Red Hat Enterprise Linux 9

Configuring basic system settings

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

Last Updated: 2026-10-08

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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.

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PROVIDING FEEDBACK ON RED HAT DOCUMENTATION

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Procedure

1. Log in to the Jira website.
   If you do not have an account, select the option to create one.
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

NetworkManager creates a connection profile for each Ethernet adapter that is installed in a host. By default, this profile uses DHCP for both IPv4 and IPv6 connections. Modify this automatically-created profile or add a new one in the following cases:

- The network requires custom settings, such as a static IP address configuration.
- You require multiple profiles because the host roams among different networks.

Red Hat Enterprise Linux provides administrators different options to configure Ethernet connections. For example:

- Use nmcli to configure connections on the command line.
- Use nmtui to configure connections in a text-based user interface.
- Use the GNOME Settings menu or nm-connection-editor application to configure connections in a graphical interface.
- Use nmstatectl to configure connections through the Nmstate API.
- Use RHEL system roles to automate the configuration of connections on one or multiple hosts.

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.
3. Toggle the **ON**/**OFF** switch to enable or disable the selected interface.
   You cannot add or remove interfaces 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.
   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.

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.

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.

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 a 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**.

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

- Automatically installing RHEL
- For more information about network device naming standards, see *Configuring and managing networking*.

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::1/64 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::1/64 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::fffe 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 profiles 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>
```

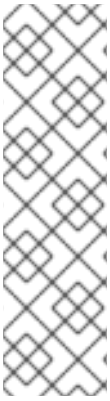
Troubleshooting

- 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 defective 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 Red Hat Knowledgebase solution NetworkManager duplicates a connection after restart of NetworkManager service .

1.3. CONFIGURING AN ETHERNET CONNECTION BY USING NMTUI

If you connect a host to an Ethernet network, you can manage the connection's settings in a text-based user interface. Use the **nmtui** application 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**.
- To return to the previous screen, use **ESC**.

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.

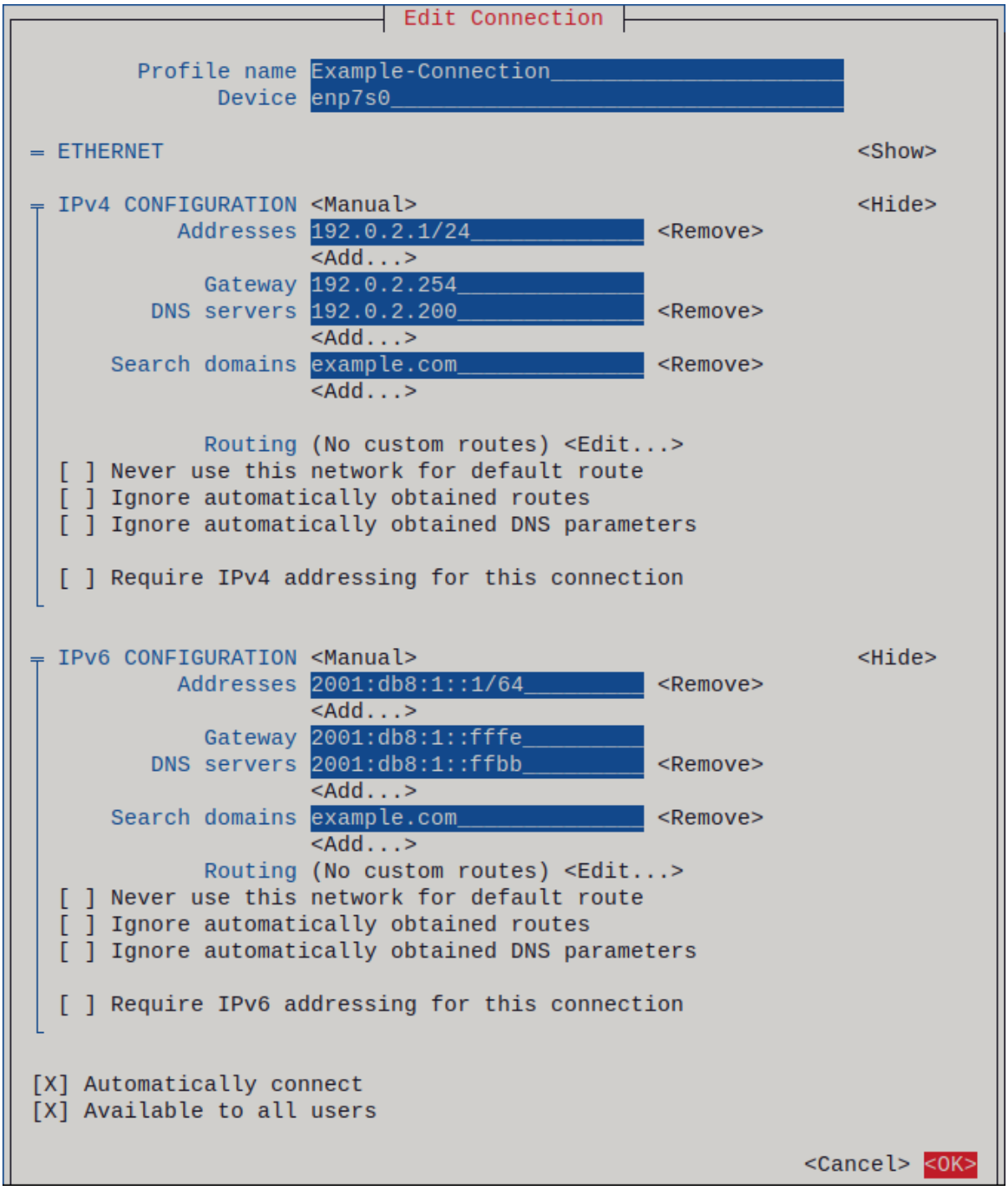
     ii. Press **Add** next to **Addresses**, and enter the IP address and the subnet mask in Classless Inter-Domain Routing (CIDR) format.
     If you do not specify a subnet mask, NetworkManager sets a **/32** subnet mask for IPv4 addresses and **/64** for IPv6 addresses.

     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::1/64 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::fffe 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 profiles 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 defective 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 Red Hat Knowledgebase solution NetworkManager duplicates a connection after restart of NetworkManager service .

Additional resources

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

1.4. CONFIGURING AN ETHERNET CONNECTION WITH A DYNAMIC IP ADDRESS BY USING THE NETWORK RHEL SYSTEM ROLE WITH AN INTERFACE NAME

You can use the **network** RHEL system role to configure an Ethernet connection that retrieves its IP addresses, gateways, and DNS settings from a DHCP server and IPv6 stateless address autoconfiguration (SLAAC). With this role you can assign the connection profile to the specified interface name.

To connect a Red Hat Enterprise Linux host to an Ethernet network, create a NetworkManager connection profile for the network device. By using Ansible and the **network** RHEL system role, you can automate this process and remotely configure connection profiles on the hosts defined in a playbook.

Prerequisites

- You have prepared the control node and the managed nodes .
- The account you use to connect to the managed nodes has **sudo** permissions for these nodes.
- A physical or virtual Ethernet device exists in the servers' configuration.
- A DHCP server and SLAAC are available in the network.
- The managed nodes use the NetworkManager service to configure the network.

Procedure

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

```
---
- name: Configure the network
  hosts: managed-node-01.example.com
  tasks:
    - name: Ethernet connection profile with dynamic IP address settings
      ansible.builtin.include_role:
        name: redhat.rhel_system_roles.network
      vars:
        network_connections:
          - name: enp1s0
            interface_name: enp1s0
            type: ethernet
            autoconnect: yes
            ip:
              dhcp4: yes
              auto6: yes
            state: up
```

The settings specified in the example playbook include the following:

dhcp4: yes

Enables automatic IPv4 address assignment from DHCP, PPP, or similar services.

auto6: yes

Enables IPv6 auto-configuration. By default, NetworkManager uses Router Advertisements. If the router announces the **managed** flag, NetworkManager requests an IPv6 address and prefix from a DHCPv6 server.

For details about all variables used in the playbook, see the **/usr/share/ansible/roles/rhel-system-roles.network/README.md** file on the control node.

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

- Query the Ansible facts of the managed node and verify that the interface received IP addresses and DNS settings:

```
# ansible managed-node-01.example.com -m ansible.builtin.setup
...
        "ansible_default_ipv4": {
            "address": "192.0.2.1",
            "alias": "enp1s0",
            "broadcast": "192.0.2.255",
            "gateway": "192.0.2.254",
            "interface": "enp1s0",
            "macaddress": "52:54:00:17:b8:b6",
            "mtu": 1500,
            "netmask": "255.255.255.0",
            "network": "192.0.2.0",
            "prefix": "24",
            "type": "ether"
        },
        "ansible_default_ipv6": {
            "address": "2001:db8:1::1",
            "gateway": "2001:db8:1::fffe",
            "interface": "enp1s0",
            "macaddress": "52:54:00:17:b8:b6",
            "mtu": 1500,
            "prefix": "64",
            "scope": "global",
            "type": "ether"
        },
        ...
        "ansible_dns": {
            "nameservers": [
                "192.0.2.1",
                "2001:db8:1::ffbb"
            ],
            "search": [
```

```
                "example.com"
            ]
        },
...
```

1.5. 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. If you have not registered the system, you have no access to the RHEL repositories. You cannot install software updates such as security, bug fixes. Even if you have a self-support subscription, it grants access to the knowledge base while more resources remain unavailable in the lack of subscriptions. By purchasing subscriptions and using Red Hat Content Delivery Network (CDN), you can track:

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

2.1. REGISTERING A SYSTEM BY USING THE COMMAND LINE

Subscriptions cover products installed on Red Hat Enterprise Linux, including the operating system itself. If you have not registered the system, you have no access to the RHEL repositories. You cannot install software updates such as security, bug fixes. Even if you have a self-support subscription, it grants access to the knowledge base while more resources remain unavailable in the lack of subscriptions. You need register the system to activate and manage Red Hat Enterprise Linux subscription for your Red Hat account.

NOTE

To register the system with Red Hat Lightspeed, you can use the **rhc connect** utility. For details, see Setting up remote host configuration .

Prerequisites

- You have an active subscription of the Red Hat Enterprise Linux system.

Procedure

- Register and subscribe the system:

```
# subscription-manager register
Registering to:                subscription.rhsm.redhat.com:443/subscription
Username: <example_username>
Password: <example_password>
The system has been registered with ID: 37to907c-ece6-49ea-9174-20b87ajk9ee7
The registered system name is:         client1.example.com
```

  The command prompts you to enter username and password of Red Hat Customer Portal account.

  If the registration process fails, you can register the system with a specific pool. For details, proceed with the following steps:

  - Determine the pool ID of a subscription:

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

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

- Attach the appropriate subscription to your system by replacing *<example_pool_id>* with the pool ID determined in the previous step:

```
# subscription-manager attach --pool=<example_pool_id>
```

Verification

- Verify the system under **Inventory** → **Systems** in the Hybrid Cloud Console.

Additional resources

- Getting Started with RHEL System Registration
- Viewing and managing your subscription inventory on the Hybrid Cloud Console

2.2. REGISTERING A SYSTEM BY USING THE WEB CONSOLE

Subscriptions cover products installed on Red Hat Enterprise Linux, including the operating system itself. If you have not registered the system, you have no access to the RHEL repositories. You cannot install software updates such as security, bug fixes. Even if you have a self-support subscription, it grants access to the Red Hat Knowledgebase portal while more resources remain unavailable in the lack of subscriptions. You can register a newly installed Red Hat Enterprise Linux with your account credentials in the Red Hat Enterprise Linux web console.

Prerequisites

- You have an active subscription of the RHEL system.
- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

Procedure

1. Log in to the RHEL 9 web console.
   For details, see Logging in to the web console .
2. In the **Health** field on 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** field, click **Register**.
4. In the **Register system** dialog, select the registration method.
   Optional: Enter your organization's name or ID. If your account belongs to more than one organization on the Red Hat Customer Portal, you must add the organization name or ID. To get the organization ID, check with your Technical Account Manager at Red Hat.
5. If you do not want to connect your system to Red Hat Red Hat Lightspeed, clear the **Insights** checkbox.

6. Click **Register**.

Verification

- Check details of your subscription in the Hybrid Cloud Console.

2.3. REGISTERING A SYSTEM IN THE GNOME DESKTOP ENVIRONMENT

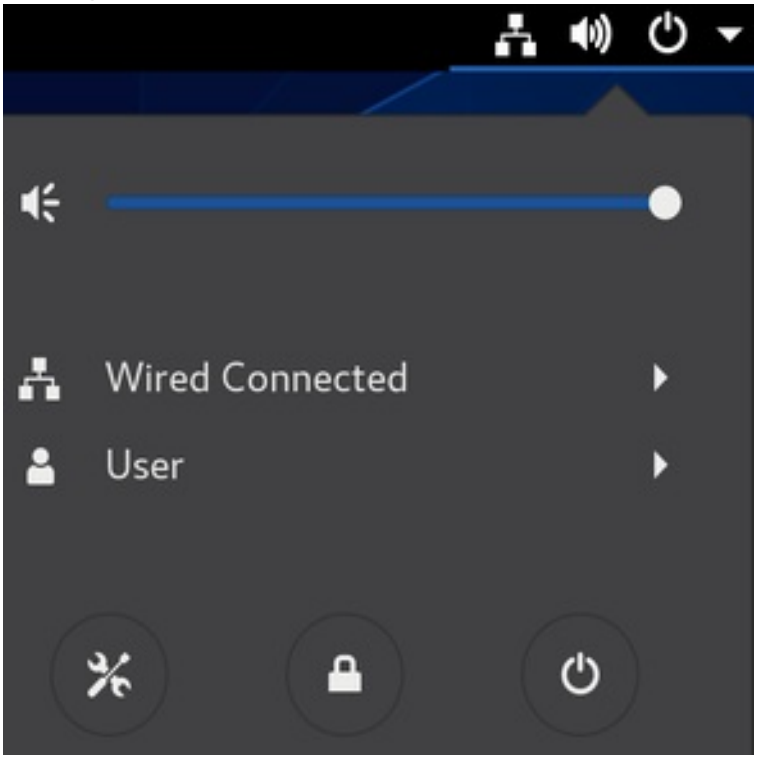
Subscriptions cover products installed on Red Hat Enterprise Linux, including the operating system itself. If you have not registered the system, you have no access to the RHEL repositories. You cannot install software updates such as security, bug fixes. Even if you have a self-support subscription, it grants access to the knowledge base while more resources remain unavailable in the lack of subscriptions. Follow the steps in this procedure to enroll the system with your Red Hat account.

Prerequisites

- You have created a Red Hat account.
- You are a root user and logged in to the GNOME desktop environment. For details, see Register and subscribe RHEL system to Red Hat Subscription Manager.

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 want to register the System through Red Hat Satellite:
   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 your preferred registration method.
5. Fill the **Registration Details** section.
6. Click **Register**.

CHAPTER 3. ACCESSING THE RED HAT SUPPORT

If you require help with troubleshooting a problem, you can contact Red Hat Support.

Procedure

- Log in to the Red Hat Support web site and choose one of the following options:
  - Open a new support case.
  - Initiate a live chat with a Red Hat expert.
  - Contact a Red Hat expert by making a call or sending an email.

3.1. USING THE SOSREPORT UTILITY TO COLLECT DIAGNOSTIC INFORMATION ABOUT A SYSTEM TO ATTACH IT TO A SUPPORT TICKET

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
```

2. Generate a report:

```
# sosreport
```

   Optionally, pass the **--upload** option to the command to automatically upload and attach the report to a support case. This requires internet access and your Customer Portal credentials.

3. Optional: Manually attach the report to your support case.
   See the Red Hat Knowledgebase solution How can I attach a file to a Red Hat support case? for more information.

Additional resources

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

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. Manually configuring the date, time, and timezone settings

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

Procedure

1. Optional: List the timezones:

```
# timedatectl list-timezones

  Europe/Berlin
```

2. Set the time zone:

```
# timedatectl set-timezone <time_zone>
```

3. Set the date and time:

```
# timedatectl set-time <YYYY-mm-dd HH:MM:SS>
```

Verification

1. Display the date, time, and timezone:

```
# 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

- **date(1)** and **timedatectl(1)** man pages

4.2. CONFIGURING TIME SETTINGS BY USING THE WEB CONSOLE

You can set a time zone and synchronize the system time with a Network Time Protocol (NTP) server in the RHEL web console.

Prerequisites

- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

Procedure

1. Log in to the RHEL 9 web console.
   For details, see Logging in to the web console .
2. Click the current system time in **Overview**.
3. Click **System time**.
4. In the **Change System Time** dialog box, change the time zone if necessary.
5. In the **Set Time** drop-down menu, select one of the following:

   Manually

   Use this option if you need to set the time manually, without an NTP server.

   Automatically using NTP server

   This is a default option, which synchronizes time automatically with the preset NTP servers.

   Automatically using specific NTP servers

   Use this option only if you need to synchronize the system with a specific NTP server. Specify the DNS name or the IP address of the server.
6. Click **Change**.

Verification

- Check the system time displayed in the **System** tab.

Additional resources

- Using the Chrony suite to configure NTP

4.3. 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

1. Optional: Display the current system locales settings:

```
# localectl status
System Locale: LANG=en_US.UTF-8
 VC Keymap: de-nodeadkeys
   X11 Layout: de
  X11 Variant: nodeadkeys
```

2. List available system locale settings:

```
$ localectl list-locales
C.UTF-8
...
en_US.UTF-8
en_ZA.UTF-8
en_ZW.UTF-8
...
```

3. Update the system locale setting:

For example:

+

```
# localectl set-locale LANG=en_US.UTF-8
```

NOTE

The GNOME Terminal does not support non-UTF8 system locales. For more information, see the Red Hat Knowledgebase solution The gnome-terminal application fails to start when the system locale is set to non-UTF8.

Additional resources

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

4.4. CONFIGURING THE KEYBOARD LAYOUT

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

Procedure

1. To list available keymaps:

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

2. To display the current status of keymaps settings:

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

3. 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)** man pages

4.5. CHANGING THE FONT SIZE IN TEXT CONSOLE MODE

You can change the font size in the virtual console.

Procedure

1. Display the currently-used font file:

```
# cat /etc/vconsole.conf

FONT="eurlatgr"
```

2. List the available font files:

```
# ls -1 /usr/lib/kbd/consolefonts/*.psfu.gz

/usr/lib/kbd/consolefonts/eurlatgr.psfu.gz
/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
```

   Select a font file that supports your character set and code page.

3. Optional: To test a font file, load it temporarily:

```
# setfont LatArCyrHeb-16.psfu.gz
```

The **setfont** utility applies the font file immediately and terminals use the new and font size until you reboot or apply a different font file.

4. To return to the font file defined in **/etc/vconsole.conf**, enter **setfont** without any parameters.

5. Edit the **/etc/vconsole.conf** file and set the **FONT** variable to the font file RHEL should load at boot time, for example:

```
FONT=LatArCyrHeb-16
```

6. Reboot the host

```
# reboot
```

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 from collecting unencrypted passwords from the connection.

5.1. GENERATING SSH KEY PAIRS

You can log in to an OpenSSH server without entering a password by generating an SSH key pair on a local system and copying the generated public key to the OpenSSH server. Each user who wants to create a key must run this procedure.

To preserve previously generated key pairs after you reinstall the system, back up the **~/.ssh**/ directory before you create new keys. After reinstalling, copy it back to your home directory. You can do this for all users on your system, including **root**.

Prerequisites

- You are logged in as a user who wants to connect to the OpenSSH server by using keys.
- The OpenSSH server is configured to allow key-based authentication.

Procedure

1. Generate an ECDSA key pair:

```
$ 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): <password>
Enter same passphrase again: <password>
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 **ssh-keygen** command without any parameter or an Ed25519 key pair by entering the **ssh-keygen -t ed25519** command. Note that the Ed25519 algorithm is not FIPS-140-compliant, and OpenSSH does not work with Ed25519

keys in FIPS mode.

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.

Verification

- Log in to the OpenSSH server by using the key file:

```
$ ssh -o PreferredAuthentications=publickey <username>@<ssh-server-example.com>
```

Additional resources

- **ssh-keygen(1)** and **ssh-copy-id(1)** man pages on your system

5.2. SETTING KEY-BASED AUTHENTICATION AS THE ONLY METHOD ON AN OPENSSH SERVER

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.
- You can already connect to the OpenSSH server by using a key.
  See the Generating SSH key pairs section for details.

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
```

3. On a system other than a new default installation, check that the **PubkeyAuthentication** parameter is either not set or set to **yes**.

4. Set the **KbdInteractiveAuthentication** directive to **no**.
   Note that the corresponding entry is commented out in the configuration file and the default value is **yes**.

5. 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
```

6. If you are connected remotely, not using console or out-of-band access, test the key-based login process before disabling password authentication.

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

```
# systemctl reload sshd
```

Additional resources

- **sshd_config(5)** and **setsebool(8)** man pages on your system

5.3. CACHING YOUR SSH CREDENTIALS BY 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 for a login session. If the agent is running and your keys are unlocked, you can log in to SSH servers by using these keys but without having to enter the key's password again. The private key and the passphrase remain secure.

Prerequisites

- You have a remote host with the 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.
  See the Generating SSH key pairs section for details.

Procedure

1. Add the command for automatically starting **ssh-agent** in your session to the **~/.bashrc** file:

   a. Open **~/.bashrc** in a text editor of your choice, for example:

```
$ vi ~/.bashrc
```

   b. Add the following line to the file:

```
eval $(ssh-agent)
```

c. Save the changes, and quit the editor.

2. Add the following line to the ~/**.ssh**/**config** file:

```
AddKeysToAgent yes
```

With this option and **ssh-agent** started in your session, the agent prompts for a password only for the first time when you connect to a host.

Verification

- Log in to a host which uses the corresponding public key of the cached private key in the agent, for example:

```
$ ssh <example.user>@<ssh-server@example.com>
```

Note that you did not have to enter the passphrase.

5.4. AUTHENTICATING BY SSH KEYS STORED ON A SMART CARD

You can create and store ECDSA and RSA keys on a smart card and authenticate by the smart card on an OpenSSH client. Smart-card authentication 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
```

2. Transfer the public key to the remote server. Use the **ssh-copy-id** command with the **keys.pub** file created in the previous step:

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

3. Connect to *<ssh-server-example.com>* by using the ECDSA key. 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" <ssh-server-example.com>
Enter PIN for 'SSH key':
[ssh-server-example.com] $
```

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

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

4. Optional: 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 <ssh-server-example.com>
Enter PIN for 'SSH key':
[ssh-server-example.com] $
```

The **ssh** client utility now automatically uses this URI and the key from the smart card.

Additional resources

- **p11-kit(8)**, **opensc.conf(5)**, **pcscd(8)**, **ssh(1)**, and **ssh-keygen(1)** man pages on your system

5.5. 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 on your system
- Configuring SELinux for applications and services with non-standard configurations
- Controlling network traffic using firewalld

CHAPTER 6. 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.

6.1. SERVICES HANDLING SYSLOG MESSAGES

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

- The **systemd-journald** daemon

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

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.

6.2. LOG FILES STORING SYSLOG MESSAGES

The following log files 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

NOTE

The above mentioned list contains only some files and the actual list of files in the **/var/log/** directory depends on which services and applications log in to this directory.

6.3. 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 log entries.

You can use the **journalctl** command to view messages in the system journal using the command line.

Table 6.1. 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 6.2. 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>***.
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 6.3. Viewing logs related to specific boots

Command	Description

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.

6.4. REVIEWING LOGS IN THE WEB CONSOLE

Learn how to access, review and filter logs in the RHEL web console.

6.4.1. Reviewing logs in the web console

The RHEL web console Logs section is a UI for the **journalctl** utility. You can access system logs in the web console interface.

Prerequisites

- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

Procedure

1. Log in to the RHEL 9 web console.
   For details, see Logging in to the web console .
2. Click **Logs**.
3. Open log entry details by clicking on your selected log entry in the list.

Next steps

- After clicking **Toggle filters** to expand the menu, you can use the **Pause** button to pause new log entries from appearing in the log view. After you resume new log entries, the web console loads all log entries that were reported after you used the **Pause** button.
- You can filter the logs by time, priority, or identifier. For more information, see Filtering logs in the web console.

6.4.2. Filtering logs in the web console

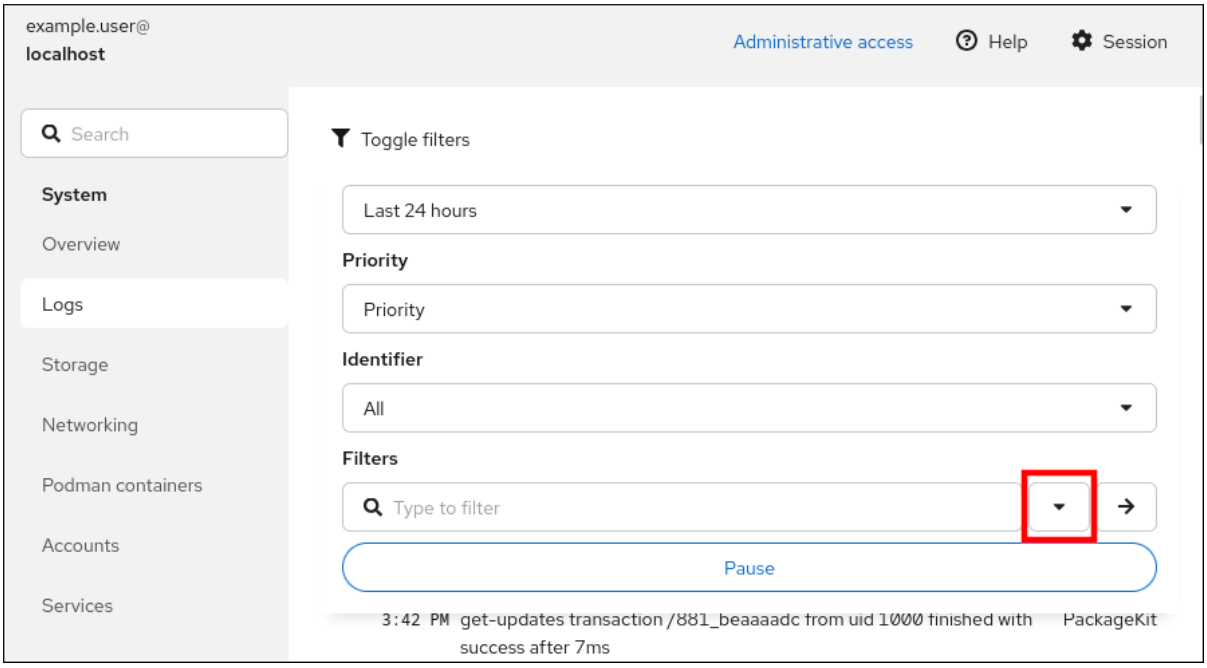
You can filter log entries in the RHEL web console.

Prerequisites

- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

Procedure

1. Log in to the RHEL 9 web console.
   For details, see Logging in to the web console .
2. Click **Logs**.
3. Click **Toggle filters**.
4. To change the default log filtering, use the **Time**, **Priority**, and **Identifier** drop-down menus.
5. Optional: By default, the web console shows the latest log entries. To filter by a specific time range, click the **Expand** button.



6. Click the → button (right pointing arrow) to apply your filters.
7. View details about a log entry by clicking the selected log entry.

6.4.3. Text search options for filtering logs in the web console

The text search option functionality provides a wide variety of options for filtering logs. You can use the predefined options in three drop-down menus or directly type the search expression.

Drop-down menus

You can use three drop-down menus that you can use to specify the main parameters of your search:

- **Time**: This drop-down menu contains predefined searches for different time ranges of your search.

- **Priority**: This drop-down menu provides options for different priority levels. It corresponds to the **journalctl --priority** option. The default priority value is **Error and above**. It is set every time you do not specify any other priority.
- **Identifier**: In this drop-down menu, you can select an identifier that you want to filter. Corresponds to the **journalctl --identifier** option.

Quantifiers

You can specify six quantifiers in your search. See the Options for filtering logs section for more information.

Log fields

To search for specific log entries, specify both the field name and the value you want to find.

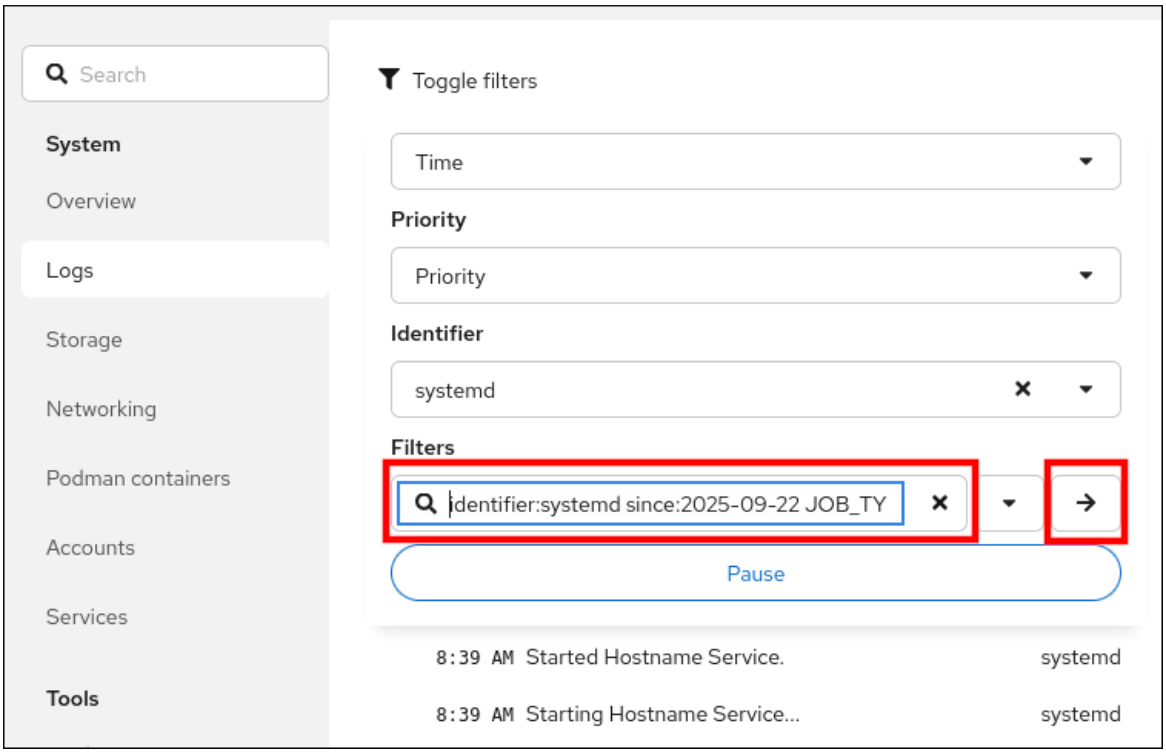
Free-form text search in logs messages

You can filter any text string of your choice in the logs messages. The string can also be in the form of a regular expressions.

Example 6.1. Advanced logs filtering I

Filter all log messages identified by systemd since September 22, 2025 midnight and journal field 'JOB_TYPE' is either **start** or **restart**.

1. Click **Toggle filters**.
2. Type **identifier:systemd since:2025-09-22 JOB_TYPE=start,restart** to the **Filters** field.
3. Click the → button (right pointing arrow) to apply your filters.
4. Check the results.



Example 6.2. Advanced logs filtering II

> Filter log messages from the **cockpit.service** systemd unit during the previous boot that contains **error** or **fail**.
>
> 1. Click **Toggle filters**.
> 2. Type **service:cockpit boot:-1 error|fail** to the **Filters** field.
> 3. Click the → button (right pointing arrow) to apply your filters.
> 4. Check the results.

6.4.4. Using a text search box to filter logs in the web console

You can filter logs according to different parameters by using the text search box in the web console. The search combines usage of the filtering drop-down menus, quantifiers, log fields, and free-form string search.

Prerequisites

- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

Procedure

1. Log in to the RHEL 9 web console.
   For details, see Logging in to the web console .
2. Click **Logs**.
3. Use the drop-down menus to specify the three main quantifiers - time range, priority, and identifier(s) - you want to filter.
   The **Priority** quantifier always has to have a value. If you do not specify it, it automatically filters the **Error and above** priority. Notice that the options you set reflect in the text search box.
4. Specify the log field you want to filter.
   You can add several log fields.
5. You can use a free-form string to search for anything else. The search box also accepts regular expressions.

6.4.5. Options for logs filtering

You can use the web console log filtering capabilities, which are based on **journalctl** command-line options. Many of these filtering options are available through the drop-down menus in the web console interface, providing a graphical alternative to command-line log filtering.

Option name	Usage	Notes
priority	Filter output by message priorities. Takes a single numeric or textual log level. The log levels are the usual syslog log levels. If a single log level is specified, all messages with this log level or a lower (therefore more important) log level are shown.	Covered in the **Priority** drop-down menu.
identifier	Show messages for the specified syslog identifier SYSLOG_IDENTIFIER. Can be specified multiple times.	Covered in the **Identifier** drop-down menu.
follow	Shows only the most recent journal entries, and continuously prints new entries as they are appended to the journal.	Not covered in a drop-down.
service	Show messages for the specified **systemd** unit. Can be specified multiple times.	Is not covered in a drop-down. Corresponds to the **journalctl --unit** parameter.
boot	Show messages from a specific boot. A positive integer looks up the boots starting from the beginning of the journal, and an equal-or-less-than zero integer looks up boots starting from the end of the journal. Therefore, 1 means the first boot found in the journal in chronological order, 2 the second and so on; while -0 is the last boot, -1 the boot before last, and so on.	Covered only as **Current boot** or **Previous boot** in the **Time** drop-down menu. Other options must be written manually.

Option name	Usage	Notes
since	Start showing entries on or newer than the specified date, or on or older than the specified date. Date specifications should be of the format "2012-10-30 18:17:16". If the time part is omitted, "00:00:00" is assumed. If only the seconds component is omitted, ":00" is assumed. If the date component is omitted, the current day is assumed. Alternatively the strings "yesterday", "today", "tomorrow" are understood, which refer to 00:00:00 of the day before the current day, the current day, or the day after the current day. "now" refers to the current time. Finally, you can specify relative times, prefixed with "-" or "+", referring to times before or after the current time.	Not covered in a drop-down.

6.5. ADDITIONAL RESOURCES

- **journalctl(1)** man page on your system
- Configuring a remote logging solution

CHAPTER 7. MANAGING USERS AND GROUPS

Preventing unauthorized access to files and processes requires 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 a host.

7.1. 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.

7.1.1. 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.

7.1.2. Configuring reserved user and group IDs

By default, 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. The UID's and GID's of users and groups created before you changed the **UID_MIN** and **GID_MIN** values do not change. The reserved user and group IDs are documented in the:

```
/usr/share/doc/setup/uidgid
```

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

Modify the **UID_MIN** and **GID_MIN** parameters in the **/etc/login.defs** file to define a start ID other than the defaults (1000).

> **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.

Procedure

1. Open the **/etc/login.defs** file in an editor.
2. Set the **UID_MIN** variable, for example:

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

3. Set the **GID_MIN** variable, for example:

```
# 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.

7.1.3. User private groups

RHEL uses the *user private group* (**UPG**) system configuration, which makes Linux 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 local groups is stored in the **/etc/group** configuration file.

7.2. 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. To define the min/max IDs for users and groups, system users and system groups, 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.

7.2.1. Managing accounts and groups using command line tools

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

Procedure

- Create a new user account:

```
# useradd example.user
```

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

```
# passwd example.user
```

- Add a user to a group:

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

Additional resources

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

7.3. 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.

7.3.1. Adding a new user from the command line

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

Prerequisites

- You have **Root** access

Procedure

- 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 7.1. Adding a new user**
>
> To add the user **sarah** with user ID **5000**, use:
>
> ```
> # useradd -u 5000 sarah
> ```

Verification

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

  ```
  # id sarah
  ```

  The command returns:

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

Additional resources

- **useradd** man page

7.3.2. Adding a new group from the command line

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

Prerequisites

- You have **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 7.2. Adding a new group**
>
> To add the group **sysadmins** with group ID **5000**, use:
>
> ```
> # groupadd -g 5000 sysadmins
> ```

Verification

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

  ```
  # getent group sysadmin
  ```

The command returns:

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

Additional resources

- **groupadd** man page

7.3.3. 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

- You have **root** access

Procedure

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

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

Verification

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

```
# groups <username>
```

7.3.4. 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.

Prerequisites

- You have **Root** access

Procedure

1. Create a directory:

```
# mkdir <directory-name>
```

2. Create a group:

```
# groupadd <group-name>
```

3. Add users to the group:

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

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

```
# chgrp <group_name> <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:

```
# chmod g+rwxs <directory>
```

Verification

- To verify the correctness of set permissions, use:

```
# ls -ld <directory>
```

The command returns:

```
*drwx__rws__r-x.* 2 root _group-name_ 6 Nov 25 08:45 _directory-name_
```

7.3.5. Removing a user on the command line

You can remove a user account by using the command line. In addition, below mentioned are the commands to remove the user account, and optionally remove the user data and metadata, such as their home directory and configuration files.

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

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

- 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

- **userdel(8)** man page

7.4. MANAGING USER ACCOUNTS IN THE WEB CONSOLE

The RHEL web console provides a graphical interface for adding, editing, and removing system user accounts.

You can also set password expiration and terminate user sessions in the web console.

7.4.1. Adding new accounts by 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

- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

Procedure

1. Log in to the RHEL 9 web console.
   For details, see Logging in to the web console .
2. Click **Accounts**.
3. Click **Create New Account**.
4. In the **Full Name** field, enter the full name of the user.
   The 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, which consists of the first letter of the first name and the entire 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 indicates the security level of the entered password, which prevents you from creating 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.

Verification

- You can view the new account in the **Accounts** settings and use its credentials to connect to the system.

7.4.2. Enforcing password expiration in the web console

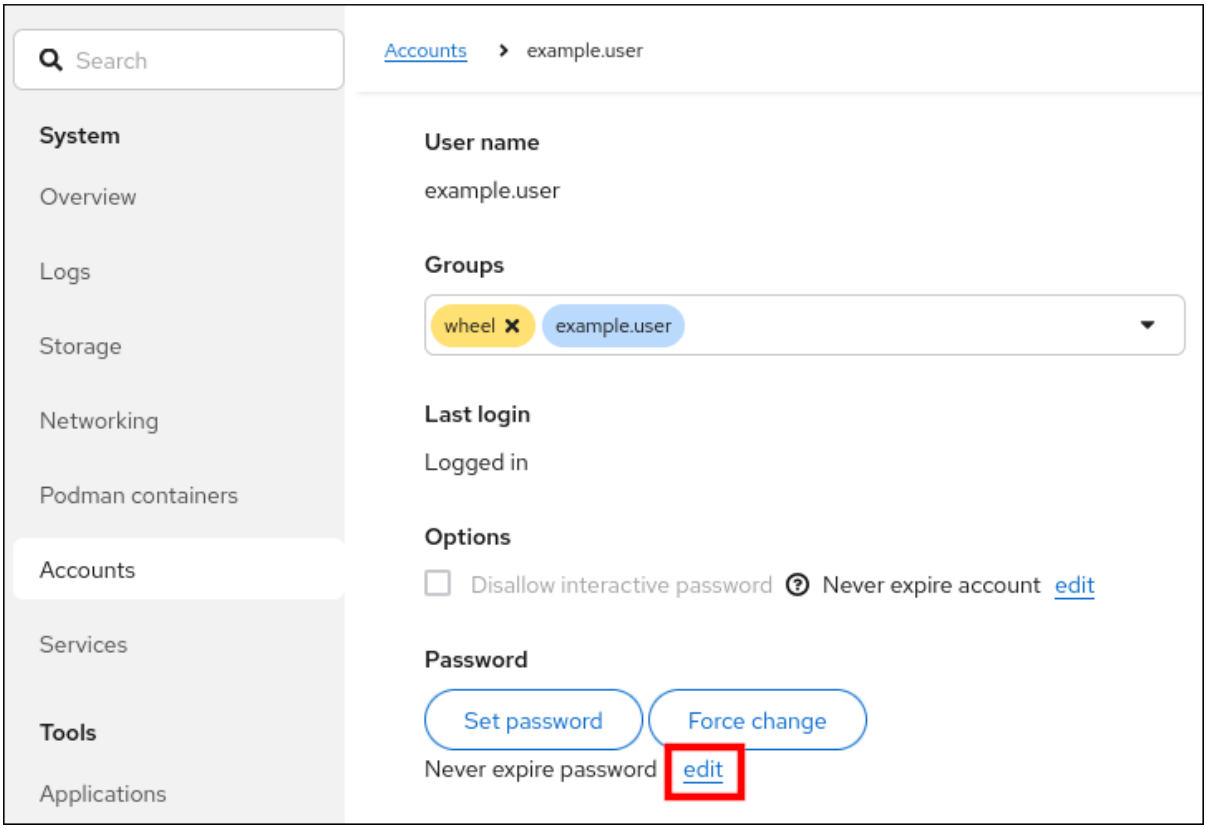
By default, user accounts have set passwords to never expire. You can set system passwords to expire after a defined number of days. When the password expires, the user must change its password at the next login attempt before the user can access the system.

Prerequisites

- You have installed the RHEL 9 web console.
- You have enabled the cockpit service.
- Your user account is allowed to log in to the web console.
  For instructions, see Installing and enabling the web console .

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.

7.5. 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.

7.5.1. 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 RHEL, 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, one, or multiple supplementary groups.

7.5.2. 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
```

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 7.3. 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**.

7.5.3. 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>
```

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.

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

```
$ groups <username>
```

7.5.4. 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

- You have **root** access

Procedure

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

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

Verification

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

```
# groups <username>
```

7.5.5. 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

- You have **root** access

Procedure

- Remove a user from a supplementary group:

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

Verification

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

```
$ groups <username>
```

7.5.6. 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

- You have **root** access.

- The supplementary groups must exist.

Procedure

- Overwrite a list of user's supplementary groups:

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

To add the user to several supplementary groups at once, separate the group names using commas and no intervening spaces. For example: **wheel,developer**.

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

Verification

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

```
# groups <username>
```

7.6. CHANGING AND RESETTING THE ROOT PASSWORD

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

7.6.1. Changing the root password as the root user

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

Prerequisites

- You have **Root** access

Procedure

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

```
# passwd
```

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

7.6.2. 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 have permissions to execute commands as root by using **sudo**.

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.

7.6.3. Resetting the root password

If you are unable to log in as root user and have no non-root user with sudo permissions, you can reset the root password or do not belong to the administrative **wheel** group, you can reset the root password by booting the system into the special mode. In this mode, the boot process stops before the system hands over the control from the **initramfs** to the actual system.

Procedure

1. Reboot the system and, on the GRUB 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. Set the cursor to the end of the line that starts with **linux**.
3. Append **rd.break** to the end of the line that starts with **linux**.
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
```

   By default, 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
```

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, to reboot the system:

```
exit
```

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

Verification

1. Log in as the **root** user by using the new root password.

2. Optional: Display the user name associated with the current effective user ID:

```
# whoami
```

CHAPTER 8. 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.

8.1. USER AUTHORIZATIONS IN SUDOERS

The **/etc/sudoers** file and, by default, drop-in files in the **/etc/sudoers.d/** directory specify which users can use the **sudo** command to execute commands as other user. 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.

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**
>
> By using ALL in some or multiple segments of a rule, can cause serious security risks.

You can negate the arguments 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

- **sudoers(5)** man page

8.2. ADDING A SUDO RULE TO ALLOW MEMBERS OF A GROUP TO EXECUTE COMMANDS AS ROOT

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 sudoers configuration file can use the **sudo** command.
- The command is executed in the shell of the user, not in the root shell. However, there are some exceptions such as when full **sudo** privileges are granted to any user. In such cases, users can switch to and run the commands in root shell. For example:
- **sudo -i**
- **sudo su -**

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

- Log in as a member of the **wheel** group and run:

```
# sudo whoami
root
```

Additional resources

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

8.3. 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. This is more secure than granting full **sudo** access to a user or giving someone the root password for the following reasons:

- More granular control over privileged actions. You can allow a user to perform certain actions on specific hosts instead of giving them full administrative access.

- Better logging. When a user performs an action through **sudo**, the action is logged with their user name and not just root.

- Transparent control. You can set email notifications for every time the user attempts to use **sudo** privileges.

Prerequisites

- You have root access to the system.

Procedure

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

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

   The file opens automatically in an editor.

2. 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 to 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
```

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

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

2. 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 whoami
```

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

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

3. If the privileges are configured correctly, sudo executes the command as the configured user. For example, with the **dnf** command, it shows the following output:

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

If the system returns the following error message, the user is not allowed to run commands with sudo.

```
<username> is not in the sudoers file. This incident will be reported.
```

+ If the system returns the following error message, the configuration was not completed correctly.

```
<username> is not allowed to run sudo on <host.example.com>.
```

+ If the system returns the following error message, the command is not correctly defined in the rule for the user.

```
`Sorry, user _<username>_ is not allowed to execute '_<path/to/command>_' as root on
_<host.example.com>_.`
```

Additional resources

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

8.4. APPLYING CUSTOM SUDOERS CONFIGURATION BY USING RHEL SYSTEM ROLES

You can use the **sudo** RHEL system role to apply custom **sudoers** configuration on your managed nodes. That way, you can define which users can run which commands on which hosts, with better configuration efficiency and more granular control.

Prerequisites

- You have prepared the control node and the managed nodes
- The account you use to connect to the managed nodes has **sudo** permissions for these nodes.

Procedure

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

```
---
- name: "Configure sudo"
  hosts: managed-node-01.example.com
  tasks:
    - name: "Apply custom /etc/sudoers configuration"
```

```
    ansible.builtin.include_role:
      name: redhat.rhel_system_roles.sudo
    vars:
      sudo_sudoers_files:
        - path: "/etc/sudoers"
          user_specifications:
            - users:
                - <user_name>
              hosts:
                - <host_name>
              commands:
                - <path_to_command_binary>
```

The settings specified in the playbook include the following:

users

The list of users that the rule applies to.

hosts

The list of hosts that the rule applies to. You can use **ALL** for all hosts.

commands

The list of commands that the rule applies to. You can use **ALL** for all commands.

For details about all variables used in the playbook, see the **/usr/share/ansible/roles/rhel-system-roles.sudo/README.md** file on the control node.

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. On the managed node, verify that the playbook applied the new rules.

```
# cat /etc/sudoers | tail -n1
<user_name> <host_name>= <path_to_command_binary>
```

CHAPTER 9. 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.

9.1. 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**).

9.1.1. 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 9.1. 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 9.2. 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 a group, 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.

9.1.2. 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.

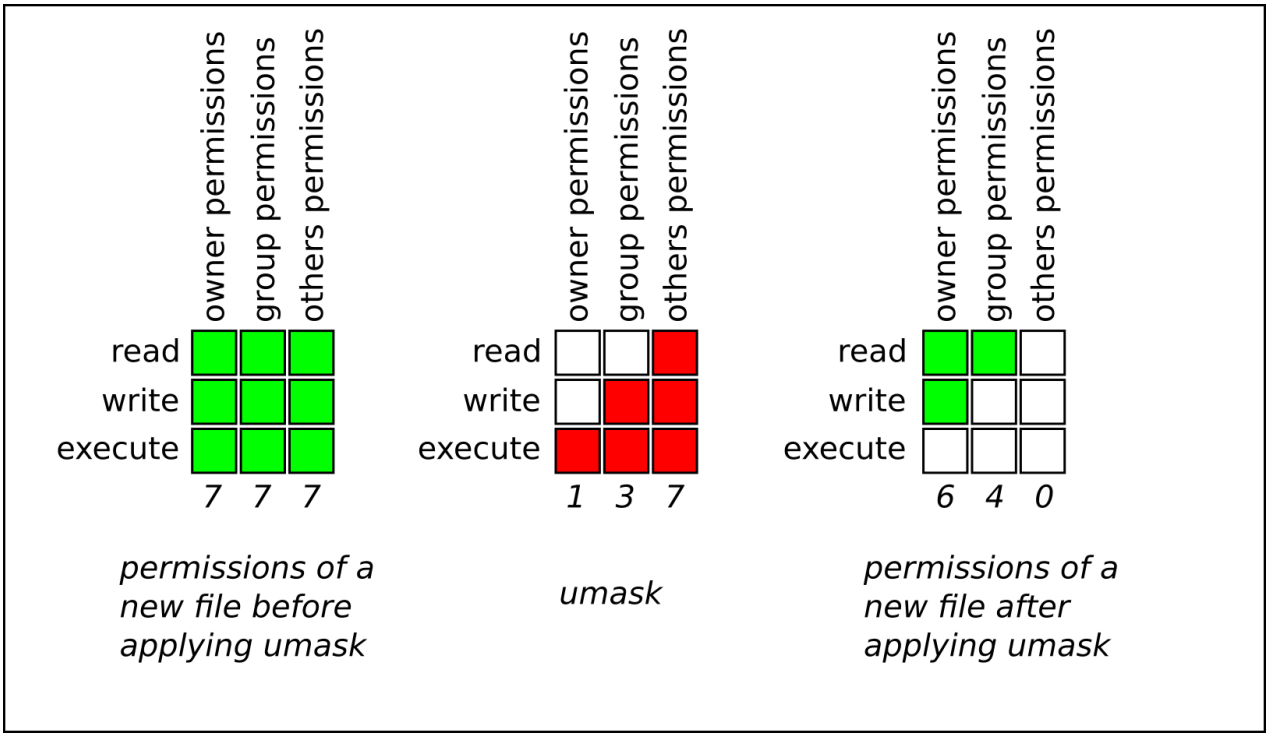
Permission	Symbolic value	Octal value
Read, write, and execute	rwx	0
Read and write	rw-	1
Read and execute	r-x	2
Read	r--	3
Write and execute	-wx	4
Write	-w-	5
Execute	--x	6
No permissions	---	7

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 9.3. 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**.



9.1.3. 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 9.4. 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 9.5. 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.

9.1.4. Changing file permissions using symbolic values

You can use the **chmod** utility with symbolic values (a combination of 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

- 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 9.6. 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**:

```
$ 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
```

9.1.5. 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.

9.2. 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).

9.2.1. Setting the Access Control List

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

Prerequisites

- You have the **root** access.

Procedure

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

```
$ getfacl file-name
```

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

- 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 on your system.

Example 9.7. 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

- 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--
  ```

9.2.2. Interaction between ACLs and standard file permissions

When you configure an Access Control List (ACL) on a file, the behavior of standard file permission tools, such as **ls** and **chmod**, changes to accommodate the ACL entries. Understanding this mapping is critical to avoid misinterpreting file permissions or unintentionally restricting access.

9.2.2.1. The ACL mask and the ls command

When a file has an ACL defined, the **ls -l** command changes its output in two specific ways:

1. The plus sign (): A `` character appears at the end of the permission string (for example, **-rw-rwxr--+**). This indicates that the file has extended security information (an ACL) associated with it.

2. The group permissions mapping: The meaning of the middle triplet of permission bits (traditionally the "group" permissions) depends on whether an ACL mask entry exists.

   a. If an ACL mask entry exists, the group bits correspond to the mask permissions.

   b. If no mask entry exists, the group bits correspond to the permissions of the owning group.

The ACL mask defines the maximum effective permissions for:

- The owning group.
- All named user entries.
- All named group entries.

This means that when you view a file with **ls -l**, the "group" column shows the upper limit of permissions granted to any user or group other than the file owner and "other".

9.2.2.2. The behavior of chmod on ACL-enabled files

The behavior of the **chmod** command mirrors the mapping used by **ls -l**:

- If no ACL mask exists: **chmod** modifies the permissions of the owning group, as it does on standard files.
- If an ACL mask exists: **chmod** modifies the mask permissions, not the owning group permissions.

This has a cascading effect:

- If you lower the permissions of the mask using **chmod**, you restrict the effective permissions of all named users and groups that rely on that mask.
- Even if a specific user is granted **rwx** in the ACL, if the mask is set to **r--** via **chmod**, that user effectively only has read access.

IMPORTANT

Do not assume that **chmod g-w** only affects the owning group of the file. On a file with an ACL, this command tightens the mask, potentially blocking write access for specific users you previously authorized with **setfacl**.

The effect of the ACL mask on permissions

The following example demonstrates how adding an ACL changes the **ls -l** output and how **chmod** affects the mask.

1. Initial state: A file named **file1** exists with standard permissions.

```
$ ls -l file1
```

```
-rw-rw-r--. 1 root root 0 Jul 3 10:00 file1
```

2. Adding a user: You grant user **john** full access (**rwx**) to the file.

```
$ setfacl -m u:john:rwx file1
```

> **NOTE**
>
> By default, **setfacl** automatically creates or updates the mask entry to be the union of all permissions affected by the mask. In this case, the mask is set to **rwx** to accommodate the new permissions granted to **john**. You can prevent this automatic recalculation by using the **-n** (no mask) option.

3. Observing the change: The **ls -l** output now shows a **+** sign, and the group permission column shows **rwx**. This **rwx** reflects the new mask (created automatically to accommodate **john**), not the owning group's permissions.

```
$ ls -l file1
```

```
-rw-rwxr--+ 1 root root 0 Jul 3 10:05 file1
```

4. Verifying with **getfacl**: The **getfacl** command confirms that **john** has **rwx**, the owning group still has **rw-**, and the mask is **rwx**.

```
$ getfacl --omit-header file1
```

```
user::rw-
user:john:rwx
group::rw-
mask::rwx
other::r--
```

5. Modifying permissions with chmod: You decide to remove write access for the group using standard **chmod**.

```
$ chmod g-w file1
```

6. The Result: This action updates the mask. Consequently, **john's effective permissions are reduced, even though his specific ACL entry remains `rwx**.

```
$ ls -l file1
```

```
-rw-r-xr--+ 1 root root 0 Jul 3 10:10 file1
```

```
$ *getfacl --omit-header file1*
```

```
user::rw-
user:john:rwx   #effective:r-x
group::rw-      #effective:r–
mask::r-x
other::r--
```

–

Note that the **#effective** comments indicate the actual permissions enforced by the system.

Additional resources

- **man acl(5)**
- **man setfacl(1)**

9.3. MANAGING THE UMASK

You can use the **umask** utility to display, set, or change the user file-creation mode mask (umask) for the current shell session. The default **umask** value for the **bash** shell is **022**

9.3.1. 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.

9.3.2. 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.

9.3.3. 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.

9.3.4. 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

- You have the **root** access.

Procedure

1. Open the **/etc/bashrc** file in the editor.

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

1. Save the changes and exit the editor.

9.3.5. 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.

9.3.6. 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.

9.3.7. 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 10. MANAGING SYSTEMD

To manage critical aspects of your system, use systemd. Systemd is a system and service manager for Red Hat Enterprise Linux. It provides tools and services for controlling, reporting, and system initialization.

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. You can find unit files in several directories. The **systemd.unit(5)** man page on your system lists these directories and their load order. Key features of systemd are:

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

The systemd manager supports several unit types, including the following 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.

10.1. 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.

10.1.1. 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

10.1.2. 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

- 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 10.1. 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**).

- 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

10.1.3. Starting and stopping a systemd unit

You can start system service in the current session by using the **systemctl start** command.

Prerequisites

- You have the Root access.

Procedure

- Start a system service in the current session:

```
# *systemctl start <systemd_unit> *
```

Replace **<systemd_unit>** 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 **sendmail** service, and you attempt to start the **postfix** service, **systemd** first automatically stops **sendmail**, because these two services are conflicting and cannot run on the same port.

Additional resources

- **systemctl(1)** man page on your system
- Enabling a system service to start at boot
- Displaying system service status

10.1.4. Stopping a system service

If you want to stop a system service in the current session, use the **systemctl 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 on your system
- Disabling a system service to start at boot
- Displaying system service status

10.1.5. Restarting and Reload 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

- You have the 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**).

  If the selected service unit is not running, this command starts it.

- Restart a service unit only if the corresponding service is already running:

```
# systemctl try-restart <name>.service
```

- 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 on your system

- Displaying system service status

10.1.6. 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

- You have Root access.

Procedure

- Verify whether the unit is masked:

```
# systemctl status <systemd_unit>
```

- If the unit is masked, unmask it first:

```
# systemctl unmask <systemd_unit>
```

- Enable a service to start at boot time:

```
# systemctl enable <systemd_unit>
```

  Replace ***<systemd_unit>*** with the name of the service unit you want to enable (for example, **httpd**).

Optionally, pass the **--now** option to the command to also start the unit right now.

Additional resources

- **systemctl (1)** man page on your system
- Displaying system service status
- Starting a system service

10.1.7. 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

- You have 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**). Optionally, pass the **--now** command to also stop the service if it is currently running.

- Optional: To prevent that the unit can be accidentally started by an administrator or as a dependency of other units, mask the service:

```
# systemctl mask <name>.service
```

Additional resources

- **systemctl (1)** man page on your system
- Displaying system service status
- Stopping a system service

10.2. 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.

10.2.1. 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 example:

- 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 10.2. 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)** and **systemd.target(5)** man pages on your system

10.2.2. Changing the default target to boot into

The **default.target** symbolic link refers to the systemd target that the system should boot into. When the system starts, systemd resolves this link and boots into the defined target. 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

- You have 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. Optional: Switch to the new default target:

```
# systemctl isolate default.target
```

Alternatively, reboot the system.

Additional resources

- **systemctl(1)**, **systemd.special(7)**, and **bootup(7)** man pages on your system

10.2.3. 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. Manually switching to a different target is only a temporary operation. When you reboot the host, systemd boots again into the default target.

Procedure

1. 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.

2. 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 on your system

10.2.4. Switching to rescue mode on a running system

To get a single-user environment for troubleshooting, you can switch a running system to rescue mode. In rescue mode, the system mounts local file systems and starts essential services, but it does not activate network interfaces.

Prerequisites

- You have administrative access to the system.

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

To prevent **systemd** from sending a message, enter the following command with the **--no-wall** command-line option:

```
# systemctl --no-wall rescue
```

Troubleshooting

If you cannot enter rescue mode, switch to emergency mode. Emergency mode provides a minimal environment. The system mounts the root file system as read-only and starts only a few essential services. It does not mount other local file systems or activate network interfaces.

To enter emergency mode on your running system:

```
# systemctl emergency
```

10.2.5. Troubleshooting the boot process

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 a minimal environment for troubleshooting.

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 select 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=rescue.target** or **systemd.unit=emergency.target**.

6. Press **Ctrl**+**X** to boot the system by using these settings.

10.3. 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.

10.3.1. 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** utility has the following advantages:

- In RHEL 8, you can schedule a shutdown by using the **time** argument. This also gives users warning that a system shutdown has been scheduled.

10.3.2. 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:

  ```
  # 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

10.3.3. 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.

10.3.4. Restarting the system

When you restart the system, **systemd** stops all running programs and services, the system shuts down, and then immediately starts again.

Prerequisites

- You have 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.

10.3.5. 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
- Hibernate

- Hybrid Sleep
- Suspend-then-hibernate

Prerequisites

- You have Root access.

Procedure

Choose the appropriate method for power saving:

- **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. To suspend the system, run:

```
# systemctl suspend
```

- **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. To hibernate the system, run:

```
# systemctl hibernate
```

- **Hybrid sleep** This combines elements of both hibernation and suspending. The system first saves the current state on 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. To hibernate and suspend the system, run:

```
# systemctl hybrid-sleep
```

- **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. Suspend and then hibernate the system:

```
# systemctl suspend-then-hibernate
```

10.3.6. 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.

10.3.6.1. Changing the behavior of the power button when pressing the button and GNOME is not running

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

- You must have administrative access in your system.

Procedure

1. Edit the **/etc/systemd/logind.conf** configuration file and set the **HandlePowerKey=poweroff** variable to 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
   ```

2. Restart the **systemd-logind** service to apply the changes:

   ```
   # systemctl reload systemd-logind
   ```

10.3.6.2. Changing the behavior of the power button when pressing the button and GNOME is running

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.

Procedure

1. Create a local database for system-wide settings in the **/etc/dconf/db/local.d/01-power** file with the following content:

```
[org/gnome/settings-daemon/plugins/power]
power-button-action=<value>
```

Replace **<value>** with one 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.

10.4. SYSTEMD UNIT FILES LOCATIONS

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

Table 10.3. 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.
/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
```

CHAPTER 11. 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. The user space daemon updates the system clock running in the kernel. Starting with Red Hat Enterprise Linux 8, the **NTP** protocol is implemented by the **chronyd** daemon, available from the repositories in the **chrony** package.

11.1. INTRODUCTION TO CHRONY SUITE

The implementation of the **Network Time Protocol (NTP)** is **chrony**. 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)
- 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 **chronyd** daemon 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.

11.2. 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**.

11.3. USING CHRONY

The following sections describe how to start, and stop **chronyd**, and how to check if **chrony** is synchronized. Sections also describe how to manually adjust System Clock.

11.3.1. Managing chrony

You can start, stop, and check the status of **chronyd**.

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
```

11.3.2. Checking if chrony is synchronized

You can check if **chrony** is synchronized with the use of the **tracking**, **sources**, and **sourcestats** commands.

Procedure

1. To check **chrony** tracking, enter:

```
$ 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 **chronyc** sources command displays information about the current time sources that **chronyd** is accessing.

```
$ 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 on your system

11.3.3. Manually adjusting the System Clock

You can manually adjust the System Clock.

Procedure

- To step the system clock immediately, bypassing any adjustments in progress by slewing, enter:

```
# chronyc makestep
```

IMPORTANT

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.

11.3.4. 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.

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.

Procedure

- To disable the **chrony** dispatcher script, create a symlink to **/dev/null**:

```
# ln -f -s /dev/null /etc/NetworkManager/dispatcher.d/20-chrony-onoffline
```

NOTE

After this change, the NTP servers remain in the online state at all times.

11.3.5. Setting up chrony 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.

To set up **chrony** for a system in an isolated network, follow the steps mentioned below:

Procedure

1. On the system selected to be the server, 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 <subnet>
```

   Where **<subnet>** is the network from which the clients are allowed to connect. Use Classless Inter-Domain Routing (CIDR) notation to specify the subnet.

2. On the systems selected to be direct clients of the server, edit the **/etc/chrony.conf** as follows:

```
server <server_fqdn>
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 <server_ip_address>
```

   Where **<server_fqdn>** is the host name of the server, and **<server_ip_address>** is the address 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.

11.3.6. Configuring remote monitoring access

The **chronyc** utility can access **chronyd** by using the following methods:

- IPv4 or IPv6.
- A domain socket, which is accessible locally by the **root** and **chrony** user.

By default, **chronyc** connects to the Unix domain socket. The default path is **/var/run/chrony/chronyd.sock**. If this connection fails, **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 by using the following methods:

- You can use the **cmdallow** directive in the configuration file of **chronyd**.
- Run 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. Configure **chrony** to listen on local interface by adding the following to the **/etc/chrony.conf** file:

   ```
   bindcmdaddress 0.0.0.0
   ```

   and

```
bindcmdaddress ::
```

2. Allow commands from remote IP addresses, networks, and subnet:
   Add the following content to the **/etc/chrony.conf** file:

```
cmdallow 192.168.1.0/24
```

```
cmdallow 2001:db8::/64
```

3. Open port 323 in the firewall to allow connections from remote systems:

```
# firewall-cmd --permanent --add-port=323/udp
```

4. Reload the firewall configuration:

```
# firewall-cmd --reload
```

Additional resources

- **chrony.conf(5)** man page on your system

11.3.7. Monitoring NTP clients

Display the list of clients that accessed the **chronyd** Network Time Protocol (NTP) server. This information is useful for verifying which clients are actively synchronizing and checking their connection history.

Prerequisites

- The **chronyd** service is running.
- **chronyd** is configured to allow NTP clients. For example, add the **allow** directive to **/etc/chrony.conf**.

Procedure

1. Display a list of clients by using the **chronyc clients** command:

```
# chronyc clients
```

2. Review the command output:

```
Hostname                      NTP  Drop  Int  IntL  Last  Cmd  Drop  Int  Last
===============================================================================
=========
client1.example.net       10    0    6   -   10s  0    0    6   12s
client2.example.net        8    0    6   -   25s  0    0    6   28s
desktop-192-0-2-100.example.net  3         6   -    9s  0    0    6   11s
```

The output fields include:

- **Hostname**: The hostname or IP address of the client.
- **NTP**: The number of NTP packets received from the client.
- **Drop**: The number of packets dropped by **chronyd**, typically due to rate-limiting.
- **Int**: The client's polling interval in seconds (as a log base 2 value, e.g., 6 = 2^6 = 64s).
- **IntL**: The average inter-poll interval (in seconds) for the client when rate limiting is active. This field shows **'-'** if rate limiting is not currently active for the client.
- **Last**: The elapsed time since the last NTP packet was received from this client. Use this value to determine which clients are synchronized or recently synchronized.
- **Cmd**: The number of **chronyc** (monitoring) command packets received from the client.

NOTE

If you have a number of clients and the command is slow to return, it might be due to performing DNS lookups. Use the **-n** option to disable hostname resolution and display IP addresses instead:

+

```
# chronyc -n clients
```

IMPORTANT

By default, **chronyd** monitors up to 4,096 clients. If you have more clients than this, you can increase the memory limit with **clientloglimit** in **/etc/chrony.conf** file. For example: **clientloglimit 10000000**

11.3.8. 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 11.1. 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

11.3.9. Additional resources

- **chronyc(1)** and **chronyd(8)** man pages on your system
- Frequently Asked Questions

11.4. CHRONY WITH HW TIMESTAMPING

Hardware timestamping (HW) in some Network Interface Controller (NICs) 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 achieve 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.

11.4.1. 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.

Procedure

- Display a device's time stamping capabilities and associated PTP hardware clock:

```
# ethtool -T enp1s0
```

11.4.2. Enabling hardware timestamping

You can enable hardware timestamping on one or multiple interfaces by using 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.

Procedure

1. Edit the **/etc/chrony.conf** file and make the following changes:

   a. Add the **hwtimestamp** setting for interfaces which support hardware timestamping. For example:

   ```
   hwtimestamp enp1s0
   hwtimestamp eno*
   ```

   You can use the * wildcard if no other application, such as **ptp4l** uses hardware timestamping.

   b. Configure a short client polling interval by appending the **minpoll** and **maxpoll** options to the server setting, for example:

   ```
   server ntp.example.comlocal minpoll 0 maxpoll 0
   ```

   For hardware timestamping, you must configure a shorter polling interval than the default range (64-1024 seconds) to minimize the offset of the system clock.

   c. Enable the NTP interleaved mode by appending the **xleave** option to the server setting:

   ```
   server ntp.example.comlocal minpoll 0 maxpoll 0 xleave
   ```

   With this setting, chrony gets the hardware transmit timestamp only after sending a packet. This behavior prevents the server from saving the timestamp in packets to which it responds. With the **xleave** option, chrony can receive transmit timestamps that were generated after the transmission.

   d. Optional: Increase the maximum size of memory allocated for logging of client's access on the server, for example:

   ```
   clientloglimit 100000000
   ```

   The default server configuration allows a few thousands of clients to use the interleaved mode concurrently. By increasing the value of the **clientloglimit** setting, you can configure the server for a large number of clients.

2. Restart the chronyd service:

   ```
   # systemctrl restart chronyd
   ```

Verification

1. Optional: Verify in the **/var/log/messages** log file that hardware timestamping is enabled:

```
chronyd[4081]: Enabled HW timestamping on enp1s0
chronyd[4081]: Enabled HW timestamping on eno1
```

2. If chronyd is configured as an NTP client or peer, display the transmit and receive timestamping modes and the interleaved mode:

```
# chronyc ntpdata

Output:

[literal,subs="+quotes,verbatim,normal"]


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
```

3. Report the stability of NTP measurements:

```
# chronyc sourcestats

Output:

[literal,subs="+quotes,verbatim,normal"]
....

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
....
```

This stability is reported in the **Std Dev** column. With hardware timestamping enabled, stability of NTP measurements should be in tens or hundreds of nanoseconds, under normal load.

11.4.3. 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.

Procedure

1. Configure the **ptp4l** and **phc2sys** programs from the **linuxptp** packages to use one interface to synchronize the system clock using **PTP**.

1. Configure **chronyd** to provide the system time using the other interface:

```
bindaddress 203.0.113.74
hwtimestamp enp1s0
local stratum 1
```

2. Restart the chronyd service:

```
# systemctrl restart chronyd
```

11.5. 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** setting to the **/etc/sysconfig/chronyd** file.

11.5.1. Enabling Network Time Security (NTS) on a client

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

- The time server supports NTS.

Procedure

Edit the **/etc/crony.conf** file, and make the following changes:

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. Add the following setting to avoid repeating the Network Time Security-Key Establishment (NTS-KE) session during system boot:

```
ntsdumpdir /var/lib/chrony
```

3. If present, comment out or remove the following setting to disable synchronization with Network Time Protocol (NTP) servers provided by **DHCP**:

```
sourcedir /run/chrony-dhcp
```

4. 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.netnod.se   NTS     1   15  256  33m    0    0    8  100
ptbtime1.ptb.de   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.netnod.se   1        6   377    44   +237us[ +237us] +/-   23ms
ptbtime1.ptb.de    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 on your system

11.5.2. Enabling Network Time Security (NTS) on a time 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. Edit the **/etc/chrony.conf** file, and make the following changes:

```
ntsserverkey /etc/pki/tls/private/<ntp-server.example.net>.key
ntsservercert /etc/pki/tls/certs/<ntp-server.example.net>.crt
```

2. Set permissions on both the private key and the certificate file that allow the chrony user to read the files, for example

```
# chown root:chrony /etc/pki/tls/private/<ntp-server.example.net>.key
/etc/pki/tls/certs/<ntp-server.example.net>.crt

# chmod 644 /etc/pki/tls/private/<ntp-server.example.net>.key /etc/pki/tls/certs/<ntp-
server.example.net>.crt
```

3. Ensure that the **ntsdumpdir /var/lib/chrony** setting is present.
4. Open the required ports in firewalld:

```
# firewall-cmd --permanent --add-port={323/udp,4460/tcp}
# firewall-cmd --reload
```

5. Restart the **chronyd** service:

```
# systemctl restart chronyd
```

Verification

1. Perform a test from a client machine:

```
$ 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.

2. 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 12. RECOVERING AND RESTORING A SYSTEM

To back up and restore your system, Red Hat Enterprise Linux provides the Relax-and-Recover (ReaR) utility.

You can use ReaR as a disaster recovery solution and also for system migration.

By using ReaR, you can perform the following tasks:

- Produce a system backup and a bootable image, and use the image to restore the system from an existing backup.
- Replicate the original storage layout.
- Restore user and system files.
- Restore the system to different hardware.

Additionally, for disaster recovery, you can also integrate certain backup software with ReaR.

12.1. SETTING UP REAR AND MANUALLY CREATING A BACKUP

To create a rescue system, first install the packages for the Relax-and-Recover (ReaR) utility, adjust ReaR settings, and manually generate a system backup. This prepares your system for potential disaster recovery operations.

Prerequisites

- The necessary configurations based on your backup restore plan are ready.

  NOTE

  The following steps use the **NETFS** backup method in example configurations. This method is fully-integrated and built-in with ReaR, and produces a backup in a location specified by the **BACKUP_URL** configuration setting. By default it uses the system **tar** utility to create a backup archive named **backup.tar.gz**.

- You are using the Intel 64 or AMD64 (x86-64) hardware architecture, or the IBM POWER little-endian (ppc64le) architecture.
  If you are using the IBM Z architecture, see Using a ReaR rescue image on the 64-bit IBM Z architecture.

  On the 64-bit ARM architecture, ReaR is currently provided only as a Technology Preview in RHEL 9.7 and later.

Procedure

1. Install the ReaR utility:

```
# dnf install rear
```

2. Modify the ReaR configuration file in an editor of your choice, for example:

```
# vi /etc/rear/local.conf
```

-

- 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
OUTPUT=ISO
BACKUP_URL=<data-backup-location>
OUTPUT_URL=<rescue-image-location>
```

  Replace *<data-backup-location>* with the location for the **tar** data backup, and *<rescue-image-location>* with the location for the rescue system **ISO** image. For example:

```
BACKUP=NETFS
OUTPUT=ISO

# Backup is stored on an external drive
BACKUP_URL=file:///run/media/user/external_drive/server_backups/

# The ISO is stored on a dedicated NFS share
OUTPUT_URL=nfs://backup-server.local/exports/rear/
```

  For further information on the syntax of the **/etc/rear/local.conf** file and for supported formats of **BACKUP_URL** and **OUTPUT_URL**, see the **rear(8)** man page.

  For a list of configuration variables that you can use in **/etc/rear/local.conf**, as well as their default values, see the **/usr/share/rear/conf/default.conf** file.

- 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
```

  To disable retention, leave the variable empty. ReaR treats any non-empty value, including **no**, as true.

- To make the backups incremental, meaning that only the changed files are backed up on each run, add the following line:

```
BACKUP_TYPE=incremental
```

- If you are planning to boot the ReaR rescue system on UEFI firmware, add the following line to ensure the boot does not fail:

```
SECURE_BOOT_BOOTLOADER=/boot/efi/EFI/redhat/shimx64.efi
```

  If your system is using the 64-bit ARM architecture (**aarch64**), use the following line instead:

```
SECURE_BOOT_BOOTLOADER=/boot/efi/EFI/redhat/shimaa64.efi
```

3. Create a rescue system and data backup based on your restore plan. For example, when using the **NETFS** backup method, run the following command:

```
# rear mkbackup
```

a. If you need to create only the rescue system, use the **rear mkrescue** command instead

b. If you need to create only the data backup, use the **rear mkbackuponly** command instead.

4. Optional: Schedule regular automatic ReaR backup. You can use a variety of backup methods, based on your use case. For example:

   - Create a **/etc/cron.d/rear** crontab file, and add the following line:

     ```
     30 1 * * * /usr/sbin/rear mkbackup
     ```

     This runs the the **rear mkbackup** command at 1:30 AM every day, which creates a rescue system and a data backup in the location set up in the **/etc/rear/local.conf** file.

   - If you use an external backup method, schedule an external backup. The details depend on the backup method that you are using in ReaR.

Verification

1. Burn the ISO image of the rescue system to a DVD, and attempt to use the DVD to boot. If this displays a **Relax-and-Recover** interface after booting, the rescue DVD works correctly.

2. Use the ReaR interface to restore the system, and test that the restored system works.

Next steps

- Recovering your system by using ReaR
- Modifying the content of the ReaR backup

12.2. USING A REAR RESCUE IMAGE ON THE 64-BIT IBM Z ARCHITECTURE

To quickly recover and restore systems running on the IBM Z architecture, you can use the Relax-and-Recover (ReaR) rescue image.

ReaR provides basic functionality on the 64-bit IBM Z architecture and is fully supported in RHEL 9.2 and later. You can create a ReaR rescue image on IBM Z only in the z/VM environment. Backing up and recovering logical partitions (LPARs) is not supported.

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.

Procedure

1. Install ReaR:

```
# dnf install rear
```

2. Add the following variables to the **/etc/rear/local.conf** file to configure ReaR for producing a rescue image on the 64-bit IBM Z architecture:

   a. To configure the **IPL** output method, add the `OUTPUT=IPL` line to the configuration.

   b. 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

   Local backup storage is currently not supported on the 64-bit IBM Z architecture.

   c. Optional: 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**.

3. To perform backup and rescue image creation:

```
# rear mkbackup
```

   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.

4. To recover the system, use the ReaR kernel and initrd files created in the previous step, 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 Booting the RHEL installation by using a prepared DASD .

5. When the rescue kernel and **initrd** are booted, the ReaR rescue environment starts. Proceed with the system recovery.

Next steps

- Recovering your system by using ReaR

Additional resources

- Installing under z/VM
- Using a Prepared DASD .

12.3. RECOVERING YOUR SYSTEM BY USING REAR

To recover your RHEL system on new hardware after a failure of the current hardware, use the Relax-and-Recover (ReaR) utility.

Prerequisites

- You have set up ReaR and created a backup. For instructions, see Setting up ReaR and manually creating a backup.
- You have a set of working hardware on which you want to run the system after you recover it.
- The hard disk on which you plan to recover your system does not contain any critical data.

> **IMPORTANT**
>
> Recovering a system on a hard disk by using ReaR erases all data currently stored on the disk.

Procedure

1. Boot the rescue system on the new hardware. For example, you can burn the ISO image of the rescue system to a DVD, and boot from the DVD.
2. In the **Relax-and-Recover** boot menu, select the option to boot to the recovery environment.
3. In the **RESCUE** prompt, run the **rear recover** command.
   The rescue system recreates the partition layout and file systems.
4. Restore user and system files from the data backup into the **/mnt/local/** directory.
   For example, if you used the **NETFS** method to create the backup, ReaR automatically performs the restoration process. However, based on your backup settings, ReaR might still require your confirmation in certain points of the restoration.

Additional resources

- Modifying the content of the ReaR backup

12.4. MODIFYING THE CONTENT OF THE REAR BACKUP

When creating a rescue system and data backup by using the Relax-and-Recover (ReaR) utility, certain files and storage components are not included in the backups. To adjust what data and devices are excluded from the backups, modify ReaR configuration.

When creating the rescue image, ReaR creates the **/var/lib/rear/layout/disklayout.conf** layout file, and embeds the file in the rescue image.

During the recovery process, ReaR uses the layout file to recreate the storage layout of the original system, where the rescue image has been produced, on the disks of the recovered system. The storage layout includes partitions, volume groups, logical volumes, file systems, and other storage components.

Prerequisites

- You have set up ReaR on your system. For instructions, see Setting up ReaR and manually creating a backup.

Procedure

1. Generate the current layout file.

```
# rear savelayout
```

2. Open the layout file to examine its configuration. For example:

```
# vi /var/lib/rear/layout/disklayout.conf
```

3. To exclude specific files or storage devices from the backup, you can configure ReaR to ignore them when creating the rescue image.

   a. Open the ReaR local configuration file for editing. For example:

   ```
   # vi /etc/rear/local.conf
   ```

   b. Adjust which storage devices will be excluded from the layout file. You can use a variety of **exclude** variables in the **/etc/rear/local.conf** file, including the following:

      - **AUTOEXCLUDE_DISKS**
      - **AUTOEXCLUDE_MULTIPATH**
      - **AUTOEXCLUDE_PATH**
      - **EXCLUDE_RECREATE**

      For information on the functions and syntax of these variables, as well as of the layout file, see the **Layout configuration** chapter in the ReaR user guide. This guide is installed with the **rear** package, and is available at **/usr/share/doc/rear/relax-and-recover-user-guide.html**.

   c. By default, when a local disk-based file system is included in the layout file, all files on that file system are backed up when you use the **rear mkbackup** or **rear mkbackuponly** commands.
      To configure specific files or a directory tree to be excluded from the backup, use the **BACKUP_PROG_EXCLUDE** variable.

      The value of **BACKUP_PROG_EXCLUDE** must be an array of glob(3)-style wildcard patterns that tar or rsync uses. Note that you must quote the patterns in order to prevent their expansion by the shell when it reads the configuration file.

      The default value of this variable is set in the **/usr/share/rear/conf/default.conf** file. The default value contains, for example, the **/tmp/*** pattern that excludes all the files and directories under the **/tmp** directory, but not the **/tmp** directory itself.

      If you need to exclude other files and directories, append further patterns to the variable. To ensure that the default values are preserved, do not override the variable.

      For example, to exclude all files and directories under the directory **/data/temp**, use:

      ```
      BACKUP_PROG_EXCLUDE+=( '/data/temp/*' )
      ```

NOTE

When you exclude all files and directories in a single mounted file system this way, ReaR recreates the file system during recovery, but it will be empty. You can use this for file systems that contain temporary data and do not require preserving, or for data that is backed up by using methods independent of ReaR.

Verification

1. To ensure that the layout file includes only the required storage components, do the following:

   a. Re-generate the layout file.

   ```
   # rear savelayout
   ```

   b. Open the new layout file and make sure that your configuration changes had the intended effect.

   ```
   # vi /var/lib/rear/layout/disklayout.conf
   ```

2. To ensure that the backup excludes specific files, use the **rear mkbackup** command. This lists the backup exclude patterns in the log.
   You can find the log file in the **/var/log/rear** directory. Use this to verify the exclude rules before performing a full system recovery. For example, the log can contain the following entries:

   ```
   2025-04-29 10:17:41.312431050 Making backup (using backup method NETFS)
   2025-04-29 10:17:41.314369109 Backup include list (backup-include.txt contents):
   2025-04-29 10:17:41.316197323   /
   2025-04-29 10:17:41.318052001 Backup exclude list (backup-exclude.txt contents):
   2025-04-29 10:17:41.319857125   /tmp/*
   2025-04-29 10:17:41.321644442   /dev/shm/*
   2025-04-29 10:17:41.323436363   /var/lib/rear/output/*
   ```

   In this example, the entire root file system is included in the backup, with the exception of all files and directories under the **/tmp**, **/dev/shm** and **/var/lib/rear/output** directories.