the status of **chronyd**, issue the following command:

```
$ systemctl status chronyd
chronyd.service - NTP client/server
   Loaded: loaded (/usr/lib/systemd/system/chronyd.service; enabled)
   Active: active (running) since Wed 2013-06-12 22:23:16 CEST; 11h ago
```

3. To start **chronyd**, issue the following command as **root**:

```
# systemctl start chronyd
```

To ensure **chronyd** starts automatically at system start, issue the following command as **root**:

```
# systemctl enable chronyd
```

4. To stop **chronyd**, issue the following command as **root**:

```
# systemctl stop chronyd
```

To prevent **chronyd** from starting automatically at system start, issue the following command as **root**:

```
# systemctl disable chronyd
```

13.2.2. Checking if chrony is synchronized

The following procedure describes how to check if **chrony** is synchronized with the use of the **tracking**, **sources**, and **sourcestats** commands.

Procedure

1. To check **chrony** tracking, issue the following command:

```
$ chronyc tracking
Reference ID    : CB00710F (ntp-server.example.net)
Stratum         : 3
Ref time (UTC)  : Fri Jan 27 09:49:17 2017
System time     :  0.000006523 seconds slow of NTP time
Last offset     : -0.000006747 seconds
RMS offset      : 0.000035822 seconds
Frequency       : 3.225 ppm slow
Residual freq   : 0.000 ppm
Skew            : 0.129 ppm
Root delay      : 0.013639022 seconds
Root dispersion : 0.001100737 seconds
Update interval : 64.2 seconds
Leap status     : Normal
```

2. The sources command displays information about the current time sources that **chronyd** is accessing. To check **chrony** sources, issue the following command:

```
$ chronyc sources
 210 Number of sources = 3
MS Name/IP address         Stratum Poll Reach LastRx Last sample
===============================================================================
====
#* GPS0                          0   4   377    11   -479ns[ -621ns] /-  134ns
^? a.b.c                        2   6   377    23   -923us[ -924us] +/-   43ms
^ d.e.f                       1   6   377    21  -2629us[-2619us] +/-   86ms
```

You can specify the optional **-v** argument to print more verbose information. In this case, extra caption lines are shown as a reminder of the meanings of the columns.

3. The **sourcestats** command displays information about the drift rate and offset estimation process for each of the sources currently being examined by **chronyd**. To check **chrony** source statistics, issue the following command:

```
$ chronyc sourcestats
210 Number of sources = 1
Name/IP Address            NP  NR  Span  Frequency  Freq Skew  Offset  Std Dev
==============================================================================
abc.def.ghi                11   5   46m     -0.001      0.045     1us    25us
```

The optional argument **-v** can be specified, meaning verbose. In this case, extra caption lines are shown as a reminder of the meanings of the columns.

Additional resources

- **chronyc(1)** man page

13.2.3. Manually adjusting the System Clock

The following procedure describes how to manually adjust the System Clock.

Procedure

1. To step the system clock immediately, bypassing any adjustments in progress by slewing, issue the following command as **root**:

```
# chronyc makestep
```

If the **rtcfile** directive is used, the real-time clock should not be manually adjusted. Random adjustments would interfere with **chrony**'s need to measure the rate at which the real-time clock drifts.

13.2.4. Disabling a chrony dispatcher script

The **chrony** dispatcher script manages the online and offline state of the NTP servers. As a system administrator, you can disable the dispatcher script to keep **chronyd** polling the servers constantly.

If you enable NetworkManager on your system to manage networking configuration, the NetworkManager executes the **chrony** dispatcher script during interface reconfiguration, stop or start operations. However, if you configure certain interfaces or routes outside of NetworkManager, you can encounter the following situation:

1. The dispatcher script might run when no route to the NTP servers exists, causing the NTP servers to switch to the offline state.

2. If you establish the route later, the script does not run again by default, and the NTP servers remain in the offline state.

To ensure that **chronyd** can synchronize with your NTP servers, which have separately managed interfaces, disable the dispatcher script.

Prerequisites

- You installed NetworkManager on your system and enabled it.
- Root access

Procedure

1. To disable the **chrony** dispatcher script, create a symlink to **/dev/null**:

```
# ln -s /dev/null /etc/NetworkManager/dispatcher.d/20-chrony-onoffline
```

NOTE

After this change, the NetworkManager cannot execute the dispatcher script, and the NTP servers remain in the online state at all times.

13.2.5. Setting up chrony for a system in an isolated network

For a network that is never connected to the Internet, one computer is selected to be the primary timeserver. The other computers are either direct clients of the server, or clients of clients. On the server, the drift file must be manually set with the average rate of drift of the system clock. If the server is rebooted, it will obtain the time from surrounding systems and calculate an average to set its system clock. Thereafter it resumes applying adjustments based on the drift file. The drift file will be updated automatically when the **settime** command is used.

The following procedure describes how to set up **chrony** for a system in an isolated network.

Procedure

1. On the system selected to be the server, using a text editor running as **root**, edit **/etc/chrony.conf** as follows:

```
driftfile /var/lib/chrony/drift
commandkey 1
keyfile /etc/chrony.keys
initstepslew 10 client1 client3 client6
local stratum 8
manual
allow 192.0.2.0/24
```

   Where **192.0.2.0/24** is the network or subnet address from which the clients are allowed to connect. For more details, see **chrony.conf(7)** man page

2. On the systems selected to be direct clients of the server, using a text editor running as **root**, edit the **/etc/chrony.conf** as follows:

```
server ntp1.example.net
driftfile /var/lib/chrony/drift
logdir /var/log/chrony
log measurements statistics tracking
keyfile /etc/chrony.keys
commandkey 24
```

```
local stratum 10
initstepslew 20 ntp1.example.net
allow 192.0.2.123
```

Where **192.0.2.123** is the address of the server, and **ntp1.example.net** is the host name of the server. Clients with this configuration will resynchronize with the server if it restarts.

On the client systems which are not to be direct clients of the server, the **/etc/chrony.conf** file should be the same except that the **local** and **allow** directives should be omitted.

In an isolated network, you can also use the **local** directive that enables a local reference mode, which allows **chronyd** operating as an **NTP** server to appear synchronized to real time, even when it was never synchronized or the last update of the clock happened a long time ago.

To allow multiple servers in the network to use the same local configuration and to be synchronized to one another, without confusing clients that poll more than one server, use the **orphan** option of the **local** directive which enables the orphan mode. Each server needs to be configured to poll all other servers with **local**. This ensures that only the server with the smallest reference ID has the local reference active and other servers are synchronized to it. When the server fails, another one will take over.

13.2.6. Configuring remote monitoring access

chronyc can access **chronyd** in two ways:

- Internet Protocol, IPv4 or IPv6.
- Unix domain socket, which is accessible locally by the **root** or **chrony** user.

By default, **chronyc** connects to the Unix domain socket. The default path is **/var/run/chrony/chronyd.sock**. If this connection fails, which can happen for example when **chronyc** is running under a non-root user, **chronyc** tries to connect to 127.0.0.1 and then ::1.

Only the following monitoring commands, which do not affect the behavior of **chronyd**, are allowed from the network:

- activity
- manual list
- rtcdata
- smoothing
- sources
- sourcestats
- tracking
- waitsync

The set of hosts from which **chronyd** accepts these commands can be configured with the **cmdallow** directive in the configuration file of **chronyd**, or the **cmdallow** command in **chronyc**. By default, the commands are accepted only from localhost (127.0.0.1 or ::1).

All other commands are allowed only through the Unix domain socket. When sent over the network, **chronyd** responds with a **Not authorised** error, even if it is from localhost.

The following procedure describes how to access chronyd remotely with **chronyc**.

Procedure

1. Allow access from both IPv4 and IPv6 addresses by adding the following to the **/etc/chrony.conf** file:

   ```
   bindcmdaddress 0.0.0.0
   ```

   or

   ```
   bindcmdaddress ::
   ```

2. Allow commands from the remote IP address, network, or subnet by using the **cmdallow** directive.
   Add the following content to the **/etc/chrony.conf** file:

   ```
   cmdallow 192.168.1.0/24
   ```

3. Open port 323 in the firewall to connect from a remote system:

   ```
   # firewall-cmd --zone=public --add-port=323/udp
   ```

   Optionally, you can open port 323 permanently using the **--permanent** option:

   ```
   # firewall-cmd --permanent --zone=public --add-port=323/udp
   ```

4. If you opened port 323 permanently, reload the firewall configuration:

   ```
   # firewall-cmd --reload
   ```

Additional resources

- **chrony.conf(5)** man page

13.2.7. Managing time synchronization using RHEL system roles

You can manage time synchronization on multiple target machines using the **timesync** role. The **timesync** role installs and configures an NTP or PTP implementation to operate as an NTP or PTP client to synchronize the system clock.

WARNING

The **timesync** role replaces the configuration of the given or detected provider service on the managed host. Previous settings are lost, even if they are not specified in the role variables. The only preserved setting is the choice of provider if the **timesync_ntp_provider** variable is not defined.

The following example shows how to apply the **timesync** role in a situation with just one pool of servers.

Example 13.1. An example playbook applying the timesync role for a single pool of servers

```
---
- hosts: timesync-test
  vars:
    timesync_ntp_servers:
      - hostname: 2.rhel.pool.ntp.org
        pool: yes
        iburst: yes
  roles:
    - rhel-system-roles.timesync
```

For a detailed reference on **timesync** role variables, install the **rhel-system-roles** package, and see the **README.md** or **README.html** files in the **/usr/share/doc/rhel-system-roles/timesync** directory.

Additional resources

- Preparing a control node and managed nodes to use RHEL system roles

13.2.8. Additional resources

- **chronyc(1)** man page
- **chronyd(8)** man page
- Frequently Asked Questions

13.3. CHRONY WITH HW TIMESTAMPING

Hardware timestamping is a feature supported in some Network Interface Controller (NICs) which provides accurate timestamping of incoming and outgoing packets. **NTP** timestamps are usually created by the kernel and **chronyd** with the use of the system clock. However, when HW timestamping is enabled, the NIC uses its own clock to generate the timestamps when packets are entering or leaving the link layer or the physical layer. When used with **NTP**, hardware timestamping can significantly improve the accuracy of synchronization. For best accuracy, both **NTP** servers and **NTP** clients need to use hardware timestamping. Under ideal conditions, a sub-microsecond accuracy may be possible.

Another protocol for time synchronization that uses hardware timestamping is **PTP**.

Unlike **NTP**, **PTP** relies on assistance in network switches and routers. If you want to reach the best accuracy of synchronization, use **PTP** on networks that have switches and routers with **PTP** support, and prefer **NTP** on networks that do not have such switches and routers.

The following sections describe how to:

- Verify support for hardware timestamping
- Enable hardware timestamping
- Configure client polling interval
- Enable interleaved mode
- Configure server for large number of clients
- Verify hardware timestamping
- Configure PTP-NTP bridge

13.3.1. Verifying support for hardware timestamping

To verify that hardware timestamping with **NTP** is supported by an interface, use the **ethtool -T** command. An interface can be used for hardware timestamping with **NTP** if **ethtool** lists the **SOF_TIMESTAMPING_TX_HARDWARE** and **SOF_TIMESTAMPING_TX_SOFTWARE** capabilities and also the **HWTSTAMP_FILTER_ALL** filter mode.

Example 13.2. Verifying support for hardware timestamping on a specific interface

```
# ethtool -T eth0
```

Output:

```
Timestamping parameters for eth0:
Capabilities:
        hardware-transmit     (SOF_TIMESTAMPING_TX_HARDWARE)
        software-transmit     (SOF_TIMESTAMPING_TX_SOFTWARE)
        hardware-receive      (SOF_TIMESTAMPING_RX_HARDWARE)
        software-receive      (SOF_TIMESTAMPING_RX_SOFTWARE)
        software-system-clock (SOF_TIMESTAMPING_SOFTWARE)
        hardware-raw-clock    (SOF_TIMESTAMPING_RAW_HARDWARE)
PTP Hardware Clock: 0
Hardware Transmit Timestamp Modes:
        off                   (HWTSTAMP_TX_OFF)
        on                    (HWTSTAMP_TX_ON)
Hardware Receive Filter Modes:
        none                  (HWTSTAMP_FILTER_NONE)
        all                   (HWTSTAMP_FILTER_ALL)
        ptpv1-l4-sync         (HWTSTAMP_FILTER_PTP_V1_L4_SYNC)
        ptpv1-l4-delay-req    (HWTSTAMP_FILTER_PTP_V1_L4_DELAY_REQ)
        ptpv2-l4-sync         (HWTSTAMP_FILTER_PTP_V2_L4_SYNC)
        ptpv2-l4-delay-req    (HWTSTAMP_FILTER_PTP_V2_L4_DELAY_REQ)
        ptpv2-l2-sync         (HWTSTAMP_FILTER_PTP_V2_L2_SYNC)
        ptpv2-l2-delay-req    (HWTSTAMP_FILTER_PTP_V2_L2_DELAY_REQ)
```

```
ptpv2-event          (HWTSTAMP_FILTER_PTP_V2_EVENT)
ptpv2-sync           (HWTSTAMP_FILTER_PTP_V2_SYNC)
ptpv2-delay-req      (HWTSTAMP_FILTER_PTP_V2_DELAY_REQ)
```

13.3.2. Enabling hardware timestamping

To enable hardware timestamping, use the **hwtimestamp** directive in the **/etc/chrony.conf** file. The directive can either specify a single interface, or a wildcard character can be used to enable hardware timestamping on all interfaces that support it. Use the wildcard specification in case that no other application, like **ptp4l** from the **linuxptp** package, is using hardware timestamping on an interface. Multiple **hwtimestamp** directives are allowed in the chrony configuration file.

Example 13.3. Enabling hardware timestamping by using the hwtimestamp directive

```
hwtimestamp eth0
hwtimestamp eth1
hwtimestamp *
```

13.3.3. Configuring client polling interval

The default range of a polling interval (64-1024 seconds) is recommended for servers on the Internet. For local servers and hardware timestamping, a shorter polling interval needs to be configured in order to minimize offset of the system clock.

The following directive in **/etc/chrony.conf** specifies a local **NTP** server using one second polling interval:

```
server ntp.local minpoll 0 maxpoll 0
```

13.3.4. Enabling interleaved mode

NTP servers that are not hardware **NTP** appliances, but rather general purpose computers running a software **NTP** implementation, like **chrony**, will get a hardware transmit timestamp only after sending a packet. This behavior prevents the server from saving the timestamp in the packet to which it corresponds. In order to enable **NTP** clients receiving transmit timestamps that were generated after the transmission, configure the clients to use the **NTP** interleaved mode by adding the **xleave** option to the server directive in **/etc/chrony.conf**:

```
server ntp.local minpoll 0 maxpoll 0 xleave
```

13.3.5. Configuring server for large number of clients

The default server configuration allows a few thousands of clients at most to use the interleaved mode concurrently. To configure the server for a larger number of clients, increase the **clientloglimit** directive in **/etc/chrony.conf**. This directive specifies the maximum size of memory allocated for logging of clients' access on the server:

```
clientloglimit 100000000
```

13.3.6. Verifying hardware timestamping

To verify that the interface has successfully enabled hardware timestamping, check the system log. The log should contain a message from **chronyd** for each interface with successfully enabled hardware timestamping.

Example 13.4. Log messages for interfaces with enabled hardware timestamping

```
chronyd[4081]: Enabled HW timestamping on eth0
chronyd[4081]: Enabled HW timestamping on eth1
```

When **chronyd** is configured as an **NTP** client or peer, you can have the transmit and receive timestamping modes and the interleaved mode reported for each **NTP** source by the **chronyc ntpdata** command:

Example 13.5. Reporting the transmit, receive timestamping and interleaved mode for each NTP source

```
# chronyc ntpdata
```

Output:

```
Remote address  : 203.0.113.15 (CB00710F)
Remote port     : 123
Local address   : 203.0.113.74 (CB00714A)
Leap status     : Normal
Version         : 4
Mode            : Server
Stratum         : 1
Poll interval   : 0 (1 seconds)
Precision       : -24 (0.000000060 seconds)
Root delay      : 0.000015 seconds
Root dispersion : 0.000015 seconds
Reference ID    : 47505300 (GPS)
Reference time  : Wed May 03 13:47:45 2017
Offset          : -0.000000134 seconds
Peer delay      : 0.000005396 seconds
Peer dispersion : 0.000002329 seconds
Response time   : 0.000152073 seconds
Jitter asymmetry: +0.00
NTP tests       : 111 111 1111
Interleaved     : Yes
Authenticated   : No
TX timestamping : Hardware
RX timestamping : Hardware
Total TX        : 27
Total RX        : 27
Total valid RX  : 27
```

Example 13.6. Reporting the stability of NTP measurements

```
# chronyc sourcestats
```

With hardware timestamping enabled, stability of **NTP** measurements should be in tens or hundreds of nanoseconds, under normal load. This stability is reported in the **Std Dev** column of the output of the **chronyc sourcestats** command:

Output:

```
210 Number of sources = 1
Name/IP Address            NP  NR  Span  Frequency  Freq Skew  Offset  Std Dev
ntp.local                  12   7    11     +0.000      0.019     +0ns    49ns
```

13.3.7. Configuring PTP-NTP bridge

If a highly accurate Precision Time Protocol (**PTP**) primary timeserver is available in a network that does not have switches or routers with **PTP** support, a computer may be dedicated to operate as a **PTP** client and a stratum-1 **NTP** server. Such a computer needs to have two or more network interfaces, and be close to the primary timeserver or have a direct connection to it. This will ensure highly accurate synchronization in the network.

Configure the **ptp4l** and **phc2sys** programs from the **linuxptp** packages to use one interface to synchronize the system clock using **PTP**.

Configure **chronyd** to provide the system time using the other interface:

Example 13.7. Configuring chronyd to provide the system time using the other interface

```
bindaddress 203.0.113.74
hwtimestamp eth1
local stratum 1
```

13.4. OVERVIEW OF NETWORK TIME SECURITY (NTS) IN CHRONY

Network Time Security (NTS) is an authentication mechanism for Network Time Protocol (NTP), designed to scale substantial clients. It verifies that the packets received from the server machines are unaltered while moving to the client machine. Network Time Security (NTS) includes a Key Establishment (NTS-KE) protocol that automatically creates the encryption keys used between the server and its clients.

WARNING

NTS is not compatible with the FIPS and OSPP profile. When you enable the FIPS and OSPP profile, **chronyd** that is configured with NTS can abort with a fatal message. You can disable the OSPP profile and FIPS mode for **chronyd** service by adding the **GNUTLS_FORCE_FIPS_MODE=0** to the **/etc/sysconfig/chronyd** file.

13.4.1. Enabling Network Time Security (NTS) in the client configuration file

By default, Network Time Security (NTS) is not enabled. You can enable NTS in the **/etc/chrony.conf**. For that, perform the following steps:

Prerequisites

- Server with the NTS support

Procedure

In the client configuration file:

1. Specify the server with the **nts** option in addition to the recommended **iburst** option.

```
For example:
server time.example.com iburst nts
server nts.netnod.se iburst nts
server ptbtime1.ptb.de iburst nts
```

2. To avoid repeating the Network Time Security-Key Establishment (NTS-KE) session during system boot, add the following line to **chrony.conf**, if it is not present:

```
ntsdumpdir /var/lib/chrony
```

3. To disable synchronization with Network Time Protocol (NTP) servers provided by **DHCP**, comment out or remove the following line in **chrony.conf**, if it is present:

```
sourcedir /run/chrony-dhcp
```

4. Save your changes.

5. Restart the **chronyd** service:

```
systemctl restart chronyd
```

Verification

- Verify if the **NTS** keys were successfully established:

```
# chronyc -N authdata

Name/IP address  Mode KeyID Type KLen Last Atmp  NAK Cook CLen
==============================================================
time.example.com  NTS     1   15  256  33m    0    0    8  100
nts.sth1.ntp.se   NTS     1   15  256  33m    0    0    8  100
nts.sth2.ntp.se   NTS     1   15  256  33m    0    0    8  100
```

  The **KeyID**, **Type**, and **KLen** should have non-zero values. If the value is zero, check the system log for error messages from **chronyd**.

- Verify the client is making NTP measurements:

```
# chronyc -N sources
```

```
MS Name/IP address Stratum Poll Reach LastRx Last sample
===============================================================
time.example.com  3      6   377    45   +355us[ +375us] +/-   11ms
nts.sth1.ntp.se   1      6   377    44   +237us[ +237us] +/-   23ms
nts.sth2.ntp.se   1      6   377    44   -170us[ -170us] +/-   22ms
```

The **Reach** column should have a non-zero value; ideally 377. If the value rarely gets 377 or never gets to 377, it indicates that NTP requests or responses are getting lost in the network.

Additional resources

- **chrony.conf(5)** man page

13.4.2. Enabling Network Time Security (NTS) on the server

If you run your own Network Time Protocol (NTP) server, you can enable the server Network Time Security (NTS) support to facilitate its clients to synchronize securely.

If the NTP server is a client of other servers, that is, it is not a Stratum 1 server, it should use NTS or symmetric key for its synchronization.

Prerequisites

- Server private key in **PEM** format
- Server certificate with required intermediate certificates in **PEM** format

Procedure

1. Specify the private key and the certificate file in **chrony.conf**. For example:

```
ntsserverkey /etc/pki/tls/private/<ntp-server.example.net>.key
ntsservercert /etc/pki/tls/certs/<ntp-server.example.net>.crt
```

2. Ensure that both the key and certificate files are readable by the chrony system user, by setting the group ownership. For example:

```
# chown :chrony /etc/pki/tls//<ntp-server.example.net>.
```

3. Ensure the **ntsdumpdir /var/lib/chrony** directive is present in the **chrony.conf**.
4. Restart the **chronyd** service:

```
# systemctl restart chronyd
```

IMPORTANT

If the server has a firewall, it needs to allow both the **UDP 123** and **TCP 4460** ports for NTP and Network Time Security-Key Establishment (NTS-KE).

Verification

- Perform a quick test from a client machine with the following command:

```
$ chronyd -Q -t 3 'server

ntp-server.example.net iburst nts maxsamples 1'
2021-09-15T13:45:26Z chronyd version 4.1 starting (+CMDMON +NTP +REFCLOCK +RTC
+PRIVDROP +SCFILTER +SIGND +ASYNCDNS +NTS +SECHASH +IPV6 +DEBUG)
2021-09-15T13:45:26Z Disabled control of system clock
2021-09-15T13:45:28Z System clock wrong by 0.002205 seconds (ignored)
2021-09-15T13:45:28Z chronyd exiting
```

The **System clock wrong** message indicates the NTP server is accepting NTS-KE connections and responding with NTS-protected NTP messages.

- Verify the NTS-KE connections and authenticated NTP packets observed on the server:

```
# chronyc serverstats

NTP packets received       : 7
NTP packets dropped        : 0
Command packets received   : 22
Command packets dropped    : 0
Client log records dropped : 0
NTS-KE connections accepted: 1
NTS-KE connections dropped : 0
Authenticated NTP packets: 7
```

If the value of the **NTS-KE connections accepted** and **Authenticated NTP packets** field is a non-zero value, it means that at least one client was able to connect to the NTS-KE port and send an authenticated NTP request.

CHAPTER 14. RECOVERING AND RESTORING A SYSTEM

To recover and restore a system using an existing backup, Red Hat Enterprise Linux provides the Relax-and-Recover (ReaR) utility.

You can use the utility as a disaster recovery solution and also for system migration.

The utility enables you to perform the following tasks:

- Produce a bootable image and restore the system from an existing backup, using the image.
- Replicate the original storage layout.
- Restore user and system files.
- Restore the system to a different hardware.

Additionally, for disaster recovery, you can also integrate certain backup software with ReaR.

Setting up ReaR involves the following high-level steps:

1. Install ReaR.
2. Modify ReaR configuration file, to add backup method details.
3. Create rescue system.
4. Generate backup files.

14.1. SETTING UP REAR

Use the following steps to install the package for using the Relax-and-Recover (ReaR) utility, create a rescue system, configure and generate a backup.

Prerequisites

- Necessary configurations as per the backup restore plan are ready.
  Note that you can use the **NETFS** backup method, a fully-integrated and built-in method with ReaR.

Procedure

1. Install the ReaR utility by running the following command:

```
# dnf install rear
```

2. Modify the ReaR configuration file in an editor of your choice, for example:

```
# vi /etc/rear/local.conf
```

3. Add the backup setting details to **/etc/rear/local.conf**. For example, in the case of the **NETFS** backup method, add the following lines:

```
BACKUP=NETFS
BACKUP_URL=backup.location
```

Replace *backup.location* by the URL of your backup location.

4. To configure ReaR to keep the previous backup archive when the new one is created, also add the following line to the configuration file:

```
NETFS_KEEP_OLD_BACKUP_COPY=y
```

5. To make the backups incremental, meaning that only the changed files are backed up on each run, add the following line:

```
BACKUP_TYPE=incremental
```

6. Create a rescue system:

```
# rear mkrescue
```

7. Take a backup as per the restore plan. For example, in the case of the **NETFS** backup method, run the following command:

```
# rear mkbackuponly
```

Alternatively, you can create the rescue system and the backup in a single step by running the following command:

```
# rear mkbackup
```

This command combines the functionality of the **rear mkrescue** and **rear mkbackuponly** commands.

14.2. USING A REAR RESCUE IMAGE ON THE 64-BIT IBM Z ARCHITECTURE

Basic Relax and Recover (ReaR) functionality is now available on the 64-bit IBM Z architecture as a Technology Preview. You can create a ReaR rescue image on IBM Z only in the z/VM environment. Backing up and recovering logical partitions (LPARs) has not been tested.

IMPORTANT

ReaR on the 64-bit IBM Z architecture is supported only with the **rear** package version 2.6-17.el9 or later. Earlier versions are available as a Technology Preview feature only. For more information about the support scope of Red Hat Technology Preview features, see https://access.redhat.com/support/offerings/techpreview.

The only output method currently available is Initial Program Load (IPL). IPL produces a kernel and an initial RAM disk (initrd) that can be used with the **zIPL** boot loader.

Prerequisites

- ReaR is installed.
  - To install ReaR, run the **dnf install rear** command

Procedure

Add the following variables to the **/etc/rear/local.conf** to configure ReaR for producing a rescue image on the 64-bit IBM Z architecture:

1. To configure the **IPL** output method, add **OUTPUT=IPL**.
2. To configure the backup method and destination, add **BACKUP** and **BACKUP_URL** variables. For example:

```
BACKUP=NETFS

BACKUP_URL=nfs://<nfsserver name>/<share path>
```

IMPORTANT

The local backup storage is currently not supported on the 64-bit IBM Z architecture.

3. Optionally, you can also configure the **OUTPUT_URL** variable to save the kernel and **initrd** files. By default, the **OUTPUT_URL** is aligned with **BACKUP_URL**.
4. To perform backup and rescue image creation:

```
# rear mkbackup
```

5. This creates the kernel and initrd files at the location specified by the **BACKUP_URL** or **OUTPUT_URL** (if set) variable, and a backup using the specified backup method.
6. To recover the system, use the ReaR kernel and initrd files created in step 3, and boot from a Direct Attached Storage Device (DASD) or a Fibre Channel Protocol (FCP)-attached SCSI device prepared with the **zipl** boot loader, kernel, and **initrd**. For more information, see Using a Prepared DASD.
7. When the rescue kernel and **initrd** get booted, it starts the ReaR rescue environment. Proceed with system recovery.

WARNING

Currently, the rescue process reformats all the DASDs (Direct Attached Storage Devices) connected to the system. Do not attempt a system recovery if there is any valuable data present on the system storage devices. This also includes the device prepared with the zipl boot loader, ReaR kernel, and initrd that were used to boot into the rescue environment. Ensure to keep a copy.

Additional resources

- Installing under z/VM
- Using a Prepared DASD