Red Hat Enterprise Linux 9

Configuring basic system settings

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

Last Updated: 2023-05-11

Red Hat Enterprise Linux 9 Configuring basic system settings

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

Legal Notice

Abstract

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

Table of Contents

MAKING OPEN SOURCE MORE INCLUSIVE

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

PROVIDING FEEDBACK ON RED HAT DOCUMENTATION

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

Submitting comments on specific passages

1. View the documentation in the **Multi-page HTML** format and ensure that you see the **Feedback** button in the upper right corner after the page fully loads.

2. Use your cursor to highlight the part of the text that you want to comment on.

3. Click the **Add Feedback** button that appears near the highlighted text.

4. Add your feedback and click **Submit**.

Submitting feedback through Bugzilla (account required)

1. Log in to the Bugzilla website.

2. Select the correct version from the **Version** menu.

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 **Submit Bug**.

CHAPTER 1. PREPARING A CONTROL NODE AND MANAGED NODES TO USE RHEL SYSTEM ROLES

Before you can use individual RHEL System Roles to manage services and settings, you must prepare the control node and managed nodes.

1.1. PREPARING A CONTROL NODE ON RHEL 9

Before using RHEL System Roles, you must configure a control node. This system then configures the managed hosts from the inventory according to the playbooks.

Prerequisites

- RHEL 8.6 or later is installed. For more information about installing RHEL, see Performing a standard RHEL 9 installation.
- The system is registered to the Customer Portal.
- A **Red Hat Enterprise Linux Server** subscription is attached to the system.
- If available in your Customer Portal account, an **Ansible Automation Platform** subscription is attached to the system.

Procedure

1. Install the **rhel-system-roles** package:

   ```
   [root@control-node]# dnf install rhel-system-roles
   ```

   This command installs the **ansible-core** package as a dependency.

   NOTE

   In RHEL 8.5 and earlier versions, Ansible packages were provided through Ansible Engine instead of Ansible Core, and with a different level of support. Do not use Ansible Engine because the packages might not be compatible with Ansible automation content in RHEL 8.6 and later. For more information, see Scope of support for the Ansible Core package included in the RHEL 9 and RHEL 8.6 and later AppStream repositories.

2. Create a user named **ansible** to manage and run playbooks:

   ```
   [root@control-node]# useradd ansible
   ```

3. Switch to the newly created **ansible** user:

   ```
   [root@control-node]# su - ansible
   ```

   Perform the rest of the procedure as this user.

4. Create an SSH public and private key:

   ```
   [ansible@control-node]$ ssh-keygen
   ```

```
Generating public/private rsa key pair.
Enter file in which to save the key (/home/ansible/.ssh/id_rsa): <password>
...
```

Use the suggested default location for the key file.

5. Optional: To prevent Ansible from prompting you for the SSH key password each time you establish a connection, configure an SSH agent.

6. Create the ~/**.ansible.cfg** file with the following content:

```
[defaults]
inventory = /home/ansible/inventory
remote_user = ansible

[privilege_escalation]
become = True
become_method = sudo
become_user = root
become_ask_pass = True
```

NOTE

Settings in the ~/**.ansible.cfg** file have a higher priority and override settings from the global /**etc/ansible/ansible.cfg** file.

With these settings, Ansible performs the following actions:

- Manages hosts in the specified inventory file.
- Uses the account set in the **remote_user** parameter when it establishes SSH connections to managed nodes.
- Uses the **sudo** utility to execute tasks on managed nodes as the **root** user.
- Prompts for the root password of the remote user every time you apply a playbook. This is recommended for security reasons.

7. Create an ~/**inventory** file in INI or YAML format that lists the hostnames of managed hosts. You can also define groups of hosts in the inventory file. For example, the following is an inventory file in the INI format with three hosts and one host group named **US**:

```
managed-node-01.example.com

[US]
managed-node-02.example.com ansible_host=192.0.2.100
managed-node-03.example.com
```

Note that the control node must be able to resolve the hostnames. If the DNS server cannot resolve certain hostnames, add the **ansible_host** parameter next to the host entry to specify its IP address.

Next steps

- Prepare the managed nodes. For more information, see Preparing a managed node.

Additional resources

- Scope of support for the Ansible Core package included in the RHEL 9 and RHEL 8.6 and later AppStream repositories
- How to register and subscribe a system to the Red Hat Customer Portal using subscription-manager
- The **ssh-keygen(1)** man page
- Connecting to remote machines with SSH keys using ssh-agent
- Ansible configuration settings
- How to build your inventory

1.2. PREPARING A MANAGED NODE

Managed nodes are the systems listed in the inventory and which will be configured by the control node according to the playbook. You do not have to install Ansible on managed hosts.

Prerequisites

- You prepared the control node. For more information, see Preparing a control node on RHEL 9 .
- You have SSH access from the control node.

> **IMPORTANT**
>
> Direct SSH access as the **root** user is a security risk. To reduce this risk, you will create a local user on this node and configure a **sudo** policy when preparing a managed node. Ansible on the control node can then use the local user account to log in to the managed node and run playbooks as different users, such as **root**.

Procedure

1. Create a user named **ansible**:

   ```
   [root@managed-node-01]# useradd ansible
   ```

   The control node later uses this user to establish an SSH connection to this host.

2. Set a password for the **ansible** user:

   ```
   [root@managed-node-01]# passwd ansible
   Changing password for user ansible.
   New password: <password>
   Retype new password: <password>
   passwd: all authentication tokens updated successfully.
   ```

   You must enter this password when Ansible uses **sudo** to perform tasks as the **root** user.

3. Install the **ansible** user's SSH public key on the managed node:

a. Log in to the control node as the **ansible** user, and copy the SSH public key to the managed node:

```
[ansible@control-node]$ ssh-copy-id managed-node-01.example.com
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed:
"/home/ansible/.ssh/id_rsa.pub"
The authenticity of host 'managed-node-01.example.com (192.0.2.100)' can't be
established.
ECDSA key fingerprint is
SHA256:9bZ33GJNODK3zbNhybokN/6Mq7hu3vpBXDrCxe7NAvo.
```

b. When prompted, connect by entering **yes**:

```
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that
are already installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is
to install the new keys
```

c. When prompted, enter the password:

```
ansible@managed-node-01.example.com's password: <password>

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh '<managed-node-01.example.com>'"
and check to make sure that only the key(s) you wanted were added.
```

d. Verify the SSH connection by remotely executing a command on the control node:

```
[ansible@control-node]$ ssh <managed-node-01.example.com> whoami
ansible
```

4. Create a **sudo** configuration for the **ansible** user:

a. Create and edit the **/etc/sudoers.d/ansible** file by using the **visudo** command:

```
[root@managed-node-01]# visudo /etc/sudoers.d/ansible
```

The benefit of using **visudo** over a normal editor is that this utility provides basic sanity checks and checks for parse errors before installing the file.

b. Configure a **sudoers** policy in the **/etc/sudoers.d/ansible** file that meets your requirements, for example:

- To grant permissions to the **ansible** user to run all commands as any user and group on this host after entering the **ansible** user's password, use:

```
ansible ALL=(ALL) ALL
```

- To grant permissions to the **ansible** user to run all commands as any user and group on this host without entering the **ansible** user's password, use:

```
ansible ALL=(ALL) NOPASSWD: ALL
```

Alternatively, configure a more fine-granular policy that matches your security requirements. For further details on **sudoers** policies, see the **sudoers(5)** man page.

Verification

1. Verify that you can execute commands from the control node on an all managed nodes:

   ```
   [ansible@control-node]$ ansible all -m ping
   BECOME password: <password>
   managed-node-01.example.com | SUCCESS => {
       "ansible_facts": {
           "discovered_interpreter_python": "/usr/bin/python3"
       },
       "changed": false,
       "ping": "pong"
   }
   ...
   ```

   The hard-coded all group dynamically contains all hosts listed in the inventory file.

2. Verify that privilege escalation works correctly by running the **whoami** utility on a managed host by using the Ansible **command** module:

   ```
   [ansible@control-node]$ ansible managed-node-01.example.com -m command -a
   whoami
   BECOME password: <password>
   managed-node-01.example.com | CHANGED | rc=0 >>
   root
   ```

   If the command returns root, you configured **sudo** on the managed nodes correctly.

Additional resources

- Preparing a control node on RHEL 9 .
- The **sudoers(5)** man page

CHAPTER 2. 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

2.1. 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 .

2.1.1. Displaying the current date and time

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

Procedure

1. Enter the **date** command:

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

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

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

Additional resources

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

2.2. CONFIGURING THE SYSTEM LOCALE

System-wide locale settings are stored in the **/etc/locale.conf** file, which 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.

This section describes how to manage system locale.

Procedure

- To list available system locale settings:

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

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

  ```
  $ localectl status
  ```

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

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

Additional resources

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

2.3. CONFIGURING THE KEYBOARD LAYOUT

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

Procedure

- To list available keymaps:

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

- To display the current status of keymaps settings:

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

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

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

Additional resources

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

2.4. CHANGING THE LANGUAGE USING DESKTOP GUI

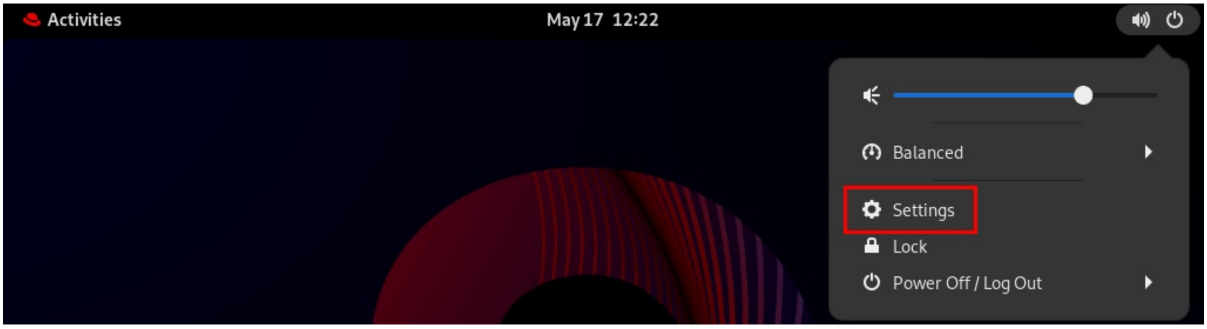
This section describes how to change the system language using the desktop GUI.

Prerequisites

- Required language packages are installed on your system

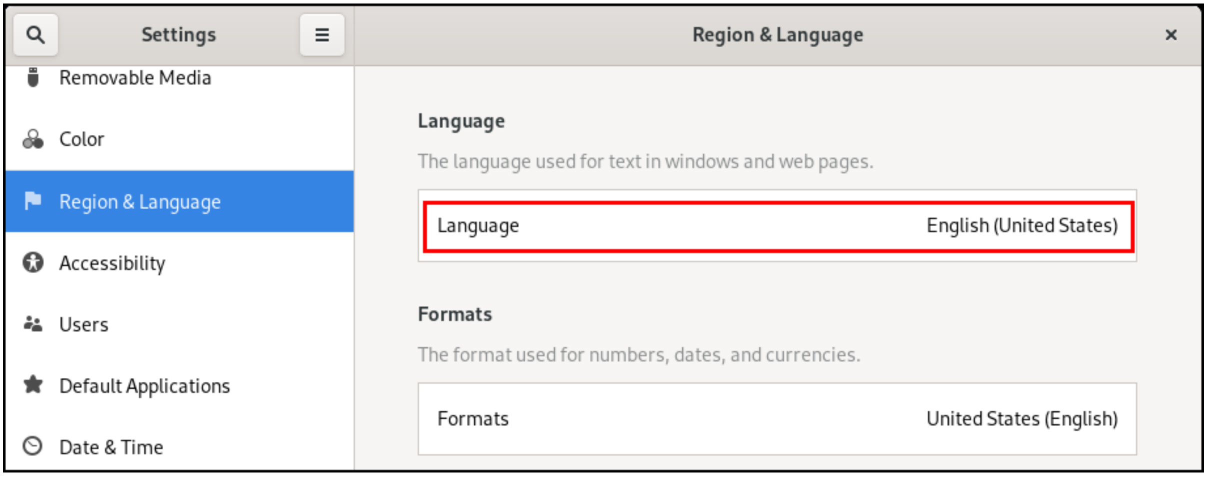
Procedure

1. Open the **Settings** application from the system menu by clicking on its icon.



2. In **Settings**, choose **Region & Language** from the left side bar.

3. Click the **Language** menu.



Language

The language used for text in windows and web pages.

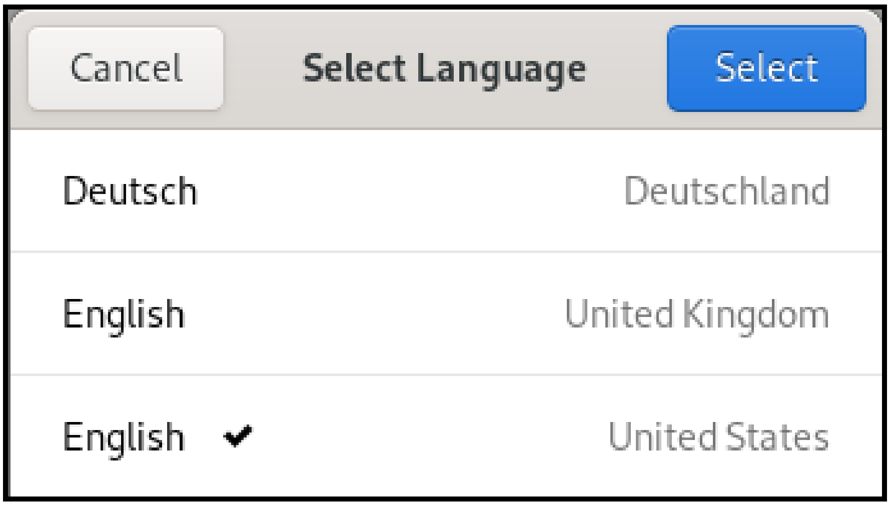
Language: English (United States)

Formats

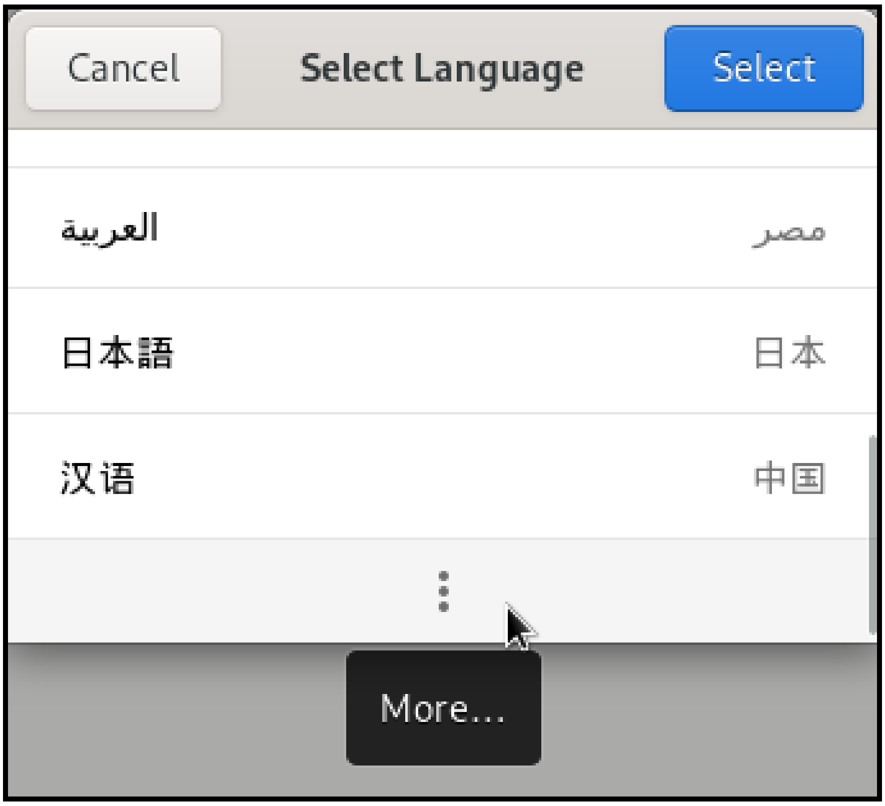
The format used for numbers, dates, and currencies.

Formats: United States (English)

4. Select the required region and language from the menu.

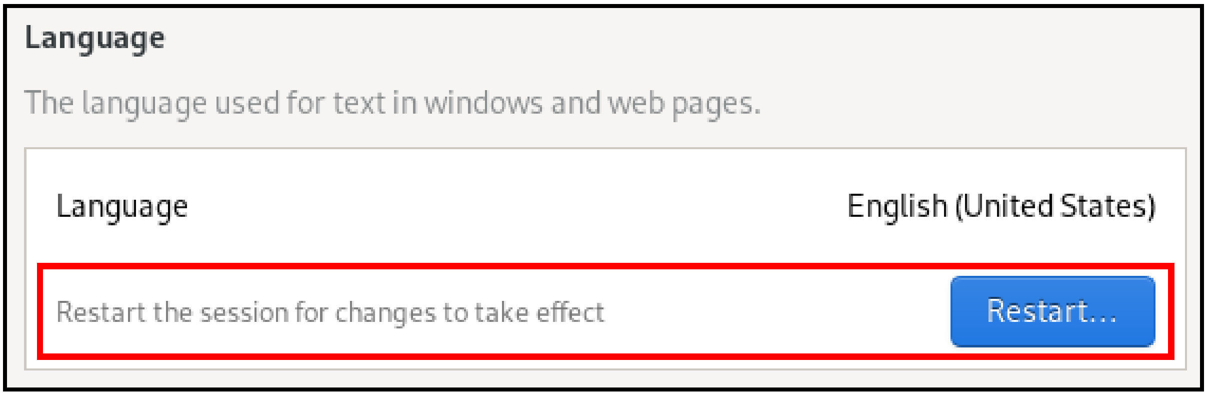


If your region and language are not listed, scroll down, and click **More** to select from available regions and languages.



5. Click **Done**.

6. Click **Restart** for changes to take effect.



The language used for text in windows and web pages.

Language English (United States)

Restart the session for changes to take effect

NOTE

Some applications do not support certain languages. The text of an application that cannot be translated into the selected language remains in US English.

Additional resources

- Launching applications in GNOME

2.5. ADDITIONAL RESOURCES

- Performing a standard RHEL 9 installation

CHAPTER 3. CONFIGURING AND MANAGING NETWORK ACCESS

This section describes different options on how to add Ethernet connections in Red Hat Enterprise Linux.

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

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

Procedure

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

   NOTE

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

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

   NOTE

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

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

NOTE

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

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

Additional resources

- Performing an advanced RHEL 9 installation

3.2. CONFIGURING AN ETHERNET CONNECTION WITH A STATIC IP ADDRESS BY USING NMCLI

To configure an Ethernet connection on the command line, use the **nmcli** utility.

For example, the procedure below creates a NetworkManager connection profile for the **enp7s0** device with the following settings:

- A static IPv4 address - **192.0.2.1** with a /**24** subnet mask
- A static IPv6 address - **2001:db8:1::1** with a /**64** subnet mask
- An IPv4 default gateway - **192.0.2.254**
- An IPv6 default gateway - **2001:db8:1::fffe**
- An IPv4 DNS server - **192.0.2.200**

- An IPv6 DNS server - **2001:db8:1::ffbb**
- A DNS search domain - **example.com**

Prerequisites

- A physical or virtual Ethernet device exists in the server’s configuration.

Procedure

1. Add a new NetworkManager connection profile for the Ethernet connection:

```
# nmcli connection add con-name Example-Connection ifname enp7s0 type ethernet
```

   The further steps modify the **Example-Connection** connection profile you created.

2. Set the IPv4 address:

```
# nmcli connection modify Example-Connection ipv4.addresses 192.0.2.1/24
```

3. Set the IPv6 address:

```
# nmcli connection modify Example-Connection ipv6.addresses 2001:db8:1::1/64
```

4. Set the IPv4 and IPv6 connection method to **manual**:

```
# nmcli connection modify Example-Connection ipv4.method manual
# nmcli connection modify Example-Connection ipv6.method manual
```

5. Set the IPv4 and IPv6 default gateways:

```
# nmcli connection modify Example-Connection ipv4.gateway 192.0.2.254
# nmcli connection modify Example-Connection ipv6.gateway 2001:db8:1::fffe
```

6. Set the IPv4 and IPv6 DNS server addresses:

```
# nmcli connection modify Example-Connection ipv4.dns "192.0.2.200"
# nmcli connection modify Example-Connection ipv6.dns "2001:db8:1::ffbb"
```

   To set multiple DNS servers, specify them space-separated and enclosed in quotes.

7. Set the DNS search domain for the IPv4 and IPv6 connection:

```
# nmcli connection modify Example-Connection ipv4.dns-search example.com
# nmcli connection modify Example-Connection ipv6.dns-search example.com
```

8. Activate the connection profile:

```
# nmcli connection up Example-Connection
Connection successfully activated (D-Bus active path:
/org/freedesktop/NetworkManager/ActiveConnection/13)
```

Verification

1. Display the status of the devices and connections:

```
# nmcli device status
DEVICE      TYPE      STATE      CONNECTION
enp7s0      ethernet  connected  Example-Connection
```

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

```
# ping host_name_or_IP_address
```

Troubleshooting

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

Additional resources

- **nm-settings(5)** man page
- **nmcli(1)** man page
- Configuring NetworkManager to avoid using a specific profile to provide a default gateway

3.3. CONFIGURING AN ETHERNET CONNECTION WITH A DYNAMIC IP ADDRESS BY USING NMTUI

The **nmtui** application provides a text-based user interface for NetworkManager. You can use **nmtui** to configure an Ethernet connection with a dynamic IP address 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 deselect checkboxes by using **Space**.

Prerequisites

- A physical or virtual Ethernet device exists in the server’s configuration.

- A DHCP server is available in the network.

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
enp7s0    ethernet  unavailable     --
...
```

2. Start **nmtui**:

```
# nmtui
```

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

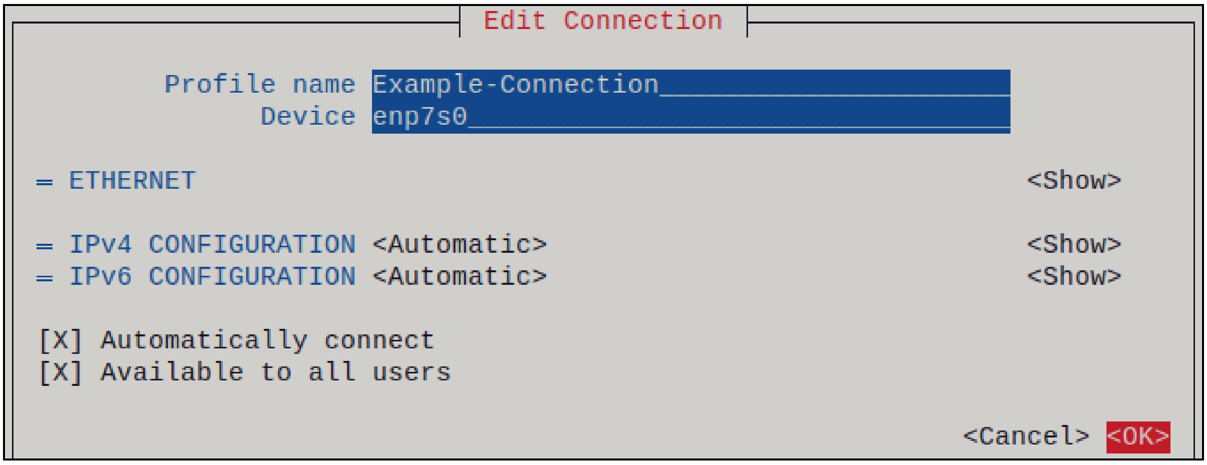
4. Press the **Add** button.

5. Select **Ethernet** from the list of network types, and press **Enter**.

6. Optional: Enter a name for the NetworkManager profile to be created.

7. Enter the network device name into the **Device** field.

8. Press the **OK** button to create and automatically activate the new connection.



```
                         Edit Connection

        Profile name Example-Connection________________________
              Device enp7s0____________________________________

 ═ ETHERNET                                                 <Show>

 ═ IPv4 CONFIGURATION <Automatic>                           <Show>
 ═ IPv6 CONFIGURATION <Automatic>                           <Show>

 [X] Automatically connect
 [X] Available to all users

                                                      <Cancel> <OK>
```

9. Press the **Back** button to return to the main menu.

10. Select **Quit**, and press **Enter** to close the **nmtui** application.

Verification

1. Display the status of the devices and connections:

```
# nmcli device status
DEVICE    TYPE      STATE      CONNECTION
enp7s0    ethernet  connected  Example-Connection
```

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

```
# ping host_name_or_IP_address
```

Troubleshooting

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

Additional resources

- Configuring NetworkManager to avoid using a specific profile to provide a default gateway

3.4. CONFIGURING AN ETHERNET CONNECTION WITH A STATIC IP ADDRESS BY USING NMTUI

The **nmtui** application provides a text-based user interface for NetworkManager. You can use **nmtui** to configure an Ethernet connection with a static IP address 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 deselect checkboxes by using **Space**.

Prerequisites

- A physical or virtual Ethernet device 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
enp7s0     ethernet  unavailable             --
...
```

2. Start **nmtui**:

```
# nmtui
```

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

4. Press the **Add** button.

5. Select **Ethernet** from the list of network types, and press **Enter**.

6. Optional: Enter a name for the NetworkManager profile to be created.

7. Enter the network device name into the **Device** field.

8. Configure the IPv4 and IPv6 address settings in the **IPv4 configuration** and **IPv6 configuration** areas:

    a. Press the **Automatic** button, and select **Manual** from the displayed list.

    b. Press the **Show** button next to the protocol you want to configure to display additional fields.

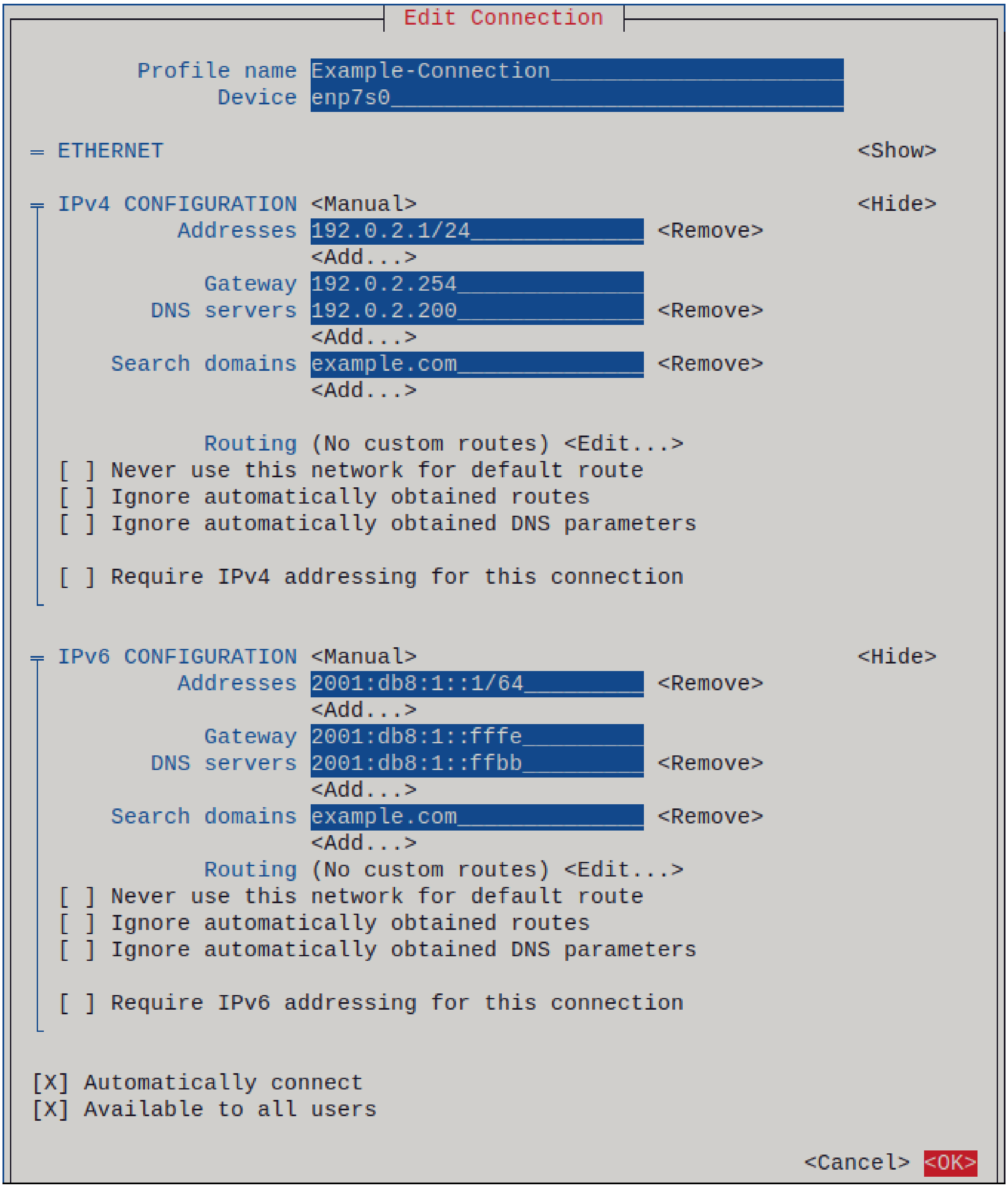
    c. Press the **Add** button next to **Addresses**, and enter the IP address and the subnet mask in Classless Inter-Domain Routing (CIDR) format.
    If you do not specify a subnet mask, NetworkManager sets a /**32** subnet mask for IPv4 addresses and /**64** for IPv6 addresses.

    d. Enter the address of the default gateway.

    e. Press the **Add** button next to **DNS servers**, and enter the DNS server address.

    f. Press the **Add** button next to **Search domains**, and enter the DNS search domain.

Figure 3.1. Example of an Ethernet connection with static IP address settings



```
                         Edit Connection

        Profile name Example-Connection________________________
              Device enp7s0____________________________________

 = ETHERNET                                                   <Show>

 ╤ IPv4 CONFIGURATION <Manual>                                <Hide>
 │          Addresses 192.0.2.1/24_____________ <Remove>
 │                    <Add...>
 │            Gateway 192.0.2.254______________
 │        DNS servers 192.0.2.200______________ <Remove>
 │                    <Add...>
 │     Search domains example.com______________ <Remove>
 │                    <Add...>
 │
 │            Routing (No custom routes) <Edit...>
 │  [ ] Never use this network for default route
 │  [ ] Ignore automatically obtained routes
 │  [ ] Ignore automatically obtained DNS parameters
 │
 │  [ ] Require IPv4 addressing for this connection
 └

 ╤ IPv6 CONFIGURATION <Manual>                                <Hide>
 │          Addresses 2001:db8:1::1/64_________ <Remove>
 │                    <Add...>
 │            Gateway 2001:db8:1::fffe_________
 │        DNS servers 2001:db8:1::ffbb_________ <Remove>
 │                    <Add...>
 │     Search domains example.com______________ <Remove>
 │                    <Add...>
 │            Routing (No custom routes) <Edit...>
 │  [ ] Never use this network for default route
 │  [ ] Ignore automatically obtained routes
 │  [ ] Ignore automatically obtained DNS parameters
 │
 │  [ ] Require IPv6 addressing for this connection
 └

 [X] Automatically connect
 [X] Available to all users

                                                         <Cancel> <OK>
```

9. Press the **OK** button to create and automatically activate the new connection.

10. Press the **Back** button to return to the main menu.

11. Select **Quit**, and press **Enter** to close the **nmtui** application.

Verification

1. Display the status of the devices and connections:

```
# nmcli device status
DEVICE    TYPE      STATE      CONNECTION
enp7s0    ethernet  connected  Example-Connection
```

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

   ```
   # ping host_name_or_IP_address
   ```

Troubleshooting

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

Additional resources

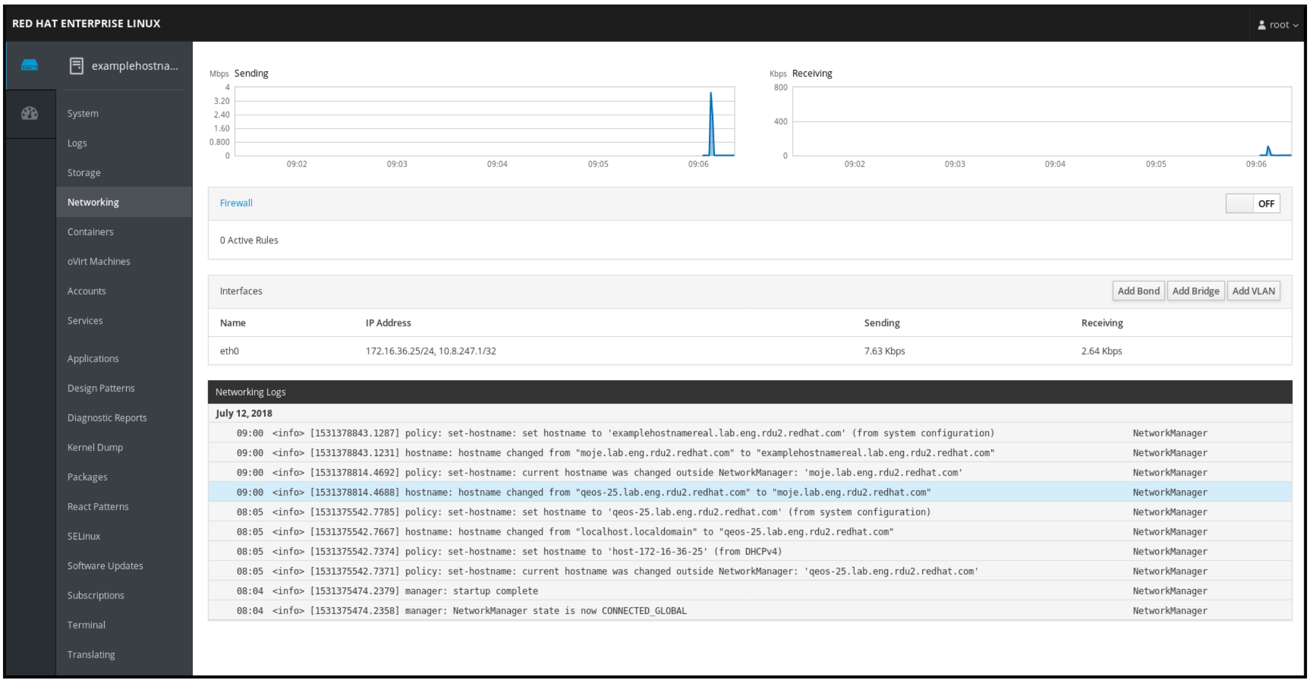
- Configuring NetworkManager to avoid using a specific profile to provide a default gateway

3.5. MANAGING NETWORKING IN THE RHEL WEB CONSOLE

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

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

Figure 3.2. Managing Networking in the RHEL web console



0 Active Rules

Interfaces

Name	IP Address	Sending	Receiving
eth0	172.16.36.25/24, 10.8.247.1/32	7.63 Kbps	2.64 Kbps

Networking Logs

July 12, 2018

```
09:00  <info> [1531378843.1287] policy: set-hostname: set hostname to 'examplehostnamereal.lab.eng.rdu2.redhat.com' (from system configuration)       NetworkManager
09:00  <info> [1531378843.1231] hostname: hostname changed from "moje.lab.eng.rdu2.redhat.com" to "examplehostnamereal.lab.eng.rdu2.redhat.com"       NetworkManager
09:00  <info> [1531378814.4692] policy: set-hostname: current hostname was changed outside NetworkManager: 'moje.lab.eng.rdu2.redhat.com'             NetworkManager
09:00  <info> [1531378814.4688] hostname: hostname changed from "qeos-25.lab.eng.rdu2.redhat.com" to "moje.lab.eng.rdu2.redhat.com"                   NetworkManager
08:05  <info> [1531375542.7785] policy: set-hostname: set hostname to 'qeos-25.lab.eng.rdu2.redhat.com' (from system configuration)                   NetworkManager
08:05  <info> [1531375542.7667] hostname: hostname changed from "localhost.localdomain" to "qeos-25.lab.eng.rdu2.redhat.com"                          NetworkManager
08:05  <info> [1531375542.7374] policy: set-hostname: set hostname to 'host-172-16-36-25' (from DHCPv4)                                               NetworkManager
08:05  <info> [1531375542.7371] policy: set-hostname: current hostname was changed outside NetworkManager: 'qeos-25.lab.eng.rdu2.redhat.com'          NetworkManager
08:04  <info> [1531375474.2379] manager: startup complete                                                                                             NetworkManager
08:04  <info> [1531375474.2358] manager: NetworkManager state is now CONNECTED_GLOBAL                                                                 NetworkManager
```

3.6. MANAGING NETWORKING USING RHEL SYSTEM ROLES

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

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

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

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

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

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

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

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

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

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

Additional resources

- Preparing a control node and managed nodes to use RHEL System Roles

3.7. ADDITIONAL RESOURCES

- Configuring and managing networking

CHAPTER 4. REGISTERING THE SYSTEM AND MANAGING SUBSCRIPTIONS

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

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

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

4.1. REGISTERING THE SYSTEM AFTER THE INSTALLATION

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

Prerequisites

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

Procedure

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

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

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

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

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

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

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

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

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

NOTE

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

Additional resources

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

4.2. REGISTERING SUBSCRIPTIONS WITH CREDENTIALS IN THE WEB CONSOLE

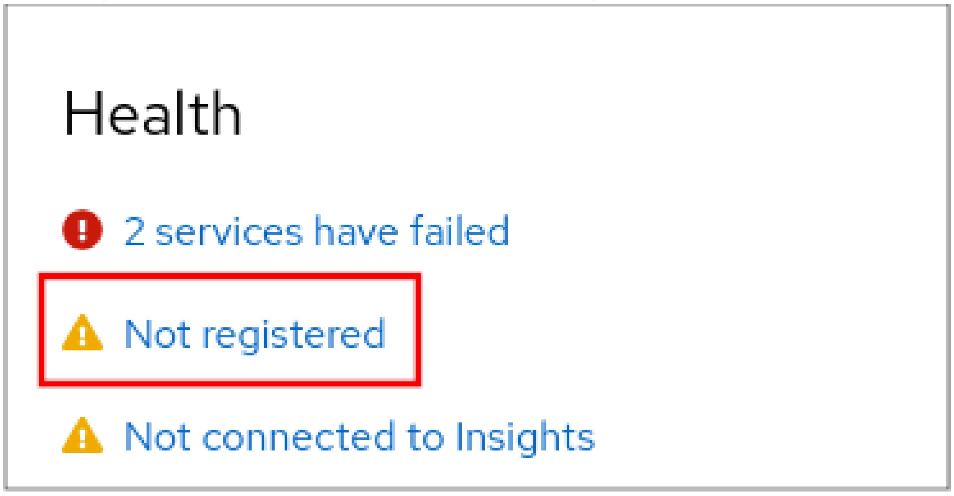
Use the following steps to register a newly installed Red Hat Enterprise Linux with account credentials using the RHEL web console.

Prerequisites

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

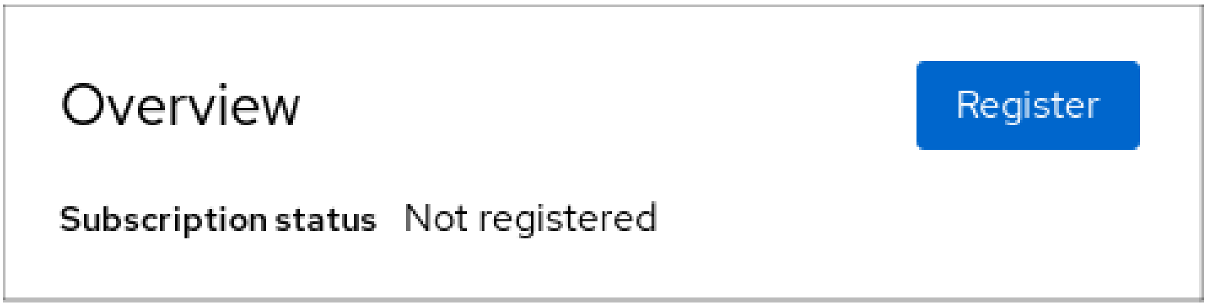
Procedure

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



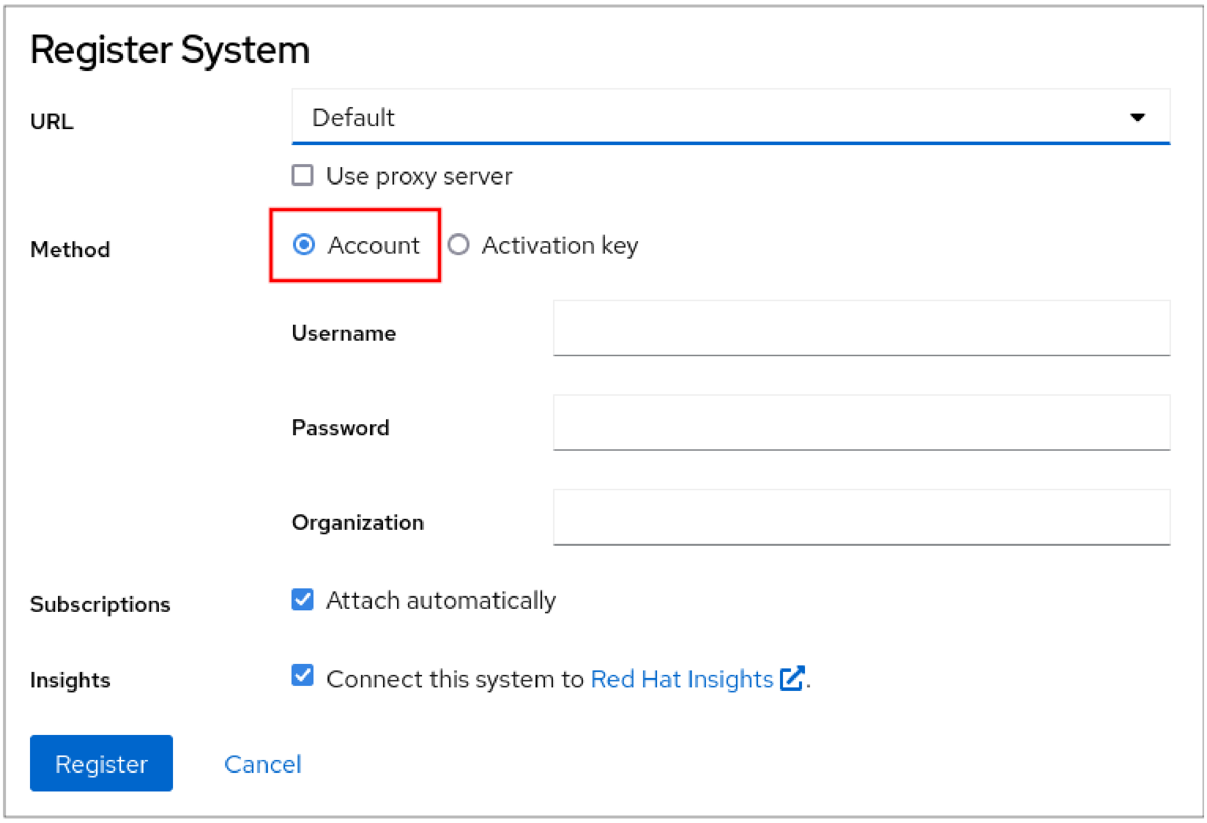
.

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



Subscription status Not registered

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



URL Default

☐ Use proxy server

Method ● Account ○ Activation key

Username

Password

Organization

Subscriptions ☑ Attach automatically

Insights ☑ Connect this system to Red Hat Insights.

5. Enter your username.

6. Enter your password.

7. Optionally, enter your organization’s name or ID.
   If your account belongs to more than one organization on the Red Hat Customer Portal, you have to add the organization name or organization ID. To get the org ID, go to your Red Hat contact point.

   - If you do not want to connect your system to Red Hat Insights, clear the **Insights** check box.

8. Click the **Register** button.

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

4.3. REGISTERING A SYSTEM USING RED HAT ACCOUNT ON GNOME

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

Prerequisites

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

Procedure

1. Open the **system menu**, which is accessible from the upper-right screen corner, and click **Settings**.
2. Go to **About** → **Subscription**.
3. If you are not using the Red Hat server:
   a. In the **Registration Server** section, select **Custom Address**.
   b. Enter the server address in the **URL** field.
4. In the **Registration Type** section, select **Red Hat Account**.
5. In the **Registration Details** section:
   - Enter your Red Hat account user name in the **Login** field.
   - Enter your Red Hat account password in the **Password** field.
   - Enter the name of your organization in the **Organization** field.
6. Click **Register**.

4.4. REGISTERING A SYSTEM USING AN ACTIVATION KEY ON GNOME

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

Prerequisites

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

Procedure

1. Open the **system menu**, which is accessible from the upper-right screen corner, and click **Settings**.
2. Go to **About** → **Subscription**.
3. If you are not using the Red Hat server:
   a. In the **Registration Server** section, select **Custom Address**.
   b. Enter the server address in the **URL** field.
4. In the **Registration Type** section, select **Activation Keys**.
5. Under **Registration Details**:
   - Enter your activation keys in the **Activation Keys** field.

Separate your keys by a comma (**,**).

- Enter the name or ID of your organization in the **Organization** field.

6. Click **Register**.

CHAPTER 5. MAKING SYSTEMD SERVICES START AT BOOT TIME

As a system administrator, you can determine how services start on your system. For managing services, you can use the **systemctl** command-line utility for controlling the **systemd** system and service manager, or you can use the RHEL web console.

5.1. ENABLING OR DISABLING SERVICES

As a system administrator, you can enable or disable a service to start at boot, these changes apply with the next reboot. If you want a service to start automatically at boot, you must enable this service. 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 must have root access to the system.
- The service you want to enable must not be masked. If you have a masked service, you must unmask it first:

  ```
  # systemctl unmask service_name
  ```

Procedure

1. Enable a service to start at boot:

   ```
   # systemctl enable service_name
   ```

   Replace *service_name* with the service you want to enable.

   You can also enable and start a service in a single command:

   ```
   # systemctl enable --now service_name
   ```

2. Disable a service to start at boot:

   ```
   # systemctl disable service_name
   ```

   Replace *service_name* with the service you want to disable.

   If you want to make a service permanently unusable, mask the service:

   ```
   # systemctl mask service_name
   ```

CHAPTER 6. CONFIGURING SYSTEM SECURITY

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

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

6.1. ENABLING THE FIREWALLD SERVICE

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

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

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

Procedure

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

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

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

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

Verification steps

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

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

Additional resources

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

6.2. MANAGING BASIC SELINUX SETTINGS

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

SELinux has two possible states:

- Disabled
- Enabled

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

- Enabled
  - Enforcing
  - Permissive

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

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

Additional resources

- Using SELinux

6.3. ENSURING THE REQUIRED STATE OF SELINUX

By default, SELinux operates in enforcing mode. However, in specific scenarios, you can set SELinux to permissive mode or even disable it.

IMPORTANT

Red Hat recommends to keep your system in enforcing mode. For debugging purposes, you can set SELinux to permissive mode.

Follow this procedure to change the state and mode of SELinux on your system.

Procedure

1. Display the current SELinux mode:

```
$ getenforce
```

2. To temporarily set SELinux:

   a. To Enforcing mode:

```
# setenforce Enforcing
```

b. To Permissive mode:

```
# setenforce Permissive
```

NOTE

After reboot, SELinux mode is set to the value specified in the **/etc/selinux/config** configuration file.

3. To set SELinux mode to persist across reboots, modify the **SELINUX** variable in the **/etc/selinux/config** configuration file.
   For example, to switch SELinux to enforcing mode:

```
# This file controls the state of SELinux on the system.
# SELINUX= can take one of these three values:
#     enforcing - SELinux security policy is enforced.
#     permissive - SELinux prints warnings instead of enforcing.
#     disabled - No SELinux policy is loaded.
SELINUX=enforcing
...
```

WARNING

Disabling SELinux reduces your system security. Avoid disabling SELinux using the **SELINUX=disabled** option in the **/etc/selinux/config** file because this can result in memory leaks and race conditions causing kernel panics. Instead, disable SELinux by adding the **selinux=0** parameter to the kernel command line. For more information, see Changing SELinux modes at boot time.

Additional resources

- Changing SELinux states and modes

6.4. ADDITIONAL RESOURCES

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

CHAPTER 7. GETTING STARTED WITH MANAGING USER ACCOUNTS

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

The following are the different types of user accounts:

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

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

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

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

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

7.1. MANAGING ACCOUNTS AND GROUPS USING COMMAND LINE TOOLS

This section describes basic command-line tools to manage user accounts and groups.

- To display user and group IDs:

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

- To create a new user account:

```
# useradd example.user
```

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

  ```
  # passwd example.user
  ```

- To add a user to a group:

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

Additional resources

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

7.2. SYSTEM USER ACCOUNTS MANAGED IN THE WEB CONSOLE

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

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

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

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

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

7.3. ADDING NEW ACCOUNTS USING THE WEB CONSOLE

Use the following steps for adding user accounts to the system and setting administration rights to the accounts through the RHEL web console.

Prerequisites

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

Procedure

1. Log in to the RHEL web console.
2. Click **Accounts**.
3. Click **Create New Account**.
4. In the **Full Name** field, enter the full name of the user.

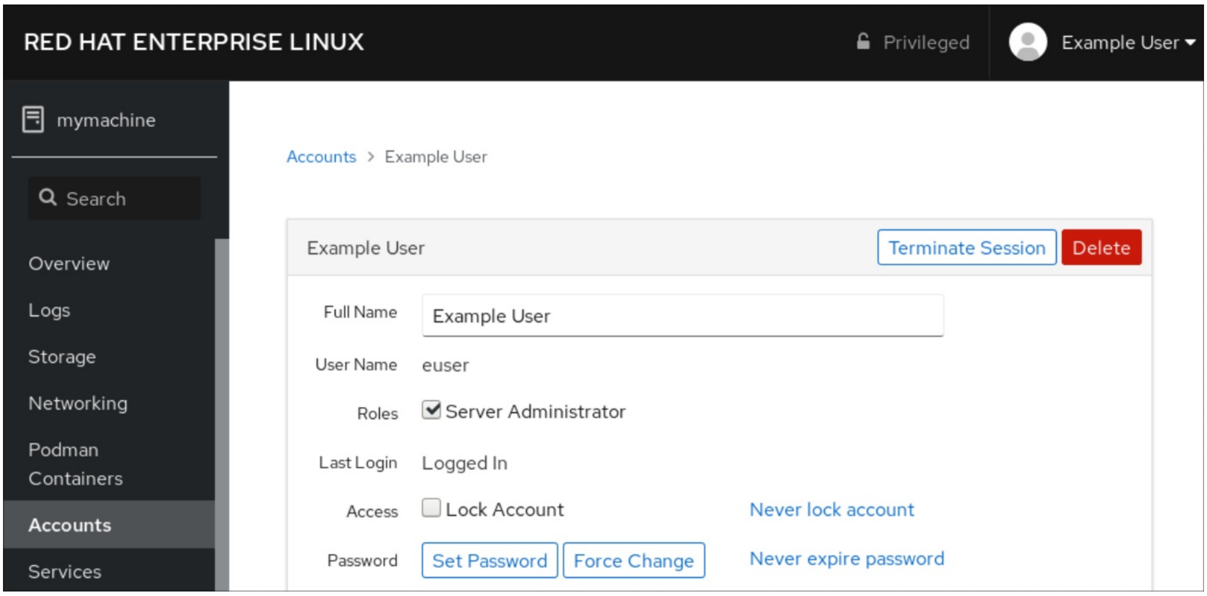
The RHEL web console automatically suggests a user name from the full name and fills it in the **User Name** field. If you do not want to use the original naming convention consisting of the first letter of the first name and the whole surname, update the suggestion.

5. In the **Password/Confirm** fields, enter the password and retype it for verification that your password is correct.
   The color bar below the fields shows you the security level of the entered password, which does not allow you to create a user with a weak password.

6. Click **Create** to save the settings and close the dialog box.

7. Select the newly created account.

8. Select **Server Administrator** in the **Roles** item.



Full Name: Example User

User Name: euser

Roles: ☑ Server Administrator

Last Login: Logged In

Access: □ Lock Account

Password

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

CHAPTER 8. DUMPING A CRASHED KERNEL FOR LATER ANALYSIS

To analyze why a system crashed, you can use the **kdump** service to save the contents of the system's memory for later analysis. This section provides a brief introduction to **kdump**, and information about configuring **kdump** using the RHEL web console or using the corresponding RHEL system role.

8.1. WHAT IS KDUMP

kdump is a service which provides a crash dumping mechanism. The service enables you to save the contents of the system memory for analysis. **kdump** uses the **kexec** system call to boot into the second kernel (a *capture kernel*) without rebooting; and then captures the contents of the crashed kernel's memory (a *crash dump* or a *vmcore*) and saves it into a file. The second kernel resides in a reserved part of the system memory.

IMPORTANT

A kernel crash dump can be the only information available in the event of a system failure (a critical bug). Therefore, operational **kdump** is important in mission-critical environments. Red Hat advise that system administrators regularly update and test **kexec-tools** in your normal kernel update cycle. This is especially important when new kernel features are implemented.

You can enable **kdump** for all installed kernels on a machine or only for specified kernels. This is useful when there are multiple kernels used on a machine, some of which are stable enough that there is no concern that they could crash.

When **kdump** is installed, a default **/etc/kdump.conf** file is created. The file includes the default minimum **kdump** configuration. You can edit this file to customize the **kdump** configuration, but it is not required.

8.2. CONFIGURING KDUMP MEMORY USAGE AND TARGET LOCATION IN WEB CONSOLE

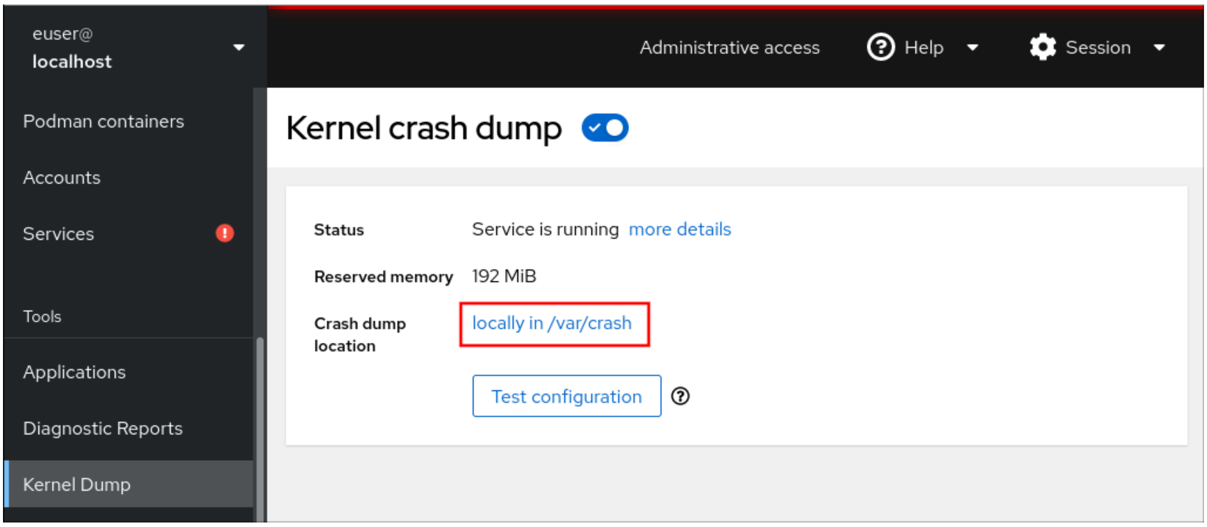
The procedure below shows you how to use the **Kernel Dump** tab in the RHEL web console interface to configure the amount of memory that is reserved for the **kdump** kernel. The procedure also describes how to specify the target location of the **vmcore** dump file and how to test your configuration.

Procedure

1. Open the **Kernel Dump** tab and start the **kdump** service.

2. Configure the **kdump** memory usage using the command line.

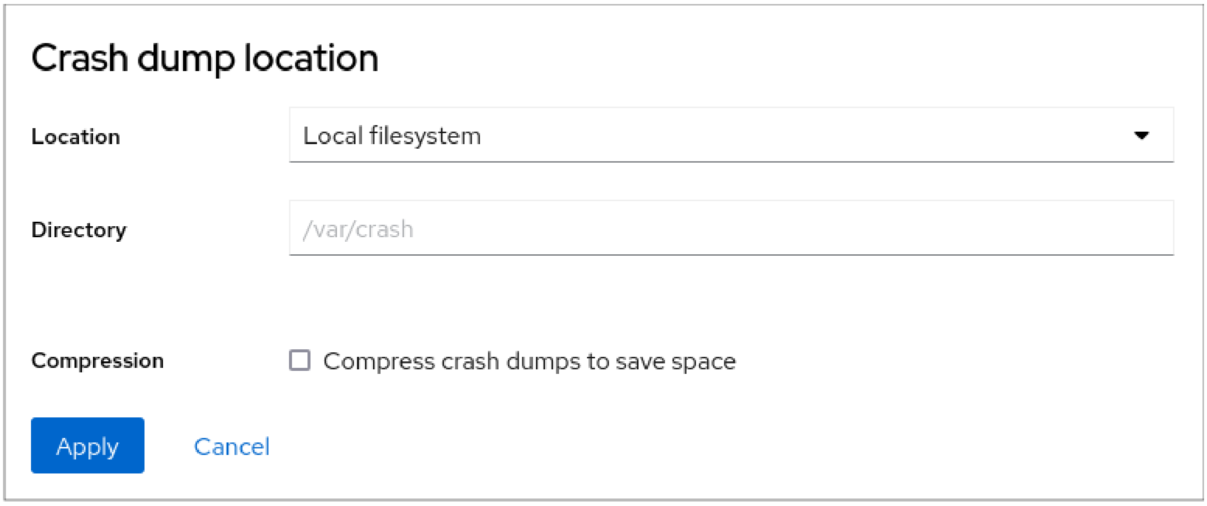
3. Click the link next to the **Crash dump location** option.



Kernel crash dump

Status	Service is running more details
Reserved memory	192 MiB
Crash dump location	locally in /var/crash

4. Select the **Local Filesystem** option from the drop-down and specify the directory you want to save the dump in.



Crash dump location

Location	Local filesystem
Directory	/var/crash
Compression	□ Compress crash dumps to save space

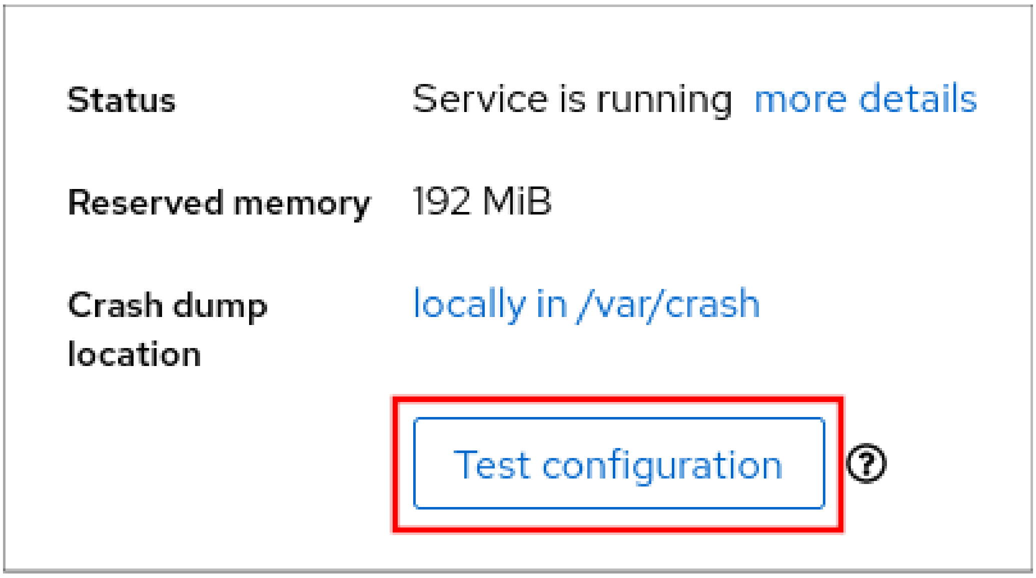
- Alternatively, select the **Remote over SSH** option from the drop-down to send the vmcore to a remote machine using the SSH protocol.
  Fill the **Server**, **ssh key**, and **Directory** fields with the remote machine address, ssh key location, and a target directory.

- Another choice is to select the **Remote over NFS** option from the drop-down and fill the **Mount** field to send the vmcore to a remote machine using the NFS protocol.

NOTE

Tick the **Compression** check box to reduce the size of the vmcore file.

5. Test your configuration by crashing the kernel.



Status: Service is running more details

Reserved memory: 192 MiB

Crash dump location: locally in /var/crash

a. Click **Test configuration**.

b. In the **Test kdump settings** field, click **Crash system**.

> WARNING
>
> This step disrupts execution of the kernel and results in a system crash and loss of data.

Additional resources

- Supported kdump targets
- Using secure communications between two systems with OpenSSH

8.3. KDUMP USING RHEL SYSTEM ROLES

RHEL System Roles is a collection of Ansible roles and modules that provide a consistent configuration interface to remotely manage multiple RHEL systems. The **kdump** role enables you to set basic kernel dump parameters on multiple systems.

> WARNING
>
> The **kdump** role replaces the **kdump** configuration of the managed hosts entirely by replacing the **/etc/kdump.conf** file. Additionally, if the **kdump** role is applied, all previous **kdump** settings are also replaced, even if they are not specified by the role variables, by replacing the **/etc/sysconfig/kdump** file.

The following example playbook shows how to apply the **kdump** system role to set the location of the crash dump files:

```
---
- hosts: kdump-test
  vars:
    kdump_path: /var/crash
  roles:
    - rhel-system-roles.kdump
```

For a detailed reference on **kdump** 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/kdump** directory.

Additional resources

- Introduction to RHEL System Roles

8.4. ADDITIONAL RESOURCES

- Installing kdump
- Configuring kdump on the command line
- Configuring kdump in the web console

CHAPTER 9. RECOVERING AND RESTORING A SYSTEM

To recover and restore a system using an existing backup, Red Hat Enterprise Linux provides the Relax-and-Recover (ReaR) utility.

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

The utility enables you to perform the following tasks:

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

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

Setting up ReaR involves the following high-level steps:

1. Install ReaR.
2. Modify ReaR configuration file, to add backup method details.
3. Create rescue system.
4. Generate backup files.

9.1. SETTING UP REAR

Use the following steps to install the package for using the Relax-and-Recover (ReaR) utility, create a rescue system, configure and generate a backup.

Prerequisites

- Necessary configurations as per the backup restore plan are ready.
  Note that you can use the **NETFS** backup method, a fully-integrated and built-in method with ReaR.

Procedure

1. Install the ReaR utility by running the following command:

   ```
   # dnf install rear
   ```

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

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

3. Add the backup setting details to **/etc/rear/local.conf**. For example, in the case of the **NETFS** backup method, add the following lines:

   ```
   BACKUP=NETFS
   BACKUP_URL=backup.location
   ```

Replace *backup.location* by the URL of your backup location.

4. To configure ReaR to keep the previous backup archive when the new one is created, also add the following line to the configuration file:

   ```
   NETFS_KEEP_OLD_BACKUP_COPY=y
   ```

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

   ```
   BACKUP_TYPE=incremental
   ```

6. Create a rescue system:

   ```
   # rear mkrescue
   ```

7. Take a backup as per the restore plan. For example, in the case of the **NETFS** backup method, run the following command:

   ```
   # rear mkbackuponly
   ```

   Alternatively, you can create the rescue system and the backup in a single step by running the following command:

   ```
   # rear mkbackup
   ```

   This command combines the functionality of the **rear mkrescue** and **rear mkbackuponly** commands.

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

Basic Relax and Recover (ReaR) functionality is now available on the 64-bit IBM Z architecture as a Technology Preview. You can create a ReaR rescue image on IBM Z only in the z/VM environment. Backing up and recovering logical partitions (LPARs) has not been tested.

IMPORTANT

ReaR on the 64-bit IBM Z architecture is supported only with the **rear** package version 2.6-17.el9 or later. Earlier versions are available as a Technology Preview feature only. For more information about the support scope of Red Hat Technology Preview features, see https://access.redhat.com/support/offerings/techpreview.

The only output method currently available is Initial Program Load (IPL). IPL produces a kernel and an initial RAM disk (initrd) that can be used with the **zIPL** boot loader.

Prerequisites

- ReaR is installed.
  - To install ReaR, run the **dnf install rear** command

Procedure

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

1. To configure the **IPL** output method, add **OUTPUT=IPL**.

2. To configure the backup method and destination, add **BACKUP** and **BACKUP_URL** variables. For example:

   ```
   BACKUP=NETFS

   BACKUP_URL=nfs://<nfsserver name>/<share path>
   ```

   IMPORTANT

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

3. Optionally, you can also configure the **OUTPUT_URL** variable to save the kernel and **initrd** files. By default, the **OUTPUT_URL** is aligned with **BACKUP_URL**.

4. To perform backup and rescue image creation:

   ```
   rear mkbackup
   ```

5. This creates the kernel and initrd files at the location specified by the **BACKUP_URL** or **OUTPUT_URL** (if set) variable, and a backup using the specified backup method.

6. To recover the system, use the ReaR kernel and initrd files created in step 3, and boot from a Direct Attached Storage Device (DASD) or a Fibre Channel Protocol (FCP)-attached SCSI device prepared with the **zipl** boot loader, kernel, and **initrd**. For more information, see Using a Prepared DASD.

7. When the rescue kernel and **initrd** get booted, it starts the ReaR rescue environment. Proceed with system recovery.

WARNING

Currently, the rescue process reformats all the DASDs (Direct Attached Storage Devices) connected to the system. Do not attempt a system recovery if there is any valuable data present on the system storage devices. This also includes the device prepared with the zipl boot loader, ReaR kernel, and initrd that were used to boot into the rescue environment. Ensure to keep a copy.

Additional resources

- Installing under z/VM

- Using a Prepared DASD

CHAPTER 10. TROUBLESHOOTING PROBLEMS 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.

10.1. SERVICES HANDLING SYSLOG MESSAGES

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

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

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

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

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

10.2. SUBDIRECTORIES STORING SYSLOG MESSAGES

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

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

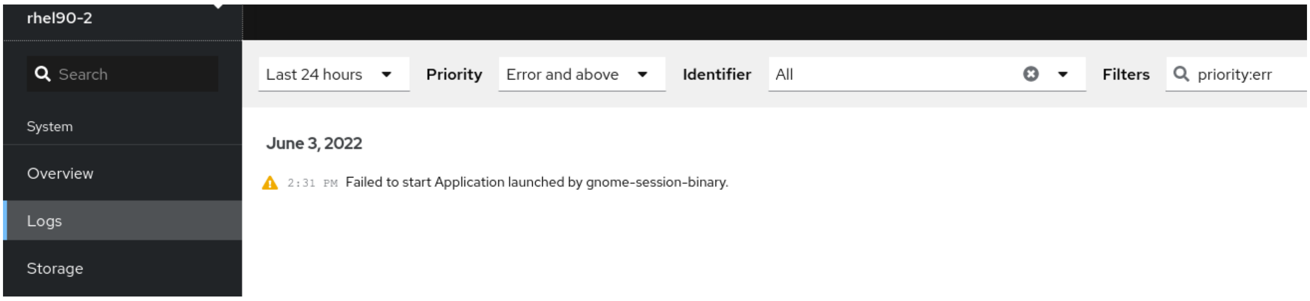
10.3. INSPECTING LOG FILES USING THE WEB CONSOLE

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

Procedure

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

Figure 10.1. Inspecting the log files in the RHEL 9 web console



June 3, 2022

2:31 PM Failed to start Application launched by gnome-session-binary.

10.4. VIEWING LOGS USING THE COMMAND LINE

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

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

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

Table 10.1. 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 10.2. Viewing information on specific services

Command	Description
journalctl -b _SYSTEMD_UNIT=foo	Filters log to see ones matching the "foo" **systemd** service.
journalctl -b _SYSTEMD_UNIT=foo _PID=number	Combines matches. For example, this command shows logs for **systemd-units** that match **foo** and the PID **number**.

Command	Description
journalctl -b _SYSTEMD_UNIT=foo _PID=number + _SYSTEMD_UNIT=foo1	The separator "+" combines two expressions in a logical OR. For example, this command shows all messages from the **foo** service process with the**PID** plus all messages from the **foo1** service (from any of its processes).
journalctl -b _SYSTEMD_UNIT=foo _SYSTEMD_UNIT=foo1	This command shows all entries matching either expression, referring to the same field. Here, this command shows logs matching a systemd-unit **foo** or a systemd-unit **foo1**.

Table 10.3. Viewing logs related to specific boots

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

10.5. ADDITIONAL RESOURCES

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

CHAPTER 11. ACCESSING THE RED HAT SUPPORT

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

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

11.1. OBTAINING RED HAT SUPPORT THROUGH RED HAT CUSTOMER PORTAL

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

Prerequisites

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

Procedure

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

11.2. TROUBLESHOOTING PROBLEMS USING SOSREPORT

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

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

Prerequisites

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

Procedure

1. Install the **sos** package:

```
# dnf install sos
```

NOTE

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

2. Generate a report:

```
# sosreport
```

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

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

Additional resources

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

CHAPTER 12. INTRODUCTION TO SYSTEMD

As a system administrator, you need to interact with **systemd**, the system and service manager for Linux operating systems. The **systemd** software suite provides tools and services to control and report the state of the system, to initialize your system during start and many more. Since Red Hat Enterprise Linux 7, **systemd** is a replacement for Upstart as the default init system, and is backwards compatible with SysV init scripts. The **systemd** software suite provides a number of features such as:

- parallel start of system services at boot time,
- on-demand activation of daemons,
- dependency-based service control logic.

As a representation of system resources and services, **systemd** introduces the concept of *systemd units*. A systemd unit, which performs or controls a particular task, is the basic object that systemd manages. See the following examples of various systemd unit types:

- service,
- target,
- device,
- mount,
- timer,
- other types that are relevant to the init system.

NOTE

If you want to display all available unit types, use:

```
# systemctl -t help
```

A systemd unit consists of a name, type and a configuration file, which defines the task of the unit. The unit configuration files are located in one of the directories listed in the following table:

Table 12.1. systemd unit files locations

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

Directory	Description
/etc/systemd/system/	systemd unit files created by **systemctl enable** 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. Use this file if you want to deviate from those defaults and override selected default 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 13. MANAGING SYSTEM SERVICES WITH SYSTEMCTL

As a system administrator, you want to manage system services and perform different tasks related to different services, such as starting, stopping, restarting, enabling, and disabling services, listing services, and displaying system services statuses. To interact with the **systemd** system and service manager, use the **systemctl** utility.

13.1. LISTING SYSTEM SERVICES

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

Procedure

- To list all currently loaded service units, enter:

```
$ 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, i.e. 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 displays:

  - **UNIT**: its full name
  - **LOAD**: information whether the unit file has been loaded
  - **ACTIVE** or **SUB**: its high-level and low-level unit file activation state
  - **DESCRIPTION**: a short description

- To list **all loaded units regardless of their state**, enter the following command with the **--all** or **-a** command line option:

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

- To list the status (**enabled** or **disabled**) of all available service units, enter:

```
$ 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**: its full name
- **STATE**: information whether the service unit is enabled or disabled

Additional resources

- Displaying system service status

13.2. DISPLAYING SYSTEM SERVICE STATUS

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

Procedure

- To display detailed information about a service unit that corresponds to a system service, enter:

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

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

This command displays the name of the selected service unit followed by its short description, one or more fields described in Available service unit information, if it is executed by the **root** user, and the most recent log entries.

Table 13.1. 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.
Active	Information whether the service unit is running followed by a time stamp.
Main PID	The PID of the corresponding system service followed by its name.
Status	Additional information about the corresponding system service.

Field	Description
Process	Additional information about related processes.
CGroup	Additional information about related Control Groups (**cgroups**).

Example 13.1. Displaying service status

The service unit for the GNOME Display Manager is named **gdm.service**. To determine the current status of this service unit, type the following at a shell prompt:

```
# systemctl status gdm.service
gdm.service - GNOME Display Manager
   Loaded: loaded (/usr/lib/systemd/system/gdm.service; enabled)
   Active: active (running) since Thu 2013-10-17 17:31:23 CEST; 5min ago
 Main PID: 1029 (gdm)
   CGroup: /system.slice/gdm.service
           ├─1029 /usr/sbin/gdm
           ├─1037 /usr/libexec/gdm-simple-slave --display-id /org/gno...
           └─1047 /usr/bin/Xorg :0 -background none -verbose -auth /r...

Oct 17 17:31:23 localhost systemd[1]: Started GNOME Display Manager.
```

- To only verify that a particular service unit is running, enter:

```
$ systemctl is-active <name>.service
```

- To determine whether a particular service unit is enabled, enter:

```
$ systemctl is-enabled <name>.service
```

NOTE

Both **systemctl is-active** and **systemctl is-enabled** return an exit status of **0** if the specified service unit is running or enabled.

- To determine what services are ordered to start before the specified service unit, enter:

```
# systemctl list-dependencies --after <name>.service
```

Replace *<name>* with the name of the service in the command.

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]
```

- To determine what services are ordered to start after the specified service unit, enter:

  ```
  # systemctl list-dependencies --before <name>.service
  ```

  Replace *<name>* with the name of the service in the command.

  For example, to view the list of services ordered 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

13.3. STARTING A SYSTEM SERVICE

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

Prerequisites

- You must have root access to the system.

Procedure

- To start a selected service unit corresponding to a system service, type the following command as **root**:

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

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

  Example 13.2. Starting httpd.service

The service unit for the Apache HTTP Server is named **httpd.service**. To activate this service unit and start the **httpd** daemon in the current session, enter the following command as **root**:

```
# systemctl start httpd.service
```

NOTE

In **systemd**, positive and negative dependencies between services exist. Starting a particular service may require starting one or more other services (**positive dependency**) or stopping one or more services (**negative dependency**).

When you attempt to start a new service, **systemd** resolves all dependencies automatically, without explicit notification to the user. This means that if you are already running a service, and you attempt to start another service with a negative dependency, the first service is automatically stopped.

For example, if you are running the **postfix** service, and you attempt to start the **sendmail** service, **systemd** first automatically stops **postfix**, because these two services are conflicting and cannot run on the same port.

Additional resources

- Positive and negative service dependencies
- Enabling a system service
- Displaying system service status

13.4. STOPPING A SYSTEM SERVICE

If you want to stop a system service in the current session, use the **stop** command.

Prerequisites

- You must have root access to the system.

Procedure

- To stop the service unit corresponding to a system service, enter the following command as **root**:

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

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

  Example 13.3. Stopping bluetoothd.service

  The service unit for the **bluetoothd** daemon is named **bluetooth.service**. To deactivate this service unit and stop the **bluetoothd** daemon in the current session, enter the following command as **root**:

  ```
  # systemctl stop bluetooth.service
  ```

Additional resources

- Disabling a system service
- Displaying system service status

13.5. RESTARTING A SYSTEM SERVICE

You can restart system service in the current session using the **restart** command.

This procedure describes how to:

- 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 must have root access to the system.

Procedure

- Restart a service unit corresponding to a system service:

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

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

  NOTE

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

- Alternatively, restart a service unit only if the corresponding service is already running:

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

- Alternatively, 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.

  Example 13.4. Reloading httpd.service

  In order to prevent users from encountering unnecessary error messages or partially rendered web pages, the Apache HTTP Server allows you to edit and reload its configuration without the need to restart it and interrupt actively processed requests. To do so, use the following command:

```
# systemctl reload httpd.service
```

Additional resources

- Displaying system service status

13.6. ENABLING A SYSTEM SERVICE

You can configure service to start automatically at the system booting time. The **enable** command reads the **[Install]** section of the selected service unit and creates appropriate symbolic links to the **/usr/lib/systemd/system/*name*.service** file in the **/etc/systemd/system/** directory and its sub-directories. However, it does not rewrite links that already exist.

Prerequisites

- You must have root access to the system.

Procedure

- Configure a service unit that corresponds to a system service to be automatically started at boot time:

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

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

- Alternatively, if you want to ensure that the symbolic links are re-created, reenable the system unit:

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

  This command disables the selected service unit and immediately enables it again.

  Example 13.5. Enabling httpd.service

  To configure the Apache HTTP Server to start automatically at boot time, use the following command:

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

Additional resources

- Displaying system service status

- Starting a system service

13.7. DISABLING A SYSTEM SERVICE

You can prevent a service unit from starting automatically at boot time. The **disable** command reads the **[Install]** section of the selected service unit and removes appropriate symbolic links to the **/usr/lib/systemd/system/*name*.service** file from the **/etc/systemd/system/** directory and its sub-directories.

Prerequisites

- You must have root access to the system.

Procedure

- To configure a service unit that corresponds to a system service not to start automatically at boot time, enter the following command as **root**:

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

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

  Example 13.6. Disabling bluetoothd.service

  The service unit for the **bluetoothd** daemon is named **bluetooth.service**. To prevent this service unit from starting at boot time, enter the following command as a **root**:

  ```
  # systemctl disable bluetooth.service
  Removed symlink /etc/systemd/system/bluetooth.target.wants/bluetooth.service.
  Removed symlink /etc/systemd/system/dbus-org.bluez.service.
  ```

- Alternatively, you can mask any service unit and prevent it from being started manually or by another service:

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

  This command replaces the **/etc/systemd/system/*name*.service** file with a symbolic link to **/dev/null**, rendering the actual unit file inaccessible to **systemd**.

- To revert this action and unmask a service unit, enter:

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

Additional resources

- Displaying system service status
- Stopping a system service

CHAPTER 14. WORKING WITH SYSTEMD TARGETS

Targets in **systemd** act as synchronization points during the start of your system. Target unit files, which end with the **.target** file extension, represent the **systemd** targets. The purpose of target units is to group together various **systemd** units through a chain of dependencies.

Consider the following examples:

- The **graphical.target unit** for starting a graphical session, starts system services such as the GNOME Display Manager (**gdm.service**) or Accounts Service (**accounts-daemon.service**), and also activates the **multi-user.target unit**.

- Similarly, the **multi-user.target** unit starts other essential system services such as NetworkManager (**NetworkManager.service**) or D-Bus (**dbus.service**) and activates another target unit named **basic.target**.

While working with **systemd** targets, you can view the default target, change it or change the current target.

14.1. VIEWING THE DEFAULT TARGET

You can display the default target using the **systemctl** command or examine the **/etc/systemd/system/default.target** file, which represents the default target unit.

Procedure

- Determine, which target unit is used by default:

```
$ systemctl get-default
graphical.target
```

- Determine the default target using the symbolic link:

```
$  ls -l /usr/lib/systemd/system/default.target
```

14.2. VIEWING THE TARGET UNITS

You can display all unit types or limit your search to the currently loaded target units. By default, the **systemctl list-units** command displays only active units.

Procedure

- List all loaded units regardless of their state:

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

- Alternatively, list all currently loaded target units:

```
$ systemctl list-units --type target

UNIT                  LOAD   ACTIVE SUB    DESCRIPTION
basic.target           loaded active active Basic System
cryptsetup.target      loaded active active Encrypted Volumes
```

```
getty.target          loaded active active Login Prompts
graphical.target      loaded active active Graphical Interface
local-fs-pre.target   loaded active active Local File Systems (Pre)
local-fs.target       loaded active active Local File Systems
multi-user.target     loaded active active Multi-User System
network.target        loaded active active Network
paths.target          loaded active active Paths
remote-fs.target      loaded active active Remote File Systems
sockets.target        loaded active active Sockets
sound.target          loaded active active Sound Card
spice-vdagentd.target loaded active active Agent daemon for Spice guests
swap.target           loaded active active Swap
sysinit.target        loaded active active System Initialization
time-sync.target      loaded active active System Time Synchronized
timers.target         loaded active active Timers

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

17 loaded units listed.
```

14.3. CHANGING THE DEFAULT TARGET

The default target unit is represented by the **/etc/systemd/system/default.target** file. The following procedure describes how to change the default target by using the systemctl command:

Procedure

1. To determine the default target unit:

```
# systemctl get-default
```

2. To configure the system to use a different target unit by default:

```
# systemctl set-default multi-user.target
rm /etc/systemd/system/default.target
ln -s /usr/lib/systemd/system/multi-user.target /etc/systemd/system/default.target
```

This command replaces the **/etc/systemd/system/default.target** file with a symbolic link to **/usr/lib/systemd/system/name.target**, where *name* is the name of the target unit you want to use. Replace *multi-user* with the name of the target unit you want to use by default.

Table 14.1. Common targets for **set-default** command

basic	unit target covering basic boot-up
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
sysinit	unit target that pulls in the services required for system initialization

3. Reboot

```
# reboot
```

Additional resources

- **systemd.special** man page
- **bootup** man page

14.4. CHANGING THE DEFAULT TARGET USING A SYMBOLIC LINK

You can change the default target by creating a symbolic link to the target you want.

Procedure

1. Determine the default target unit:

   ```
   #  ls -l /etc/systemd/system/default.target
   ```

   Note that in certain cases, the **/etc/systemd/system/default.target** link might not exist, and systemd looks for the default target unit in **/usr**. In such cases, determine the default target unit using the following command:

   ```
   #  ls -l /usr/lib/systemd/system/default.target
   ```

2. Delete the **/etc/systemd/system/default.target** link:

   ```
   # rm /etc/systemd/system/default.target
   ```

3. Create a symbolic link:

   ```
   #  ln -sf /usr/lib/systemd/system/graphical.target /etc/systemd/system/default.target
   ```

4. Reboot the system:

   ```
   # reboot
   ```

Verification steps

- Verify the newly created **default.target**:

```
$ systemctl get-default
multi-user.target
```

14.5. CHANGING THE CURRENT TARGET

When you set a default target unit, the current target remains unchanged until the next reboot. If you want to change the target unit in the current session without reboot, use the **systemctl isolate** command.

Procedure

- Change to a different target unit in the current session:

  ```
  # systemctl isolate multi-user.target
  ```

  This command starts the target unit named *multi-user* and all dependent units, and immediately stops all others.

Replace *multi-user* with the name of the target unit you want to use by default.

Verification steps

- Verify the newly created default.target:

  ```
  $ systemctl get-default
  multi-user.target
  ```

14.6. BOOTING TO RESCUE MODE

Rescue mode provides a convenient single-user environment and allows you to repair your system in situations when it is unable to complete a regular booting process. In rescue mode, the system attempts to mount all local file systems and start certain important system services, but it does not activate network interfaces or allow more users to be logged into the system at the same time.

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 2013-10-25 18:23:15 CEST):

  The system is going down to rescue mode NOW!
  ```

NOTE

This command is similar to **systemctl isolate rescue.target**, but it also sends an informative message to all users that are currently logged into the system.

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

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

14.7. BOOTING TO EMERGENCY MODE

Emergency mode provides the most minimal environment possible and allows you to repair your system even in situations when the system is unable to enter rescue mode. In emergency mode, the system mounts the root file system only for reading, does not attempt to mount any other local file systems, does not activate network interfaces, and only starts a few essential services.

Procedure

- To enter the emergency mode, change the current target:

```
# systemctl emergency
```

NOTE

This command is similar to **systemctl isolate emergency.target**, but it also sends an informative message to all users that are currently logged into the system.

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

```
# systemctl --no-wall emergency
```

CHAPTER 15. SHUTTING DOWN, SUSPENDING, AND HIBERNATING THE SYSTEM

This section contains instructions about shutting down, suspending, or hibernating your operating system.

15.1. SYSTEM SHUTDOWN

To shut down the system, you can either use the **systemctl** utility directly, or call this utility through the **shutdown** command.

The advantage of using the **shutdown** command is:

- The support for time argument
  This is particularly useful for scheduled maintenance. Also, users have more time to react to the warning that a system shutdown has been scheduled.

- The option to cancel the shutdown

Additional resources

- Shutting down the system using the shutdown command
- Shutting down the system using the systemctl command
- Overview of the power management commands with systemctl

15.2. SHUTTING DOWN THE SYSTEM USING THE SHUTDOWN COMMAND

By following this procedure, you can use the **shutdown** command to perform various operations. You can either shut down the system and power off the machine at a certain time, or shut down and halt the system without powering off the machine, or cancel a pending shutdown.

Prerequisites

- Switch to the **root** user

Procedure

- To shut down the system and power off the machine at a certain time, use the command in the following format:

  ```
  shutdown --poweroff hh:mm
  ```

  Where *hh:mm* is the time in 24 hour clock format. The **/run/nologin** file is created 5 minutes before system shutdown to prevent new logins.

  When a time argument is used, an optional *wall message* can be appended to the command.

  Alternatively, to shut down and halt the system after a delay, without powering off the machine, use:

```
shutdown --halt +m
```

Where *+m* is the delay time in minutes. The **now** keyword is an alias for **+0**.

To cancel a pending shutdown, use:

```
shutdown -c
```

Additional resources

- **shutdown(8)** manual page
- Shutting down the system using the systemctl command

15.3. SHUTTING DOWN THE SYSTEM USING THE SYSTEMCTL COMMAND

By following this procedure, you can use the **systemctl** command to perform various operations. You can either shut down the system and power off the machine, or shut down and halt the system without powering off the machine.

Prerequisites

- Switch to the **root** user

Procedure

- To shut down the system and power off the machine, use the command in the following format:

  ```
  systemctl poweroff
  ```

  Alternatively, to shut down and halt the system without powering off the machine, use:

  ```
  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.

Additional resources

- Shutting down the system using the shutdown command

15.4. RESTARTING THE SYSTEM

You can restart the system by following this procedure.

Prerequisites

- Switch to the **root** user

Procedure

- To restart the system, run the following command:

```
systemctl reboot
```

> NOTE
>
> By default, this command 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 this command with the **--no-wall** command line option.

15.5. SUSPENDING THE SYSTEM

You can suspend the system by following this procedure.

Prerequisites

- Switch to the **root** user.

Procedure

- To suspend the system, run the following command:

```
systemctl suspend
```

  This command 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, note that the suspended system state is also vulnerable to power outages.

Additional resources

- Hibernating the system

15.6. HIBERNATING THE SYSTEM

By following this procedure, you can either hibernate the system, or hibernate and suspend the system.

Prerequisites

- Switch to the **root** user.

Procedure

- To hibernate the system, run the following command:

```
systemctl hibernate
```

This command 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.

Alternatively, to hibernate and suspend the system, run the following command:

```
systemctl hybrid-sleep
```

Additional resources

- Suspending the system

15.7. OVERVIEW OF THE POWER MANAGEMENT COMMANDS WITH SYSTEMCTL

You can use the following list of the **systemctl** commands to control the power management of your system.

Table 15.1. Overview of the systemctl power management commands

systemctl command	Description
systemctl halt	Halts the system.
systemctl poweroff	Powers off the system.
systemctl reboot	Restarts the system.
systemctl suspend	Suspends the system.
systemctl hibernate	Hibernates the system.
systemctl hybrid-sleep	Hibernates and suspends the system.

CHAPTER 16. WORKING WITH SYSTEMD UNIT FILES

This chapter includes the description of **systemd** unit files. The following sections show you how to:

- Create custom unit files
- Convert SysV init scripts to unit files
- Modify existing unit files
- Work with instantiated units

16.1. INTRODUCTION TO UNIT FILES

A unit file contains configuration directives that describe the unit and define its behavior. Several **systemctl** commands work with unit files in the background. To make finer adjustments, system administrator must edit or create unit files manually. systemd unit files locations lists three main directories where unit files are stored on the system, the **/etc/systemd/system/** directory is reserved for unit files created or customized by the system administrator.

Unit file names take the following form:

```
unit_name.type_extension
```

Here, *unit_name* stands for the name of the unit and *type_extension* identifies the unit type. For a complete list of unit types, see systemd unit files

For example, there usually is **sshd.service** as well as **sshd.socket** unit present on your system.

Unit files can be supplemented with a directory for additional configuration files. For example, to add custom configuration options to **sshd.service**, create the **sshd.service.d/custom.conf** file and insert additional directives there. For more information on configuration directories, see Modifying existing unit files.

Also, the **sshd.service.wants/** and **sshd.service.requires/** directories can be created. These directories contain symbolic links to unit files that are dependencies of the **sshd** service. The symbolic links are automatically created either during installation according to [Install] unit file options or at runtime based on [Unit] options. It is also possible to create these directories and symbolic links manually. For more details on [Install] and [Unit] options, see the tables below.

Many unit file options can be set using the so called **unit specifiers** – wildcard strings that are dynamically replaced with unit parameters when the unit file is loaded. This enables creation of generic unit files that serve as templates for generating instantiated units. See Working with instantiated units.

16.2. UNIT FILE STRUCTURE

Unit files typically consist of three sections:

- The **[Unit]** section — contains generic options that are not dependent on the type of the unit. These options provide unit description, specify the unit's behavior, and set dependencies to other units. For a list of most frequently used [Unit] options, see Important [Unit] section options.
- The **[Unit type]** section — if a unit has type-specific directives, these are grouped under a section named after the unit type. For example, service unit files contain the **[Service]** section.

- The **[Install]** section – contains information about unit installation used by **systemctl enable** and **disable** commands. For a list of options for the **[Install]** section, see Important [Install] section options.

Additional resources

- Important [Unit] section options
- Important [Service] section options
- Important [Install] section options

16.3. IMPORTANT [UNIT] SECTION OPTIONS

The following tables lists important options of the [Unit] section.

Table 16.1. Important [Unit] section options

Option [a]	Description
Description	A meaningful description of the unit. This text is displayed for example in the output of the **systemctl status** command.
Documentation	Provides a list of URIs referencing documentation for the unit.
After[b]	Defines the order in which units are started. The unit starts only after the units specified in **After** are active. Unlike **Requires**, **After** does not explicitly activate the specified units. The **Before** option has the opposite functionality to **After**.
Requires	Configures dependencies on other units. The units listed in **Requires** are activated together with the unit. If any of the required units fail to start, the unit is not activated.
Wants	Configures weaker dependencies than **Requires**. If any of the listed units does not start successfully, it has no impact on the unit activation. This is the recommended way to establish custom unit dependencies.
Conflicts	Configures negative dependencies, an opposite to **Requires**.

[a] For a complete list of options configurable in the [Unit] section, see the **systemd.unit(5)** manual page.

[b] In most cases, it is sufficient to set only the ordering dependencies with **After** and **Before** unit file options. If you also set a requirement dependency with **Wants** (recommended) or **Requires**, the ordering dependency still needs to be specified. That is because ordering and requirement dependencies work independently from each other.

16.4. IMPORTANT [SERVICE] SECTION OPTIONS

The following tables lists important options of the [Service] section.

Table 16.2. Important [Service] section options

Option [a]	Description
Type	Configures the unit process startup type that affects the functionality of **ExecStart** and related options. One of: * **simple** – The default value. The process started with **ExecStart** is the main process of the service. * **forking** – The process started with**ExecStart** spawns a child process that becomes the main process of the service. The parent process exits when the startup is complete. * **oneshot** – This type is similar to**simple**, but the process exits before starting consequent units. * **dbus** – This type is similar to**simple**, but consequent units are started only after the main process gains a D-Bus name. * **notify** – This type is similar to**simple**, but consequent units are started only after a notification message is sent via the sd_notify() function. * **idle** – similar to **simple**, the actual execution of the service binary is delayed until all jobs are finished, which avoids mixing the status output with shell output of services.
ExecStart	Specifies commands or scripts to be executed when the unit is started. **ExecStartPre** and **ExecStartPost** specify custom commands to be executed before and after **ExecStart**. **Type=oneshot** enables specifying multiple custom commands that are then executed sequentially.
ExecStop	Specifies commands or scripts to be executed when the unit is stopped.
ExecReload	Specifies commands or scripts to be executed when the unit is reloaded.
Restart	With this option enabled, the service is restarted after its process exits, with the exception of a clean stop by the **systemctl** command.

Option [a]	Description
RemainAfterExit	If set to True, the service is considered active even when all its processes exited. Default value is False. This option is especially useful if **Type=oneshot** is configured.

[a] For a complete list of options configurable in the [Service] section, see the **systemd.service(5)** manual page.

16.5. IMPORTANT [INSTALL] SECTION OPTIONS

The following tables lists important options of the [Install] section.

Table 16.3. Important [Install] section options

Option [a]	Description
Alias	Provides a space-separated list of additional names for the unit. Most **systemctl** commands, excluding **systemctl enable**, can use aliases instead of the actual unit name.
RequiredBy	A list of units that depend on the unit. When this unit is enabled, the units listed in **RequiredBy** gain a **Require** dependency on the unit.
WantedBy	A list of units that weakly depend on the unit. When this unit is enabled, the units listed in **WantedBy** gain a **Want** dependency on the unit.
Also	Specifies a list of units to be installed or uninstalled along with the unit.
DefaultInstance	Limited to instantiated units, this option specifies the default instance for which the unit is enabled. See Working with instantiated units.

[a] For a complete list of options configurable in the [Install] section, see the **systemd.unit(5)** manual page.

16.6. CREATING CUSTOM UNIT FILES

There are several use cases for creating unit files from scratch: you could run a custom daemon, create a second instance of some existing service as in Creating a custom unit file by using the second instance of the sshd service

On the other hand, if you intend just to modify or extend the behavior of an existing unit, use the instructions from Modifying existing unit files.

Procedure

The following procedure describes the general process of creating a custom service:

1. Prepare the executable file with the custom service. This can be a custom-created script, or an executable delivered by a software provider. If required, prepare a PID file to hold a constant PID for the main process of the custom service. It is also possible to include environment files to store shell variables for the service. Make sure the source script is executable (by executing the **chmod a+x**) and is not interactive.

2. Create a unit file in the **/etc/systemd/system/** directory and make sure it has correct file permissions. Execute as **root**:

   ```
   touch /etc/systemd/system/name.service

   chmod 664 /etc/systemd/system/name.service
   ```

   Replace *name* with a name of the service to be created. Note that file does not need to be executable.

3. Open the ***name*.service** file created in the previous step, and add the service configuration options. There is a variety of options that can be used depending on the type of service you wish to create, see Unit file structure.
   The following is an example unit configuration for a network-related service:

   ```
   [Unit]
   Description=service_description
   After=network.target

   [Service]
   ExecStart=path_to_executable
   Type=forking
   PIDFile=path_to_pidfile

   [Install]
   WantedBy=default.target
   ```

   Where:

   - *service_description* is an informative description that is displayed in journal log files and in the output of the **systemctl status** command.
   - the **After** setting ensures that the service is started only after the network is running. Add a space-separated list of other relevant services or targets.
   - *path_to_executable* stands for the path to the actual service executable.
   - **Type=forking** is used for daemons that make the fork system call. The main process of the service is created with the PID specified in *path_to_pidfile*. Find other startup types in Important [Service] section options.
   - **WantedBy** states the target or targets that the service should be started under. Think of these targets as of a replacement of the older concept of runlevels.

4. Notify **systemd** that a new ***name*.service** file exists by executing the following command as **root**:

```
systemctl daemon-reload

systemctl start name.service
```

WARNING

Always run the **systemctl daemon-reload** command after creating new unit files or modifying existing unit files. Otherwise, the **systemctl start** or **systemctl enable** commands could fail due to a mismatch between states of **systemd** and actual service unit files on disk. Note, that on systems with a large number of units this can take a long time, as the state of each unit has to be serialized and subsequently deserialized during the reload.

16.7. CREATING A CUSTOM UNIT FILE BY USING THE SECOND INSTANCE OF THE SSHD SERVICE

System Administrators often need to configure and run multiple instances of a service. This is done by creating copies of the original service configuration files and modifying certain parameters to avoid conflicts with the primary instance of the service. The following procedure shows how to create a second instance of the **sshd** service.

Procedure

1. Create a copy of the **sshd_config** file that will be used by the second daemon:

```
# cp /etc/ssh/sshd{,-second}_config
```

2. Edit the **sshd-second_config** file created in the previous step to assign a different port number and PID file to the second daemon:

```
Port 22220
PidFile /var/run/sshd-second.pid
```

See the **sshd_config**(5) manual page for more information on **Port** and **PidFile** options. Make sure the port you choose is not in use by any other service. The PID file does not have to exist before running the service, it is generated automatically on service start.

3. Create a copy of the systemd unit file for the **sshd** service:

```
# cp /usr/lib/systemd/system/sshd.service /etc/systemd/system/sshd-second.service
```

4. Alter the **sshd-second.service** created in the previous step as follows:

   a. Modify the **Description** option:

```
Description=OpenSSH server second instance daemon
```

b. Add sshd.service to services specified in the **After** option, so that the second instance starts only after the first one has already started:

```
After=syslog.target network.target auditd.service sshd.service
```

c. The first instance of sshd includes key generation, therefore remove the **ExecStartPre=/usr/sbin/sshd-keygen** line.

d. Add the **-f /etc/ssh/sshd-second_config** parameter to the **sshd** command, so that the alternative configuration file is used:

```
ExecStart=/usr/sbin/sshd -D -f /etc/ssh/sshd-second_config $OPTIONS
```

e. After the above modifications, the sshd-second.service should look as follows:

```
[Unit]
Description=OpenSSH server second instance daemon
After=syslog.target network.target auditd.service sshd.service

[Service]
EnvironmentFile=/etc/sysconfig/sshd
ExecStart=/usr/sbin/sshd -D -f /etc/ssh/sshd-second_config $OPTIONS
ExecReload=/bin/kill -HUP $MAINPID
KillMode=process
Restart=on-failure
RestartSec=42s

[Install]
WantedBy=multi-user.target
```

5. If using SELinux, add the port for the second instance of sshd to SSH ports, otherwise the second instance of sshd will be rejected to bind to the port:

```
# semanage port -a -t ssh_port_t -p tcp 22220
```

6. Enable sshd-second.service, so that it starts automatically upon boot:

```
# systemctl enable sshd-second.service
```

7. Verify if the sshd-second.service is running by using the **systemctl status** command.

8. Verify if the port is enabled correctly by connecting to the service:

```
$ ssh -p 22220 user@server
```

If the firewall is in use, make sure that it is configured appropriately in order to allow connections to the second instance of sshd.

16.8. CONVERTING SYSV INIT SCRIPTS TO UNIT FILES

Before taking time to convert a SysV init script to a unit file, make sure that the conversion was not already done elsewhere. All core services installed on Red Hat Enterprise Linux come with default unit files, and the same applies for many third-party software packages.

Converting an init script to a unit file requires analyzing the script and extracting the necessary information from it. Based on this data you can create a unit file. As init scripts can vary greatly depending on the type of the service, you might need to employ more configuration options for translation than outlined in this chapter. Note that some levels of customization that were available with init scripts are no longer supported by systemd units.

The majority of information needed for conversion is provided in the script's header. The following example shows the opening section of the init script used to start the **postfix** service on Red Hat Enterprise Linux 6:

```
#!/bin/bash
# postfix      Postfix Mail Transfer Agent
# chkconfig: 2345 80 30
# description: Postfix is a Mail Transport Agent, which is the program that moves mail from one
machine to another.
# processname: master
# pidfile: /var/spool/postfix/pid/master.pid
# config: /etc/postfix/main.cf
# config: /etc/postfix/master.cf
### BEGIN INIT INFO
# Provides: postfix MTA
# Required-Start: $local_fs $network $remote_fs
# Required-Stop: $local_fs $network $remote_fs
# Default-Start: 2 3 4 5
# Default-Stop: 0 1 6
# Short-Description: start and stop postfix
# Description: Postfix is a Mail Transport Agent, which is the program that moves mail from one
machine to another.
### END INIT INFO
```

In the above example, only lines starting with **# chkconfig** and **# description** are mandatory, so you might not find the rest in different init files. The text enclosed between the **BEGIN INIT INFO**and **END INIT INFO** lines is called **Linux Standard Base (LSB) header**. If specified, LSB headers contain directives defining the service description, dependencies, and default runlevels. What follows is an overview of analytic tasks aiming to collect the data needed for a new unit file. The postfix init script is used as an example.

16.9. FINDING THE SYSTEMD SERVICE DESCRIPTION

You can find descriptive information about the script on the line starting with **#description**. Use this description together with the service name in the **Description** option in the [Unit] section of the unit file. The LSB header might contain similar data on the **#Short-Description** and **#Description** lines.

16.10. FINDING THE SYSTEMD SERVICE DEPENDENCIES

The LSB header might contain several directives that form dependencies between services. Most of them are translatable to systemd unit options, see the following table:

Table 16.4. Dependency options from the LSB header

LSB Option	Description	Unit File Equivalent
Provides	Specifies the boot facility name of the service, that can be referenced in other init scripts (with the "$" prefix). This is no longer needed as unit files refer to other units by their file names.	–
Required-Start	Contains boot facility names of required services. This is translated as an ordering dependency, boot facility names are replaced with unit file names of corresponding services or targets they belong to. For example, in case of **postfix**, the Required-Start dependency on $network was translated to the After dependency on network.target.	**After**, **Before**
Should-Start	Constitutes weaker dependencies than Required-Start. Failed Should-Start dependencies do not affect the service startup.	**After**, **Before**
Required-Stop, **Should-Stop**	Constitute negative dependencies.	**Conflicts**

16.11. FINDING DEFAULT TARGETS OF THE SERVICE

The line starting with **#chkconfig** contains three numerical values. The most important is the first number that represents the default runlevels in which the service is started. Map these runlevels to equivalent systemd targets. Then list these targets in the **WantedBy** option in the [Install] section of the unit file. For example, **postfix** was previously started in runlevels 2, 3, 4, and 5, which translates to multi-user.target and graphical.target. Note that the graphical.target depends on multiuser.target, therefore it is not necessary to specify both. You might find information on default and forbidden runlevels also at **#Default-Start** and **#Default-Stop** lines in the LSB header.

The other two values specified on the **#chkconfig** line represent startup and shutdown priorities of the init script. These values are interpreted by **systemd** if it loads the init script, but there is no unit file equivalent.

16.12. FINDING FILES USED BY THE SERVICE

Init scripts require loading a function library from a dedicated directory and allow importing configuration, environment, and PID files. Environment variables are specified on the line starting with **#config** in the init script header, which translates to the **EnvironmentFile** unit file option. The PID file specified on the **#pidfile** init script line is imported to the unit file with the **PIDFile** option.

The key information that is not included in the init script header is the path to the service executable, and potentially some other files required by the service. In previous versions of Red Hat Enterprise Linux, init scripts used a Bash case statement to define the behavior of the service on default actions, such as **start**, **stop**, or **restart**, as well as custom-defined actions. The following excerpt from the **postfix** init script shows the block of code to be executed at service start.

```
conf_check() {
    [ -x /usr/sbin/postfix ] || exit 5
    [ -d /etc/postfix ] || exit 6
    [ -d /var/spool/postfix ] || exit 5
}

make_aliasesdb() {
 if [ "$(/usr/sbin/postconf -h alias_database)" == "hash:/etc/aliases" ]
 then
  # /etc/aliases.db might be used by other MTA, make sure nothing
  # has touched it since our last newaliases call
  [ /etc/aliases -nt /etc/aliases.db ] ||
   [ "$ALIASESDB_STAMP" -nt /etc/aliases.db ] ||
   [ "$ALIASESDB_STAMP" -ot /etc/aliases.db ] || return
  /usr/bin/newaliases
  touch -r /etc/aliases.db "$ALIASESDB_STAMP"
 else
  /usr/bin/newaliases
 fi
}

start() {
 [ "$EUID" != "0" ] && exit 4
 # Check that networking is up.
 [ ${NETWORKING} = "no" ] && exit 1
 conf_check
 # Start daemons.
 echo -n $"Starting postfix: "
 make_aliasesdb >/dev/null 2>&1
 [ -x $CHROOT_UPDATE ] && $CHROOT_UPDATE
 /usr/sbin/postfix start 2>/dev/null 1>&2 && success || failure $"$prog start"
 RETVAL=$?
 [ $RETVAL -eq 0 ] && touch $lockfile
        echo
 return $RETVAL
}
```

The extensibility of the init script allowed specifying two custom functions, **conf_check()** and **make_aliasesdb()**, that are called from the **start()** function block. On closer look, several external files and directories are mentioned in the above code: the main service executable **/usr/sbin/postfix**, the **/etc/postfix/** and **/var/spool/postfix/** configuration directories, as well as the **/usr/sbin/postconf/** directory.

systemd supports only the predefined actions, but enables executing custom executables with **ExecStart**, **ExecStartPre**, **ExecStartPost**, **ExecStop**, and **ExecReload** options. The **/usr/sbin/postfix** together with supporting scripts are executed on service start. Converting complex init scripts requires understanding the purpose of every statement in the script. Some of the statements are specific to the operating system version, therefore you do not need to translate them. On the other hand, some adjustments might be needed in the new environment, both in unit file as well as in the service executable and supporting files.

16.13. MODIFYING EXISTING UNIT FILES

Services installed on the system come with default unit files that are stored in the **/usr/lib/systemd/system/** directory. System Administrators should not modify these files directly, therefore any customization must be confined to configuration files in the **/etc/systemd/system/** directory.

Procedure

1. Depending on the extent of the required changes, pick one of the following approaches:
   - Create a directory for supplementary configuration files at **/etc/systemd/system/*unit*.d/**. This method is recommended for most use cases. It enables extending the default configuration with additional functionality, while still referring to the original unit file. Changes to the default unit introduced with a package upgrade are therefore applied automatically. See Extending the default unit configuration for more information.
   - Create a copy of the original unit file **/usr/lib/systemd/system/** in **/etc/systemd/system/** and make changes there. The copy overrides the original file, therefore changes introduced with the package update are not applied. This method is useful for making significant unit changes that should persist regardless of package updates. See Overriding the default unit configuration for details.
2. To return to the default configuration of the unit, delete custom-created configuration files in **/etc/systemd/system/**.
3. To apply changes to unit files without rebooting the system, execute:

   ```
   systemctl daemon-reload
   ```

   The **daemon-reload** option reloads all unit files and recreates the entire dependency tree, which is needed to immediately apply any change to a unit file. As an alternative, you can achieve the same result with the following command, which must be executed under the **root** user:

   ```
   init q
   ```
4. If the modified unit file belongs to a running service, this service must be restarted to accept new settings:

   ```
   systemctl restart name.service
   ```

IMPORTANT

To modify properties, such as dependencies or timeouts, of a service that is handled by a SysV initscript, do not modify the initscript itself. Instead, create a **systemd** drop-in configuration file for the service as described in: Extending the default unit configuration and Overriding the default unit configuration .

Then manage this service in the same way as a normal **systemd** service.

For example, to extend the configuration of the **network** service, do not modify the **/etc/rc.d/init.d/network** initscript file. Instead, create new directory **/etc/systemd/system/network.service.d/** and a **systemd** drop-in file **/etc/systemd/system/network.service.d/*my_config*.conf**. Then, put the modified values into the drop-in file. Note: **systemd** knows the **network** service as **network.service**, which is why the created directory must be called **network.service.d**

16.14. EXTENDING THE DEFAULT UNIT CONFIGURATION

This section describes how to extend the default unit file with additional configuration options.

Procedure

1. To extend the default unit file with additional configuration options, first create a configuration directory in **/etc/systemd/system/**. If extending a service unit, execute the following command as **root**:

   ```
   mkdir /etc/systemd/system/name.service.d/
   ```

   Replace *name* with the name of the service you want to extend. The above syntax applies to all unit types.

2. Create a configuration file in the directory made in the previous step. Note that the file name must end with the **.conf** suffix. Type:

   ```
   touch /etc/systemd/system/name.service.d/config_name.conf
   ```

   Replace *config_name* with the name of the configuration file. This file adheres to the normal unit file structure, therefore all directives must be specified under appropriate sections, see Unit file structure.

   For example, to add a custom dependency, create a configuration file with the following content:

   ```
   [Unit]
   Requires=new_dependency
   After=new_dependency
   ```

   Where *new_dependency* stands for the unit to be marked as a dependency. Another example is a configuration file that restarts the service after its main process exited, with a delay of 30 seconds:

   ```
   [Service]
   Restart=always
   RestartSec=30
   ```

It is recommended to create small configuration files focused only on one task. Such files can be easily moved or linked to configuration directories of other services.

3. To apply changes made to the unit, execute as **root**:

```
systemctl daemon-reload
systemctl restart name.service
```

Example 16.1. Extending the httpd.service configuration

To modify the httpd.service unit so that a custom shell script is automatically executed when starting the Apache service, perform the following steps.

1. Create a directory and a custom configuration file:

```
# mkdir /etc/systemd/system/httpd.service.d/
```

```
# touch /etc/systemd/system/httpd.service.d/custom_script.conf
```

2. Provided that the script you want to start automatically with Apache is located at **/usr/local/bin/custom.sh**, insert the following text to the **custom_script.conf** file:

```
[Service]
ExecStartPost=/usr/local/bin/custom.sh
```

3. To apply the unit changes, execute:

```
# systemctl daemon-reload
```

```
# systemctl restart httpd.service
```

NOTE

The configuration files from configuration directories in **/etc/systemd/system/** take precedence over unit files in **/usr/lib/systemd/system/**. Therefore, if the configuration files contain an option that can be specified only once, such as **Description** or **ExecStart**, the default value of this option is overridden. Note that in the output of the **systemd-delta** command, described in Monitoring overridden units ,such units are always marked as [EXTENDED], even though in sum, certain options are actually overridden.

16.15. OVERRIDING THE DEFAULT UNIT CONFIGURATION

This section describes how to override the default unit configuration.

Procedure

1. To make changes that will persist after updating the package that provides the unit file, first copy the file to the **/etc/systemd/system/** directory. To do so, execute the following command as **root**:

```
cp /usr/lib/systemd/system/name.service /etc/systemd/system/name.service
```

Where *name* stands for the name of the service unit you wish to modify. The above syntax applies to all unit types.

2. Open the copied file with a text editor, and make the desired changes. To apply the unit changes, execute as **root**:

```
systemctl daemon-reload
systemctl restart name.service
```

16.16. CHANGING THE TIMEOUT LIMIT

You can specify a timeout value per service to prevent a malfunctioning service from freezing the system. Otherwise, timeout is set by default to 90 seconds for normal services and to 300 seconds for SysV-compatible services.

For example, to extend timeout limit for the **httpd** service:

Procedure

1. Copy the **httpd** unit file to the **/etc/systemd/system/** directory:

```
cp /usr/lib/systemd/system/httpd.service /etc/systemd/system/httpd.service
```

2. Open file **/etc/systemd/system/httpd.service** and specify the **TimeoutStartUSec** value in the **[Service]** section:

```
…
[Service]
…
PrivateTmp=true
TimeoutStartSec=10

[Install]
WantedBy=multi-user.target
…
```

3. Reload the **systemd** daemon:

```
systemctl daemon-reload
```

4. **Optional.** Verify the new timeout value:

```
systemctl show httpd -p TimeoutStartUSec
```

NOTE

To change the timeout limit globally, input the **DefaultTimeoutStartSec** in the **/etc/systemd/system.conf** file.

16.17. MONITORING OVERRIDDEN UNITS

This section describes how to display an overview of overridden or modified unit files.

Procedure

- To display an overview of overridden or modified unit files, use the following command:

  ```
  systemd-delta
  ```

  For example, the output of the above command can look as follows:

  ```
  [EQUIVALENT] /etc/systemd/system/default.target → /usr/lib/systemd/system/default.target
  [OVERRIDDEN] /etc/systemd/system/autofs.service →
  /usr/lib/systemd/system/autofs.service

  --- /usr/lib/systemd/system/autofs.service      2014-10-16 21:30:39.000000000 -0400
  + /etc/systemd/system/autofs.service  2014-11-21 10:00:58.513568275 -0500
  @@ -8,7 +8,8 @@
   EnvironmentFile=-/etc/sysconfig/autofs
   ExecStart=/usr/sbin/automount $OPTIONS --pid-file /run/autofs.pid
   ExecReload=/usr/bin/kill -HUP $MAINPID
  -TimeoutSec=180
  +TimeoutSec=240
  +Restart=Always

   [Install]
   WantedBy=multi-user.target

  [MASKED]     /etc/systemd/system/cups.service → /usr/lib/systemd/system/cups.service
  [EXTENDED]   /usr/lib/systemd/system/sssd.service →
  /etc/systemd/system/sssd.service.d/journal.conf

  4 overridden configuration files found.
  ```

16.18. WORKING WITH INSTANTIATED UNITS

It is possible to instantiate multiple units from a single template configuration file at runtime. The "@" character is used to mark the template and to associate units with it. Instantiated units can be started from another unit file (using **Requires** or **Wants** options), or with the **systemctl start** command. Instantiated service units are named the following way:

```
template_name@instance_name.service
```

Where *template_name* stands for the name of the template configuration file. Replace *instance_name* with the name for the unit instance. Several instances can point to the same template file with configuration options common for all instances of the unit. Template unit name has the form of:

```
unit_name@.service
```

For example, the following **Wants** setting in a unit file:

```
Wants=getty@ttyA.service getty@ttyB.service
```

first makes systemd search for given service units. If no such units are found, the part between "@" and the type suffix is ignored and **systemd** searches for the **getty@.service** file, reads the configuration from it, and starts the services.

For example, the **getty@.service** template contains the following directives:

```
[Unit]
Description=Getty on %I
…
[Service]
ExecStart=-/sbin/agetty --noclear %I $TERM
…
```

When the getty@ttyA.service and getty@ttyB.service are instantiated from the above template, **Description**= is resolved as **Getty on ttyA** and **Getty on ttyB**.

16.19. IMPORTANT UNIT SPECIFIERS

Wildcard characters, called **unit specifiers**, can be used in any unit configuration file. Unit specifiers substitute certain unit parameters and are interpreted at runtime. The following table lists unit specifiers that are particularly useful for template units.

Table 16.5. Important unit specifiers

Unit Specifier	Meaning	Description
%n	Full unit name	Stands for the full unit name including the type suffix. **%N** has the same meaning but also replaces the forbidden characters with ASCII codes.
%p	Prefix name	Stands for a unit name with type suffix removed. For instantiated units %p stands for the part of the unit name before the "@" character.
%i	Instance name	Is the part of the instantiated unit name between the "@" character and the type suffix. **%I** has the same meaning but also replaces the forbidden characters for ASCII codes.
%H	Host name	Stands for the hostname of the running system at the point in time the unit configuration is loaded.

Unit Specifier	Meaning	Description
%t	Runtime directory	Represents the runtime directory, which is either **/run** for the **root** user, or the value of the XDG_RUNTIME_DIR variable for unprivileged users.

For a complete list of unit specifiers, see the **systemd.unit(5)** manual page.

16.20. ADDITIONAL RESOURCES

- How to write a service unit file which enforces that particular services have to be started
- How to decide what dependencies a systemd service unit definition should have
- Is there any useful information about writing unit files?
- How to set limits for services in RHEL 7 and systemd

CHAPTER 17. OPTIMIZING SYSTEMD TO SHORTEN THE BOOT TIME

There is a list of systemd unit files that are enabled by default. System services that are defined by these unit files are automatically run at boot, which influences the boot time.

This section describes:

- The tools to examine system boot performance.
- The purpose of systemd units enabled by default, and circumstances under which you can safely disable such systemd units in order to shorten the boot time.

17.1. EXAMINING SYSTEM BOOT PERFORMANCE

To examine system boot performance, you can use the **systemd-analyze** command. This command has many options available. However, this section covers only the selected ones that may be important for systemd tuning in order to shorten the boot time.

For a complete list and detailed description of all options, see the **systemd-analyze** man page.

Prerequisites

- Before starting to examine systemd in order to tune the boot time, you may want to list all enabled services:

Procedure

```
$ systemctl list-unit-files --state=enabled
```

Analyzing overall boot time

Procedure

- For the overall information about the time that the last successful boot took, use:

```
$ systemd-analyze
```

Analyzing unit initialization time

Procedure

- For the information about the initialization time of each systemd unit, use:

```
$ systemd-analyze blame
```

The output lists the units in descending order according to the time they took to initialize during the last successful boot.

Identifying critical units

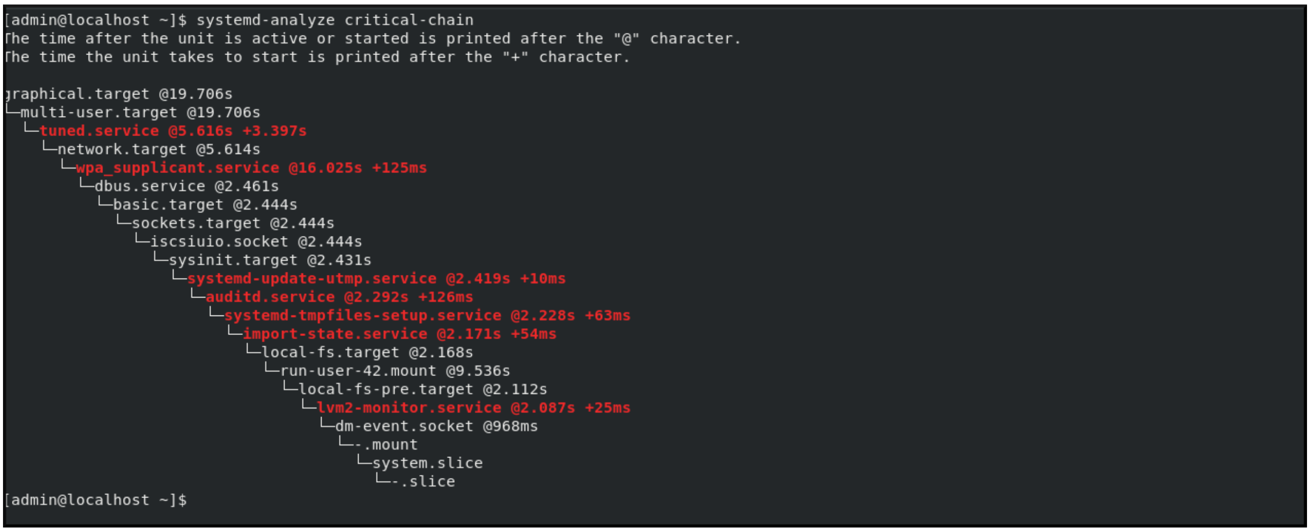
Procedure

- To identify the units that took most time to initialize at the last successful boot, use:

```
$ systemd-analyze critical-chain
```

The output highlights the units that critically slow down the boot with the red color.

Figure 17.1. The output of the systemd-analyze critical-chain command



```
[admin@localhost ~]$ systemd-analyze critical-chain
The time after the unit is active or started is printed after the "@" character.
The time the unit takes to start is printed after the "+" character.

graphical.target @19.706s
└─multi-user.target @19.706s
  └─tuned.service @5.616s +3.397s
    └─network.target @5.614s
      └─wpa_supplicant.service @16.025s +125ms
        └─dbus.service @2.461s
          └─basic.target @2.444s
            └─sockets.target @2.444s
              └─iscsiuio.socket @2.444s
                └─sysinit.target @2.431s
                  └─systemd-update-utmp.service @2.419s +10ms
                    └─auditd.service @2.292s +126ms
                      └─systemd-tmpfiles-setup.service @2.228s +63ms
                        └─import-state.service @2.171s +54ms
                          └─local-fs.target @2.168s
                            └─run-user-42.mount @9.536s
                              └─local-fs-pre.target @2.112s
                                └─lvm2-monitor.service @2.087s +25ms
                                  └─dm-event.socket @968ms
                                    └─-.mount
                                      └─system.slice
                                        └─-.slice
[admin@localhost ~]$
```

17.2. A GUIDE TO SELECTING SERVICES THAT CAN BE SAFELY DISABLED

If you find the boot time of your system long, you can shorten it by disabling some of the services enabled on boot by default.

To list such services, run:

```
$ systemctl list-unit-files --state=enabled
```

To disable a service, run:

```
# systemctl disable service_name
```

However, certain services must stay enabled in order that your operating system is safe and functions in the way you need.

You can use the table below as a guide to selecting the services that you can safely disable. The table lists all services enabled by default on a minimal installation of Red Hat Enterprise Linux, and for each service it states whether this service can be safely disabled.

The table also provides more information about the circumstances under which the service can be disabled, or the reason why you should not disable the service.

Table 17.1. Services enabled by default on a minimal installation of RHEL

Service name	Can it be disabled?	More information
auditd.service	yes	Disable **auditd.service** only if you do not need audit messages from the kernel. Be aware that if you disable **auditd.service**, the **/var/log/audit/audit.log** file is not produced. Consequently, you are not able to retroactively review some commonly-reviewed actions or events, such as user logins, service starts or password changes. Also note that auditd has two parts: a kernel part, and a service itself. By using the **systemctl disable auditd** command, you only disable the service, but not the kernel part. To disable system auditing in its entirety, set **audit=0** on kernel command line.
autovt@.service	no	This service runs only when it is really needed, so it does not need to be disabled.
crond.service	yes	Be aware that no items from crontab will run if you disable crond.service.
dbus-org.fedoraproject.FirewallD1.service	yes	A symlink to **firewalld.service**
dbus-org.freedesktop.NetworkManager.service	yes	A symlink to **NetworkManager.service**
dbus-org.freedesktop.nm-dispatcher.service	yes	A symlink to **NetworkManager-dispatcher.service**
firewalld.service	yes	Disable **firewalld.service** only if you do not need firewall.
getty@.service	no	This service runs only when it is really needed, so it does not need to be disabled.
import-state.service	yes	Disable **import-state.service** only if you do not need to boot from a network storage.
irqbalance.service	yes	Disable **irqbalance.service** only if you have just one CPU. Do not disable **irqbalance.service** on systems with multiple CPUs.

Service name	Can it be disabled?	More information
kdump.service	yes	Disable **kdump.service** only if you do not need reports from kernel crashes.
loadmodules.service	yes	This service is not started unless the **/etc/rc.modules** or **/etc/sysconfig/modules** directory exists, which means that it is not started on a minimal RHEL installation.
lvm2-monitor.service	yes	Disable **lvm2-monitor.service** only if you do not use Logical Volume Manager (LVM).
microcode.service	no	Do not be disable the service because it provides updates of the microcode software in CPU.
NetworkManager-dispatcher.service	yes	Disable **NetworkManager-dispatcher.service** only if you do not need notifications on network configuration changes (for example in static networks).
NetworkManager-wait-online.service	yes	Disable **NetworkManager-wait-online.service** only if you do not need working network connection available right after the boot. If the service is enabled, the system does not finish the boot before the network connection is working. This may prolong the boot time significantly.
NetworkManager.service	yes	Disable **NetworkManager.service** only if you do not need connection to a network.
nis-domainname.service	yes	Disable **nis-domainname.service** only if you do not use Network Information Service (NIS).
rhsmcertd.service	no	
rngd.service	yes	Disable **rngd.service** only if you do not need a lot of entropy on your system, or you do not have any sort of hardware generator. Note that the service is necessary in environments that require a lot of good entropy, such as systems used for generation of X.509 certificates (for example the FreeIPA server).
rsyslog.service	yes	Disable **rsyslog.service** only if you do not need persistent logs, or you set **systemd-journald** to persistent mode.

Service name	Can it be disabled?	More information
selinux-autorelabel-mark.service	yes	Disable **selinux-autorelabel-mark.service** only if you do not use SELinux.
sshd.service	yes	Disable **sshd.service** only if you do not need remote logins by OpenSSH server.
sssd.service	yes	Disable **sssd.service** only if there are no users who log in the system over the network (for example by using LDAP or Kerberos). Red Hat recommends to disable all **sssd-*** units if you disable **sssd.service**.
syslog.service	yes	An alias for **rsyslog.service**
tuned.service	yes	Disable **tuned.service** only if you do need to use performance tuning.
lvm2-lvmpolld.socket	yes	Disable **lvm2-lvmpolld.socket** only if you do not use Logical Volume Manager (LVM).
dnf-makecache.timer	yes	Disable **dnf-makecache.timer** only if you do not need your package metadata to be updated automatically.
unbound-anchor.timer	yes	Disable **unbound-anchor.timer** only if you do not need daily update of the root trust anchor for DNS Security Extensions (DNSSEC). This root trust anchor is used by Unbound resolver and resolver library for DNSSEC validation.

To find more information about a service, you can run one of the following commands:

```
$ systemctl cat <service_name>
```

```
$ systemctl help <service_name>
```

The **systemctl cat** command provides the content of the service file located under **/usr/lib/systemd/system/<service>**, as well as all applicable overrides. The applicable overrides include unit file overrides from the **/etc/systemd/system/<service>** file or drop-in files from a corresponding **unit.type.d** directory.

For more information on drop-in files, see the **systemd.unit** man page.

The **systemctl help** command shows the man page of the particular service.

17.3. ADDITIONAL RESOURCES

- **systemctl**(1) man page
- **systemd**(1) man page
- **systemd-delta**(1) man page
- **systemd.directives**(7) man page
- **systemd.unit**(5) man page
- **systemd.service**(5) man page
- **systemd.target**(5) man page
- **systemd.kill**(5) man page
- systemd Home Page

CHAPTER 18. 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.

18.1. 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.

18.2. CONFIGURING RESERVED USER AND GROUP IDS

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

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

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

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

Procedure

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

1. Open the **/etc/login.defs** file in an editor of your choice.

2. Find the lines that define the minimum value for automatic UID selection.

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

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

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

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

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

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

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

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

NOTE

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

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

WARNING

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

18.3. USER PRIVATE GROUPS

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

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

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

CHAPTER 19. MANAGING USER ACCOUNTS IN THE WEB CONSOLE

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

After reading this section, you will know:

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

Prerequisites

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

19.1. SYSTEM USER ACCOUNTS MANAGED IN THE WEB CONSOLE

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

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

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

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

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

19.2. ADDING NEW ACCOUNTS USING THE WEB CONSOLE

Use the following steps for adding user accounts to the system and setting administration rights to the accounts through the RHEL web console.

Prerequisites

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

Procedure

1. Log in to the RHEL web console.

2. Click **Accounts**.

3. Click **Create New Account**.

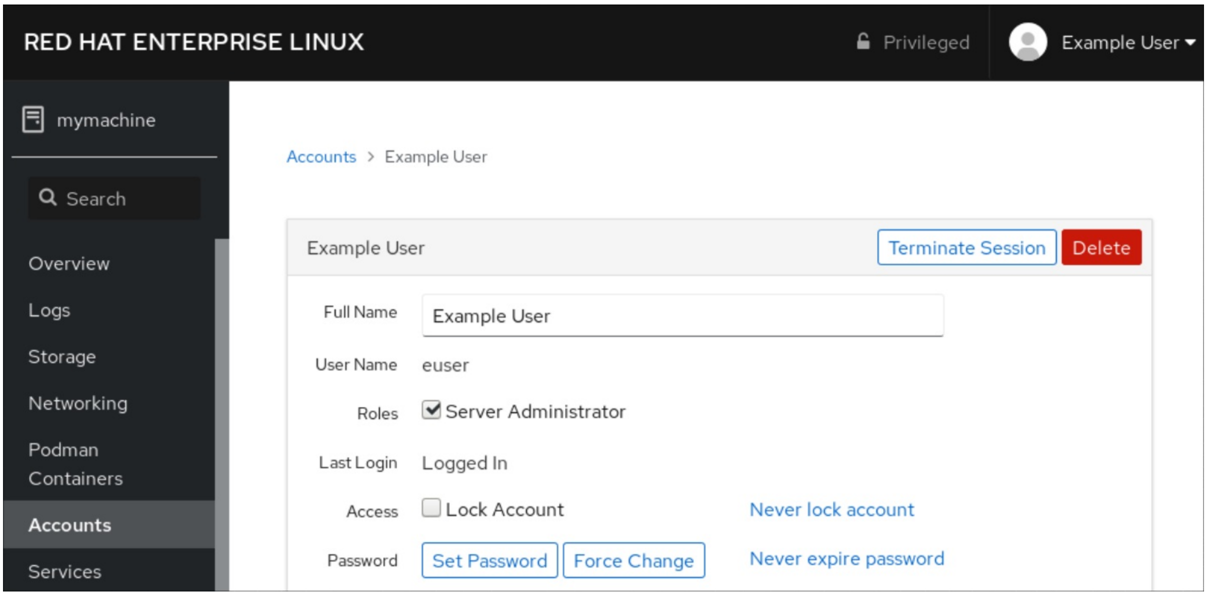
4. In the **Full Name** field, enter the full name of the user.
   The RHEL web console automatically suggests a user name from the full name and fills it in the **User Name** field. If you do not want to use the original naming convention consisting of the first letter of the first name and the whole surname, update the suggestion.

5. In the **Password/Confirm** fields, enter the password and retype it for verification that your password is correct.
   The color bar below the fields shows you the security level of the entered password, which does not allow you to create a user with a weak password.

6. Click **Create** to save the settings and close the dialog box.

7. Select the newly created account.

8. Select **Server Administrator** in the **Roles** item.



Example User

Full Name: Example User

User Name: euser

Roles: ☑ Server Administrator

Last Login: Logged In

Access: □ Lock Account

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

19.3. ENFORCING PASSWORD EXPIRATION IN THE WEB CONSOLE

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

Procedure

1. Log in to the RHEL 9 web console.

2. Click **Accounts**.

3. Select the user account for which to enforce password expiration.

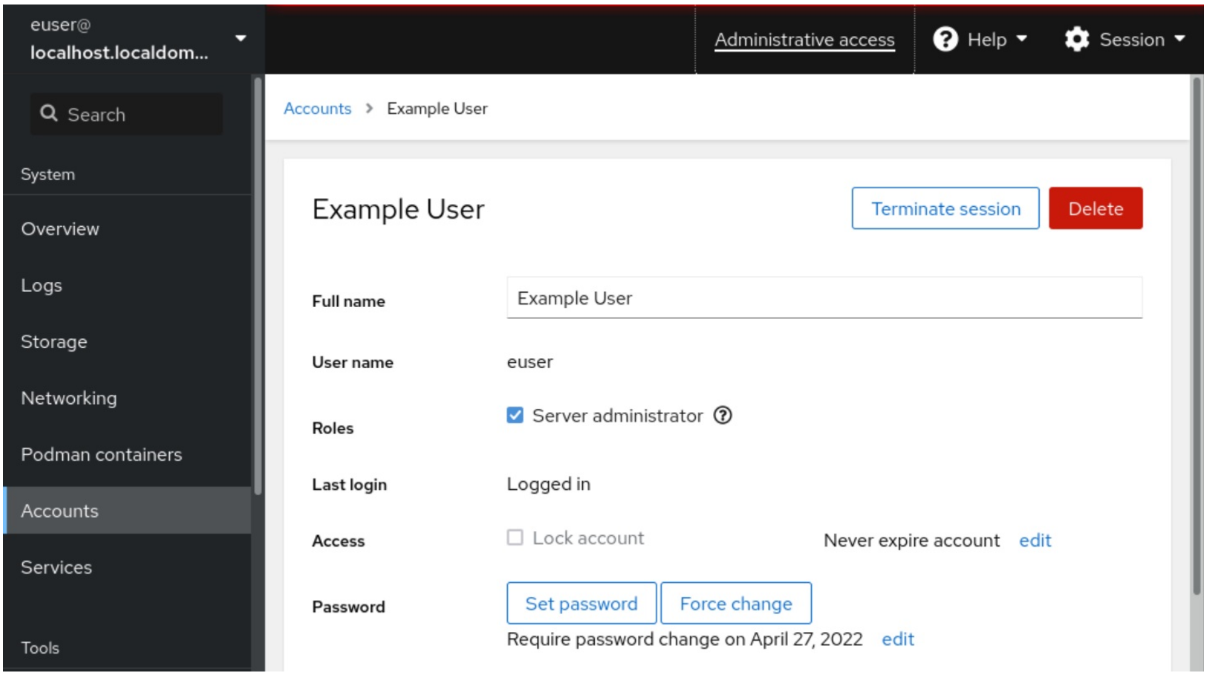
4. In the user account settings, click the second **edit**.

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**.

Verification steps

- To verify that the password expiration is set, open the account settings.
  The RHEL 9 web console displays a link with the date of expiration.



Example User

Full name: Example User

User name: euser

Roles: ☑ Server administrator

Last login: Logged in

Access: □ Lock account Never expire account edit

Password: Require password change on April 27, 2022 edit

19.4. TERMINATING USER SESSIONS IN THE WEB CONSOLE

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

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

Procedure

1. Log in to the RHEL 9 web console.

2. Click **Accounts**.

3. Click the user account for which you want to terminate the session.

4. Click **Terminate Session**.
   If the **Terminate Session** button is inactive, the user is not logged in to the system.

The RHEL web console terminates the sessions.

CHAPTER 20. 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.

20.1. ADDING A NEW USER FROM THE COMMAND LINE

This section describes how to use the **useradd** utility to add a new user.

Prerequisites

- **Root** access

Procedure

- To add a new user, use:

  ```
  # useradd options username
  ```

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

  > **Example 20.1. Adding a new user**
  >
  > To add the user **sarah** with user ID **5000**, use:
  >
  > ```
  > # useradd -u 5000 sarah
  > ```

Verification steps

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

  ```
  # id sarah
  ```

  The output returns:

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

Additional resources

- **useradd** man page

20.2. ADDING A NEW GROUP FROM THE COMMAND LINE

This section describes how to use the **groupadd** utility to add a new group.

Prerequisites

- **Root** access

Procedure

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

Verification steps

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

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

  The output returns:

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

Additional resources

- **groupadd** man page

20.3. ADDING A USER TO A SUPPLEMENTARY GROUP FROM THE COMMAND LINE

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

Prerequisites

- **root** access

Procedure

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

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

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

  > **Example 20.3. Adding a user to a supplementary group**
  >
  > To add the user **sysadmin** to the group **system-administrators**, use:

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

Verification steps

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

  ```
  # groups sysadmin
  ```

  The output displays:

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

20.4. CREATING A GROUP DIRECTORY

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

The following section describes how to create group directories.

Prerequisites

- **Root** access

Procedure

1. Create a directory:

   ```
   # mkdir directory-name
   ```

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

2. Create a group:

   ```
   # groupadd group-name
   ```

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

3. Add users to the group:

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

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

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

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

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

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

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

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

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

Verification steps

- To verify the correctness of set permissions, use:

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

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

The output returns:

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

CHAPTER 21. 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.

21.1. PRIMARY AND SUPPLEMENTARY USER GROUPS

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

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

Primary group

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

Supplementary groups

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

21.2. LISTING THE PRIMARY AND SUPPLEMENTARY GROUPS OF A USER

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

Procedure

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

  ```
  $ groups user-name
  ```

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

  > **Example 21.1. Listing of groups for user sarah:**
  >
  > ```
  > $ groups sarah
  > ```
  >
  > The output displays:
  >
  > ```
  > sarah : sarah wheel developer
  > ```

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

Example 21.2. Listing of groups for user marc:

```
$ groups marc
```

The output displays:

```
marc : marc
```

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

21.3. CHANGING THE PRIMARY GROUP OF A USER

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

Prerequisites:

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

Procedure

- Change the primary group of a user:

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

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

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

  Example 21.3. Example of changing the primary group of a user:

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

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

Verification steps

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

  ```
  $ groups sarah
  ```

  The output displays:

  ```
  sarah : sarah2
  ```

21.4. ADDING A USER TO A SUPPLEMENTARY GROUP FROM THE COMMAND LINE

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

Prerequisites

- **root** access

Procedure

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

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

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

  > **Example 21.4. Adding a user to a supplementary group**
  >
  > To add the user **sysadmin** to the group **system-administrators**, use:
  >
  > ```
  > # usermod --append -G system-administrators sysadmin
  > ```

Verification steps

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

  ```
  # groups sysadmin
  ```

  The output displays:

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

21.5. REMOVING A USER FROM A SUPPLEMENTARY GROUP

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

Prerequisites

- **root** access

Procedure

- Remove a user from a supplementary group:

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

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

  Example 21.5. Removing user from a supplementary group

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

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

Verification steps

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

  ```
  $ groups sarah
  ```

  The output displays:

  ```
  sarah : sarah2 wheel
  ```

21.6. CHANGING ALL OF THE SUPPLEMENTARY GROUPS OF A USER

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

Prerequisites

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

Procedure

- Overwrite a list of user’s supplementary groups:

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

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

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

IMPORTANT

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

Example 21.6. Changing the list of supplementary groups of a user

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

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

Verification steps

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

  ```
  # groups sarah
  ```

  The output displays:

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

CHAPTER 22. 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 enter such commands without logging in to the **root** user account.

22.1. USER AUTHORIZATIONS IN SUDOERS

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

When a user tries to use **sudo** privileges to run a command that is not allowed in the **/etc/sudoers** file, the system records a message containing ***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 removing the **#** comment character from the beginning of the line. The authorizations section relevant for user 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 use the following format to create new **sudoers** authorizations and to modify existing authorizations:

```
username hostname=path/to/command
```

Where:

- *username* is the name of the user or group, for example, **user1** or **%group1**.
- *hostname* is the name of the host on which the rule applies.
- *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 replace any of these variables with **ALL** to apply the rule to all users, hosts, or commands.

> **WARNING**
>
> With overly permissive rules, such as **ALL ALL=(ALL) ALL**, all users are able to run all commands as all users on all hosts. This can lead to security risks.

You can specify the arguments negatively using the **!** operator. For example, use **!root** to specify all users except the **root** user. Note that using the allowlists to allow specific users, groups, and commands, is more secure than using the blocklists to disallowing specific users, groups, and commands. By using the allowlists you also block new unauthorized users or groups.

> **WARNING**
>
> Avoid using negative rules for commands because users can overcome such rules by renaming commands using 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.

The preferred way of adding new rules to **sudoers** is by creating new files in the **/etc/sudoers.d/** directory instead of entering rules directly to the **/etc/sudoers** file. This is because the contents of this directory are preserved during system updates. In addition, it is easier to fix any errors in the separate files than in the **/etc/sudoers** file. The system reads the files in the **/etc/sudoers.d** directory when it reaches the following line in the **/etc/sudoers** file:

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

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

Additional resources

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

22.2. GRANTING SUDO ACCESS TO A USER

System administrators can grant **sudo** access to allow non-root users to execute administrative commands. 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**. The command is then executed as if they were the **root** user.

Be aware of the following limitations:

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

Prerequisites

- **root** access

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** does not have the **#** comment character before it.

4. Save any changes, and exit the editor.

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

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

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

Verification steps

- Verify that the user is added to the administrative **wheel** group:

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

Additional resources

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

22.3. 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.

For example, you can enable the user *<example.user>* to install programs on the **host.example.com** workstation using the **dnf** command with **sudo** privileges.

Prerequisites

- You must have **root** access to the system.

Procedure

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

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

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

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

The file opens automatically.

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

   ```
   <example.user> <host.example.com> = /usr/bin/dnf
   ```

   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.

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

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

5. Save the changes, and exit the editor.

Verification

1. To verify if the user *<example.user>* can run the **dnf** command with **sudo** privileges, switch the account:

   ```
   # su <example.user> -
   ```

2. Enter the **sudo dnf** command:

   ```
   $ sudo dnf
   [sudo] password for <example.user>:
   ```

   Enter the **sudo** password for the user *<example.user>*.

3. The system displays the list of **dnf** commands and options:

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

   If the system returns the ***<example.user>* is not in the sudoers file. This incident will be reported** error message, you have not created the file for *<example.user>* in **/etc/sudoers.d/**.

   If you receive the ***<example.user>* is not allowed to run sudo on *<host.example.com>*** error message, you have not completed the configuration correctly. Ensure that you are logged in as **root** and that you followed the steps thoroughly.

Additional resources

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

CHAPTER 23. CHANGING AND RESETTING THE ROOT PASSWORD

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

23.1. CHANGING THE ROOT PASSWORD AS THE ROOT USER

This section describes how to use the **passwd** command to change the **root** password as the **root** user.

Prerequisites

- **Root** access

Procedure

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

  ```
  # passwd
  ```

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

23.2. CHANGING OR RESETTING THE FORGOTTEN ROOT PASSWORD AS A NON-ROOT USER

This section describes how to use the **passwd** command to change or reset the forgotten **root** password as a non-root user.

Prerequisites

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

Procedure

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

  ```
  $ sudo passwd root
  ```

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

23.3. RESETTING THE ROOT PASSWORD ON BOOT

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

Procedure

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

The kernel boot parameters appear.

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

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

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

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

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

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

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

5. Remount the file system as writable:

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

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

6. Enter the **chroot** environment:

   ```
   chroot /sysroot
   ```

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

7. Reset the **root** password:

   ```
   passwd
   ```

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

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

   ```
   touch /.autorelabel
   ```

9. Exit the **chroot** environment:

   ```
   exit
   ```

10. Exit the **switch_root** prompt:

```
exit
```

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

Verification steps

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

2. Run the interactive shell as root:

   ```
   $ su
   ```

3. Enter your new **root** password.

4. Print the user name associated with the current effective user ID:

   ```
   whoami
   ```

   The output returns:

   ```
   root
   ```

CHAPTER 24. MANAGING FILE PERMISSIONS

File permissions control the ability of user and group accounts to view, modify, access, and execute the contents of the files and directories.

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**).

24.1. 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 24.1. 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 24.2. Permissions for a directory

If a directory has the following permissions:

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

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

NOTE

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

24.2. 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.

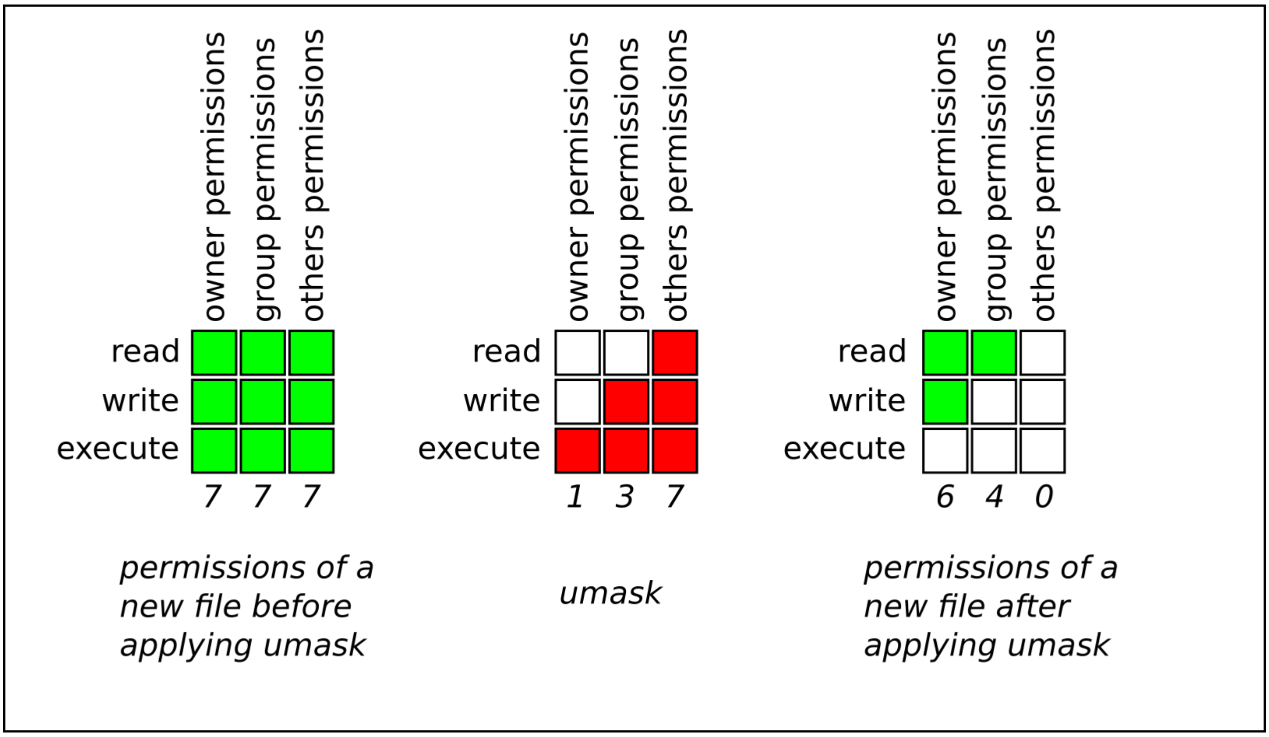
Permission	Symbolic value	Octal value
Read, write, and execute	rwx	0
Read and write	rw-	1
Read and execute	r-x	2
Read	r--	3
Write and execute	-wx	4
Write	-w-	5
Execute	--x	6
No permissions	---	7

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 24.3. 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**.



24.3. 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 24.4. 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 24.5. 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.

24.4. CHANGING FILE PERMISSIONS USING SYMBOLIC VALUES

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

You can assign the following *permissions*:

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

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

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

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

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

Procedure

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

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

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

See Base file permissions for more details.

Verification steps

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

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

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

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

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

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

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

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

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

Example 24.6. Changing permissions for files and directories

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

  1. Display the current permissions for **my-file.txt**:

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

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

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

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

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

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

- To change file permissions for **my-directory** from **drwxrwx---** to **drwxrwxr-x**, use:

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

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

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

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

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

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

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

24.5. 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.

CHAPTER 25. MANAGING THE UMASK

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

25.1. 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.

25.2. DISPLAYING THE DEFAULT BASH UMASK

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

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

Example 25.1. Determining if you are working in a login or a non-login bash shell

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

  ```
  $ echo $0
  bash
  ```

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

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

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

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

Procedure

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

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

  The output returns:

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

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

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

  The output returns:

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

25.3. SETTING THE UMASK USING SYMBOLIC VALUES

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

You can assign the following *permissions*:

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

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

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

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

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

NOTE

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

Procedure

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

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

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

See User file-creation mode for more details.

NOTE

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

25.4. SETTING THE UMASK USING OCTAL VALUES

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

Procedure

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

```
$ umask octal_value
```

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

NOTE

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

25.5. CHANGING THE DEFAULT UMASK FOR THE NON-LOGIN SHELL

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

Prerequisites

- **root** access

Procedure

1. As **root**, open the **/etc/bashrc** file in the editor.

2. Modify the following sections to set a new default **bash** *umask*:

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

```
else
  umask 022
fi
```

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

3. Save the changes and exit the editor.

25.6. CHANGING THE DEFAULT UMASK FOR THE LOGIN SHELL

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

Prerequisites

- **root** access

Procedure

1. As **root**, open the **/etc/login.defs** file in the editor.

2. Modify the following sections to set a new default **bash** *umask*:

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

UMASK           022
```

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

3. Save the changes and exit the editor.

25.7. CHANGING THE DEFAULT UMASK FOR A SPECIFIC USER

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

Procedure

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

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

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

25.8. SETTING DEFAULT PERMISSIONS FOR NEWLY CREATED HOME DIRECTORIES

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

Procedure

1. As **root**, open the **/etc/login.defs** file in the editor.

2. Modify the following section to set a new default *HOME_MODE*:

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

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

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

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

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

   UMASK           022
   ```

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

5. Save the changes and exit the editor.

CHAPTER 26. RECORDING DNS QUERIES BY USING DNSTAP IN RHEL

As a network administrator, you can record Domain Name System (DNS) details to analyze DNS traffic patterns, monitor DNS server performance, and troubleshoot DNS issues. If you want an advanced way to monitor and log details of incoming name queries, use the **dnstap** interface that records sent messages from the **named** service. You can capture and record DNS queries to collect information about websites or IP addresses.

Prerequisites

- Upgrade **BIND** packages to version **bind-9.16.15-3** or later, which contains the **dnstap** interface.

> **WARNING**
>
> If you already have a **BIND** version installed and running, adding a new version of **BIND** will overwrite the existing version.

Procedure

1. Enable **dnstap** and the target file by editing the **/etc/named.conf** file in the **options** block:

```
options
{
# …

dnstap { all; }; # Configure filter
dnstap-output file "/var/named/data/dnstap.bin" versions 2;

# …
};
# end of options
```

2. To specify which types of DNS traffic you want to log, add **dnstap** filters to the **dnstap** block in the **/etc/named.conf** file. You can use the following filters:

   - **auth** - Authoritative zone response or answer.
   - **client** - Internal client query or answer.
   - **forwarder** - Forwarded query or response from it.
   - **resolver** - Iterative resolution query or response.
   - **update** - Dynamic zone update requests.
   - **all** - Any from the above options.

- **query** or **response** - If you do not specify a **query** or a **response** keyword, **dnstap** records both.

> NOTE
>
> The **dnstap** filter contains multiple definitions delimited by a **;** in the **dnstap {}** block with the following syntax: **dnstap { (all | auth | client | forwarder | resolver | update) [(query | response)]; ... };**

3. To customize the behavior of the **dnstap** utility on the recorded packets, modify the **dnstap-output** option by providing additional parameters, as follows:

   - **size** (unlimited | <size>) - Enable automatic rolling over of the **dnstap** file when its size reaches the specified limit.

   - **versions** (unlimited | <integer>) - Specify the number of automatically rolled files to keep.

   - **suffix** (increment | timestamp) - Choose the naming convention for rolled out files. By default, the increment starts with **.0**. Alternatively, you can use the UNIX timestamp by setting the **timestamp** value.
     The following example requests **auth** responses only, **client** queries, and both queries and responses of dynamic **updates**:

     ```
     Example:

     dnstap {auth response; client query; update;};
     ```

4. To apply your changes, restart the **named** service:

   ```
   # systemctl restart named.service
   ```

5. Configure a periodic rollout for active logs
   In the following example, the **cron** scheduler runs the content of the user-edited script once a day. The **roll** option with the value **3** specifies that **dnstap** can create up to three backup log files. The value **3** overrides the **version** parameter of the **dnstap-output** variable, and limits the number of backup log files to three. Additionally, the binary log file is moved to another directory and renamed, and it never reaches the **.2** suffix, even if three backup log files already exist. You can skip this step if automatic rolling of binary logs based on size limit is sufficient.

   ```
   Example:

   sudoedit /etc/cron.daily/dnstap

   #!/bin/sh
   rndc dnstap -roll 3
   mv /var/named/data/dnstap.bin.1 /var/log/named/dnstap/dnstap-$(date -I).bin

   # use dnstap-read to analyze saved logs
   sudo chmod a+x /etc/cron.daily/dnstap
   ```

6. Handle and analyze logs in a human-readable format by using the **dnstap-read** utility:
   In the following example, the **dnstap-read** utility prints the output in the **YAML** file format.

> Example:
>
> dnstap-read -y *[file-name]*

CHAPTER 27. 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).

27.1. DISPLAYING THE CURRENT ACCESS CONTROL LIST

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

Procedure

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

  ```
  $ getfacl file-name
  ```

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

27.2. SETTING THE ACCESS CONTROL LIST

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

Prerequisites

- **root** access.

Procedure

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

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

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

> **Example 27.1. Modifying permissions for a group project**
>
> The following example describes how to modify permissions for the **group-project** file owned by the **root** user that belongs to the **root** group so that this file is:
>
> - Not executable by anyone.
> - The user **andrew** has the **rw-** permissions.
> - The user **susan** has the **---** permissions.
> - Other users have the **r--** permissions.
>
> **Procedure**
>
> ```
> # setfacl -m u:andrew:rw- group-project
> # setfacl -m u:susan:--- group-project
> ```

Verification steps

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

  ```
  $ getfacl group-project
  ```

  The output returns:

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

CHAPTER 28. USING THE CHRONY SUITE TO CONFIGURE NTP

Accurate timekeeping is important for several reasons in IT. In networking for example, accurate time stamps in packets and logs are required. In Linux systems, the **NTP** protocol is implemented by a daemon running in user space.

The user space daemon updates the system clock running in the kernel. The system clock can keep time by using various clock sources. Usually, the *Time Stamp Counter* (**TSC**) is used. The TSC is a CPU register which counts the number of cycles since it was last reset. It is very fast, has a high resolution, and there are no interruptions.

Starting with Red Hat Enterprise Linux 8, the **NTP** protocol is implemented by the **chronyd** daemon, available from the repositories in the **chrony** package.

The following sections describe how to use the **chrony** suite to configure NTP.

28.1. INTRODUCTION TO CHRONY SUITE

chrony is an implementation of the **Network Time Protocol (NTP)**. You can use **chrony**:

- To synchronize the system clock with **NTP** servers
- To synchronize the system clock with a reference clock, for example a GPS receiver
- To synchronize the system clock with a manual time input
- As an **NTPv4(RFC 5905)** server or peer to provide a time service to other computers in the network

chrony performs well in a wide range of conditions, including intermittent network connections, heavily congested networks, changing temperatures (ordinary computer clocks are sensitive to temperature), and systems that do not run continuously, or run on a virtual machine.

Typical accuracy between two machines synchronized over the Internet is within a few milliseconds, and for machines on a LAN within tens of microseconds. Hardware timestamping or a hardware reference clock may improve accuracy between two machines synchronized to a sub-microsecond level.

chrony consists of **chronyd**, a daemon that runs in user space, and **chronyc**, a command line program which can be used to monitor the performance of **chronyd** and to change various operating parameters when it is running.

The **chrony** daemon, **chronyd**, can be monitored and controlled by the command line utility **chronyc**. This utility provides a command prompt which allows entering a number of commands to query the current state of **chronyd** and make changes to its configuration. By default, **chronyd** accepts only commands from a local instance of **chronyc**, but it can be configured to accept monitoring commands also from remote hosts. The remote access should be restricted.

28.2. USING CHRONYC TO CONTROL CHRONYD

This section describes how to control **chronyd** 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**.

CHAPTER 29. USING CHRONY

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

29.1. MANAGING CHRONY

The following procedure describes how to install, start, stop, and check the status of **chronyd**.

Procedure

1. The **chrony** suite is installed by default on Red Hat Enterprise Linux. To ensure that it is, run the following command as **root**:

   ```
   # dnf install chrony
   ```

   The default location for the **chrony** daemon is **/usr/sbin/chronyd**. The command line utility will be installed to **/usr/bin/chronyc**.

2. To check the status of **chronyd**, issue the following command:

   ```
   $ systemctl status chronyd
   chronyd.service - NTP client/server
     Loaded: loaded (/usr/lib/systemd/system/chronyd.service; enabled)
     Active: active (running) since Wed 2013-06-12 22:23:16 CEST; 11h ago
   ```

3. To start **chronyd**, issue the following command as **root**:

   ```
   # systemctl start chronyd
   ```

   To ensure **chronyd** starts automatically at system start, issue the following command as **root**:

   ```
   # systemctl enable chronyd
   ```

4. To stop **chronyd**, issue the following command as **root**:

   ```
   # systemctl stop chronyd
   ```

   To prevent **chronyd** from starting automatically at system start, issue the following command as **root**:

   ```
   # systemctl disable chronyd
   ```

29.2. CHECKING IF CHRONY IS SYNCHRONIZED

The following procedure describes how to check if **chrony** is synchronized with the use of the **tracking**, **sources**, and **sourcestats** commands.

Procedure

1. To check **chrony** tracking, issue the following command:

```
$ chronyc tracking
Reference ID    : CB00710F (foo.example.net)
Stratum         : 3
Ref time (UTC)  : Fri Jan 27 09:49:17 2017
System time     :  0.000006523 seconds slow of NTP time
Last offset     : -0.000006747 seconds
RMS offset      : 0.000035822 seconds
Frequency       : 3.225 ppm slow
Residual freq   : 0.000 ppm
Skew            : 0.129 ppm
Root delay      : 0.013639022 seconds
Root dispersion : 0.001100737 seconds
Update interval : 64.2 seconds
Leap status     : Normal
```

2. The sources command displays information about the current time sources that **chronyd** is accessing. To check **chrony** sources, issue the following command:

```
$ chronyc sources
 210 Number of sources = 3
MS Name/IP address         Stratum Poll Reach LastRx Last sample
===============================================================================
====
#* GPS0                          0   4   377    11   -479ns[ -621ns] /-  134ns
^? a.b.c                         2   6   377    23   -923us[ -924us] +/-   43ms
^ d.e.f                          1   6   377    21  -2629us[-2619us] +/-   86ms
```

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.

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

29.3. MANUALLY ADJUSTING THE SYSTEM CLOCK

The following procedure describes how to manually adjust the System Clock.

Procedure

1. To step the system clock immediately, bypassing any adjustments in progress by slewing, issue the following command as **root**:

```
# chronyc makestep
```

If the **rtcfile** directive is used, the real-time clock should not be manually adjusted. Random adjustments would interfere with **chrony**'s need to measure the rate at which the real-time clock drifts.

29.4. DISABLING A CHRONY DISPATCHER SCRIPT

The **chrony** dispatcher script manages the online and offline state of the NTP servers. As a system administrator, you can disable the dispatcher script to keep **chronyd** polling the servers constantly.

If you enable NetworkManager on your system to manage networking configuration, the NetworkManager executes the **chrony** dispatcher script during interface reconfiguration, stop or start operations. However, if you configure certain interfaces or routes outside of NetworkManager, you can encounter the following situation:

1. The dispatcher script might run when no route to the NTP servers exists, causing the NTP servers to switch to the offline state.
2. If you establish the route later, the script does not run again by default, and the NTP servers remain in the offline state.

To ensure that **chronyd** can synchronize with your NTP servers, which have separately managed interfaces, disable the dispatcher script.

Prerequisites

- You installed NetworkManager on your system and enabled it.
- Root access

Procedure

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

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

NOTE

After this change, the NetworkManager cannot execute the dispatcher script, and the NTP servers remain in the online state at all times.

29.5. SETTING UP CHRONY FOR A SYSTEM IN AN ISOLATED NETWORK

For a network that is never connected to the Internet, one computer is selected to be the primary timeserver. The other computers are either direct clients of the server, or clients of clients. On the server, the drift file must be manually set with the average rate of drift of the system clock. If the server is rebooted, it will obtain the time from surrounding systems and calculate an average to set its system clock. Thereafter it resumes applying adjustments based on the drift file. The drift file will be updated automatically when the **settime** command is used.

The following procedure describes how to set up **chrony** for a system in an isolated network.

Procedure

1. On the system selected to be the server, using a text editor running as **root**, edit **/etc/chrony.conf** as follows:

   ```
   driftfile /var/lib/chrony/drift
   commandkey 1
   keyfile /etc/chrony.keys
   initstepslew 10 client1 client3 client6
   local stratum 8
   manual
   allow 192.0.2.0
   ```

   Where **192.0.2.0** is the network or subnet address from which the clients are allowed to connect.

2. On the systems selected to be direct clients of the server, using a text editor running as **root**, edit the **/etc/chrony.conf** as follows:

   ```
   server ntp1.example.net
   driftfile /var/lib/chrony/drift
   logdir /var/log/chrony
   log measurements statistics tracking
   keyfile /etc/chrony.keys
   commandkey 24
   local stratum 10
   initstepslew 20 ntp1.example.net
   allow 192.0.2.123
   ```

   Where **192.0.2.123** is the address of the server, and **ntp1.example.net** is the host name of the server. Clients with this configuration will resynchronize with the server if it restarts.

On the client systems which are not to be direct clients of the server, the **/etc/chrony.conf** file should be the same except that the **local** and **allow** directives should be omitted.

In an isolated network, you can also use the **local** directive that enables a local reference mode, which allows **chronyd** operating as an **NTP** server to appear synchronized to real time, even when it was never synchronized or the last update of the clock happened a long time ago.

To allow multiple servers in the network to use the same local configuration and to be synchronized to one another, without confusing clients that poll more than one server, use the **orphan** option of the **local** directive which enables the orphan mode. Each server needs to be configured to poll all other servers with **local**. This ensures that only the server with the smallest reference ID has the local reference active and other servers are synchronized to it. When the server fails, another one will take over.

29.6. CONFIGURING REMOTE MONITORING ACCESS

chronyc can access **chronyd** in two ways:

- Internet Protocol, IPv4 or IPv6.
- Unix domain socket, which is accessible locally by the **root** or **chrony** user.

By default, **chronyc** connects to the Unix domain socket. The default path is **/var/run/chrony/chronyd.sock**. If this connection fails, which can happen for example when **chronyc** is running under a non-root user, **chronyc** tries to connect to 127.0.0.1 and then ::1.

Only the following monitoring commands, which do not affect the behavior of **chronyd**, are allowed from the network:

- activity
- manual list
- rtcdata
- smoothing
- sources
- sourcestats
- tracking
- waitsync

The set of hosts from which **chronyd** accepts these commands can be configured with the **cmdallow** directive in the configuration file of **chronyd**, or the **cmdallow** command in **chronyc**. By default, the commands are accepted only from localhost (127.0.0.1 or ::1).

All other commands are allowed only through the Unix domain socket. When sent over the network, **chronyd** responds with a **Not authorised** error, even if it is from localhost.

The following procedure describes how to access chronyd remotely with **chronyc**.

Procedure

1. Allow access from both IPv4 and IPv6 addresses by adding the following to the **/etc/chrony.conf** file:

   ```
   bindcmdaddress 0.0.0.0
   ```

   or

   ```
   bindcmdaddress ::
   ```

2. Allow commands from the remote IP address, network, or subnet by using the **cmdallow** directive.
   Add the following content to the **/etc/chrony.conf** file:

   ```
   cmdallow 192.168.1.0/24
   ```

3. Open port 323 in the firewall to connect from a remote system:

   ```
   # firewall-cmd --zone=public --add-port=323/udp
   ```

   Optionally, you can open port 323 permanently using the **--permanent** option:

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

4. If you opened port 323 permanently, reload the firewall configuration:

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

Additional resources

- **chrony.conf(5)** man page

29.7. MANAGING TIME SYNCHRONIZATION USING RHEL SYSTEM ROLES

You can manage time synchronization on multiple target machines using the **timesync** role. The **timesync** role installs and configures an NTP or PTP implementation to operate as an NTP or PTP client to synchronize the system clock.

> **WARNING**
>
> The **timesync** role replaces the configuration of the given or detected provider service on the managed host. Previous settings are lost, even if they are not specified in the role variables. The only preserved setting is the choice of provider if the **timesync_ntp_provider** variable is not defined.

The following example shows how to apply the **timesync** role in a situation with just one pool of servers.

Example 29.1. 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

29.8. ADDITIONAL RESOURCES

- **chronyc(1)** man page
- **chronyd(8)** man page
- Frequently Asked Questions

CHAPTER 30. CHRONY WITH HW TIMESTAMPING

Hardware timestamping is a feature supported in some Network Interface Controller (NICs) which provides accurate timestamping of incoming and outgoing packets. **NTP** timestamps are usually created by the kernel and **chronyd** with the use of the system clock. However, when HW timestamping is enabled, the NIC uses its own clock to generate the timestamps when packets are entering or leaving the link layer or the physical layer. When used with **NTP**, hardware timestamping can significantly improve the accuracy of synchronization. For best accuracy, both **NTP** servers and **NTP** clients need to use hardware timestamping. Under ideal conditions, a sub-microsecond accuracy may be possible.

Another protocol for time synchronization that uses hardware timestamping is **PTP**.

Unlike **NTP**, **PTP** relies on assistance in network switches and routers. If you want to reach the best accuracy of synchronization, use **PTP** on networks that have switches and routers with **PTP** support, and prefer **NTP** on networks that do not have such switches and routers.

The following sections describe how to:

- Verify support for hardware timestamping
- Enable hardware timestamping
- Configure client polling interval
- Enable interleaved mode
- Configure server for large number of clients
- Verify hardware timestamping
- Configure PTP-NTP bridge

30.1. VERIFYING SUPPORT FOR HARDWARE TIMESTAMPING

To verify that hardware timestamping with **NTP** is supported by an interface, use the **ethtool -T** command. An interface can be used for hardware timestamping with **NTP** if **ethtool** lists the **SOF_TIMESTAMPING_TX_HARDWARE** and **SOF_TIMESTAMPING_TX_SOFTWARE** capabilities and also the **HWTSTAMP_FILTER_ALL** filter mode.

Example 30.1. Verifying support for hardware timestamping on a specific interface

```
# ethtool -T eth0
```

Output:

```
Timestamping parameters for eth0:
Capabilities:
        hardware-transmit     (SOF_TIMESTAMPING_TX_HARDWARE)
        software-transmit     (SOF_TIMESTAMPING_TX_SOFTWARE)
        hardware-receive      (SOF_TIMESTAMPING_RX_HARDWARE)
        software-receive      (SOF_TIMESTAMPING_RX_SOFTWARE)
        software-system-clock (SOF_TIMESTAMPING_SOFTWARE)
        hardware-raw-clock    (SOF_TIMESTAMPING_RAW_HARDWARE)
PTP Hardware Clock: 0
Hardware Transmit Timestamp Modes:
	off                   (HWTSTAMP_TX_OFF)
	on                    (HWTSTAMP_TX_ON)
Hardware Receive Filter Modes:
	none                  (HWTSTAMP_FILTER_NONE)
	all                   (HWTSTAMP_FILTER_ALL)
	ptpv1-l4-sync         (HWTSTAMP_FILTER_PTP_V1_L4_SYNC)
	ptpv1-l4-delay-req    (HWTSTAMP_FILTER_PTP_V1_L4_DELAY_REQ)
	ptpv2-l4-sync         (HWTSTAMP_FILTER_PTP_V2_L4_SYNC)
	ptpv2-l4-delay-req    (HWTSTAMP_FILTER_PTP_V2_L4_DELAY_REQ)
	ptpv2-l2-sync         (HWTSTAMP_FILTER_PTP_V2_L2_SYNC)
	ptpv2-l2-delay-req    (HWTSTAMP_FILTER_PTP_V2_L2_DELAY_REQ)
	ptpv2-event           (HWTSTAMP_FILTER_PTP_V2_EVENT)
	ptpv2-sync            (HWTSTAMP_FILTER_PTP_V2_SYNC)
	ptpv2-delay-req       (HWTSTAMP_FILTER_PTP_V2_DELAY_REQ)
```

30.2. ENABLING HARDWARE TIMESTAMPING

To enable hardware timestamping, use the **hwtimestamp** directive in the **/etc/chrony.conf** file. The directive can either specify a single interface, or a wildcard character can be used to enable hardware timestamping on all interfaces that support it. Use the wildcard specification in case that no other application, like **ptp4l** from the **linuxptp** package, is using hardware timestamping on an interface. Multiple **hwtimestamp** directives are allowed in the chrony configuration file.

Example 30.2. Enabling hardware timestamping by using the hwtimestamp directive

```
hwtimestamp eth0
hwtimestamp eth1
hwtimestamp *
```

30.3. CONFIGURING CLIENT POLLING INTERVAL

The default range of a polling interval (64-1024 seconds) is recommended for servers on the Internet. For local servers and hardware timestamping, a shorter polling interval needs to be configured in order to minimize offset of the system clock.

The following directive in **/etc/chrony.conf** specifies a local **NTP** server using one second polling interval:

```
server ntp.local minpoll 0 maxpoll 0
```

30.4. ENABLING INTERLEAVED MODE

NTP servers that are not hardware **NTP** appliances, but rather general purpose computers running a software **NTP** implementation, like **chrony**, will get a hardware transmit timestamp only after sending a packet. This behavior prevents the server from saving the timestamp in the packet to which it corresponds. In order to enable **NTP** clients receiving transmit timestamps that were generated after the transmission, configure the clients to use the **NTP** interleaved mode by adding the **xleave** option to the server directive in **/etc/chrony.conf**:

```
server ntp.local minpoll 0 maxpoll 0 xleave
```

30.5. CONFIGURING SERVER FOR LARGE NUMBER OF CLIENTS

The default server configuration allows a few thousands of clients at most to use the interleaved mode concurrently. To configure the server for a larger number of clients, increase the **clientloglimit** directive in **/etc/chrony.conf**. This directive specifies the maximum size of memory allocated for logging of clients' access on the server:

```
clientloglimit 100000000
```

30.6. VERIFYING HARDWARE TIMESTAMPING

To verify that the interface has successfully enabled hardware timestamping, check the system log. The log should contain a message from **chronyd** for each interface with successfully enabled hardware timestamping.

Example 30.3. Log messages for interfaces with enabled hardware timestamping

```
chronyd[4081]: Enabled HW timestamping on eth0
chronyd[4081]: Enabled HW timestamping on eth1
```

When **chronyd** is configured as an **NTP** client or peer, you can have the transmit and receive timestamping modes and the interleaved mode reported for each **NTP** source by the **chronyc ntpdata** command:

Example 30.4. Reporting the transmit, receive timestamping and interleaved mode for each NTP source

```
# chronyc ntpdata
```

Output:

```
Remote address  : 203.0.113.15 (CB00710F)
Remote port     : 123
Local address   : 203.0.113.74 (CB00714A)
Leap status     : Normal
Version         : 4
Mode            : Server
Stratum         : 1
Poll interval   : 0 (1 seconds)
Precision       : -24 (0.000000060 seconds)
Root delay      : 0.000015 seconds
Root dispersion : 0.000015 seconds
Reference ID    : 47505300 (GPS)
Reference time  : Wed May 03 13:47:45 2017
Offset          : -0.000000134 seconds
Peer delay      : 0.000005396 seconds
Peer dispersion : 0.000002329 seconds
Response time   : 0.000152073 seconds
Jitter asymmetry: +0.00
NTP tests       : 111 111 1111
Interleaved     : Yes
Authenticated   : No
```

```
TX timestamping : Hardware
RX timestamping : Hardware
Total TX        : 27
Total RX        : 27
Total valid RX  : 27
```

Example 30.5. Reporting the stability of NTP measurements

```
# chronyc sourcestats
```

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

Output:

```
210 Number of sources = 1
Name/IP Address            NP  NR  Span  Frequency  Freq Skew  Offset  Std Dev
ntp.local                12   7    11     +0.000      0.019     +0ns    49ns
```

30.7. CONFIGURING PTP-NTP BRIDGE

If a highly accurate Precision Time Protocol (**PTP**) primary timeserver is available in a network that does not have switches or routers with **PTP** support, a computer may be dedicated to operate as a **PTP** client and a stratum-1 **NTP** server. Such a computer needs to have two or more network interfaces, and be close to the primary timeserver or have a direct connection to it. This will ensure highly accurate synchronization in the network.

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

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

Example 30.6. Configuring chronyd to provide the system time using the other interface

```
bindaddress 203.0.113.74
hwtimestamp eth1
local stratum 1
```

CHAPTER 31. 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.

31.1. ENABLING NETWORK TIME SECURITY (NTS) IN THE CLIENT CONFIGURATION FILE

By default, Network Time Security (NTS) is not enabled. You can enable NTS in the **/etc/chrony.conf**. For that, perform the following steps:

Prerequisites

- Server with the NTS support

Procedure

In the client configuration file:

1. Specify the server with the **nts** option in addition to the recommended **iburst** option.

   ```
   For example:
   server time.example.com iburst nts
   server nts.netnod.se iburst nts
   server ptbtime1.ptb.de iburst nts
   ```

2. To avoid repeating the Network Time Security-Key Establishment (NTS-KE) session during system boot, add the following line to **chrony.conf**, if it is not present:

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

3. To disable synchronization with Network Time Protocol (NTP) servers provided by **DHCP**, comment out or remove the following line in **chrony.conf**, if it is present:

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

4. Save your changes.

5. Restart the **chronyd** service:

   ```
   systemctl restart chronyd
   ```

Verification

- Verify if the **NTS** keys were successfully established:

  ```
  # chronyc -N authdata
  ```

```
Name/IP address  Mode KeyID Type KLen Last Atmp  NAK Cook CLen
=========================================================================
time.example.com  NTS     1   15  256  33m    0    0    8  100
nts.sth1.ntp.se   NTS     1   15  256  33m    0    0    8  100
nts.sth2.ntp.se   NTS     1   15  256  33m    0    0    8  100
```

The **KeyID**, **Type**, and **KLen** should have non-zero values. If the value is zero, check the system log for error messages from **chronyd**.

- Verify the client is making NTP measurements:

```
# chronyc -N sources

MS Name/IP address Stratum Poll Reach LastRx Last sample
=================================================================
time.example.com   3       6   377    45   +355us[ +375us] +/-   11ms
nts.sth1.ntp.se    1       6   377    44   +237us[ +237us] +/-   23ms
nts.sth2.ntp.se    1       6   377    44   -170us[ -170us] +/-   22ms
```

The **Reach** column should have a non-zero value; ideally 377. If the value rarely gets 377 or never gets to 377, it indicates that NTP requests or responses are getting lost in the network.

Additional resources

- **chrony.conf(5)** man page

31.2. ENABLING NETWORK TIME SECURITY (NTS) ON THE SERVER

If you run your own Network Time Protocol (NTP) server, you can enable the server Network Time Security (NTS) support to facilitate its clients to synchronize securely.

If the NTP server is a client of other servers, that is, it is not a Stratum 1 server, it should use NTS or symmetric key for its synchronization.

Prerequisites

- Server private key in **PEM** format
- Server certificate with required intermediate certificates in **PEM** format

Procedure

1. Specify the private key and the certificate file in **chrony.conf**

```
For example:
ntsserverkey /etc/pki/tls/private/foo.example.net.key
ntsservercert /etc/pki/tls/certs/foo.example.net.crt
```

2. Ensure that both the key and certificate files are readable by the chrony system user, by setting the group ownership.

```
For example:
chown :chrony /etc/pki/tls/*/foo.example.net.*
```

3. Ensure the **ntsdumpdir /var/lib/chrony** directive is present in the **chrony.conf**.

4. Restart the **chronyd** service:

   ```
   systemctl restart chronyd
   ```

   IMPORTANT

   If the server has a firewall, it needs to allow both the **UDP 123** and **TCP 4460** ports for NTP and Network Time Security-Key Establishment (NTS-KE).

Verification

- Perform a quick test from a client machine with the following command:

  ```
  $ chronyd -Q -t 3 'server

  foo.example.net iburst nts maxsamples 1'
  2021-09-15T13:45:26Z chronyd version 4.1 starting (+CMDMON +NTP +REFCLOCK +RTC
  +PRIVDROP +SCFILTER +SIGND +ASYNCDNS +NTS +SECHASH +IPV6 +DEBUG)
  2021-09-15T13:45:26Z Disabled control of system clock
  2021-09-15T13:45:28Z System clock wrong by 0.002205 seconds (ignored)
  2021-09-15T13:45:28Z chronyd exiting
  ```

  The **System clock wrong** message indicates the NTP server is accepting NTS-KE connections and responding with NTS-protected NTP messages.

- Verify the NTS-KE connections and authenticated NTP packets observed on the server:

  ```
  # chronyc serverstats

  NTP packets received       : 7
  NTP packets dropped        : 0
  Command packets received   : 22
  Command packets dropped    : 0
  Client log records dropped : 0
  NTS-KE connections accepted: 1
  NTS-KE connections dropped : 0
  Authenticated NTP packets: 7
  ```

  If the value of the **NTS-KE connections accepted** and **Authenticated NTP packets** field is a non-zero value, it means that at least one client was able to connect to the NTS-KE port and send an authenticated NTP request.

CHAPTER 32. USING SECURE COMMUNICATIONS BETWEEN TWO SYSTEMS WITH OPENSSH

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

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

32.1. SSH AND OPENSSH

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

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

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

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

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

NOTE

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

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

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

Two versions of SSH currently exist: version 1, and the newer version 2. The OpenSSH suite in RHEL supports only SSH version 2. It has an enhanced key-exchange algorithm that is not vulnerable to exploits known in version 1.

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

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

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

Additional resources

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

32.2. CONFIGURING AND STARTING AN OPENSSH SERVER

Use the following procedure for a basic configuration that might be required for your environment and for starting an OpenSSH server. Note that after the default RHEL installation, the **sshd** daemon is already started and server host keys are automatically created.

Prerequisites

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

Procedure

1. Start the **sshd** daemon in the current session and set it to start automatically at boot time:

```
# systemctl start sshd
# systemctl enable sshd
```

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

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

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

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

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

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

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

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

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

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

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

Verification

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

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

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

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

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

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

Additional resources

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

32.3. SETTING AN OPENSSH SERVER FOR KEY-BASED AUTHENTICATION

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

Prerequisites

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

Procedure

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

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

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

   ```
   PasswordAuthentication no
   ```

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

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

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

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

   ```
   # systemctl reload sshd
   ```

Additional resources

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

32.4. GENERATING SSH KEY PAIRS

Use this procedure to generate an SSH key pair on a local system and to copy the generated public key to an OpenSSH server. If the server is configured accordingly, you can log in to the OpenSSH server without providing any password.

IMPORTANT

If you complete the following steps as **root**, only **root** is able to use the keys.

Procedure

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

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

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

2. To copy the public key to a remote machine:

```
$ ssh-copy-id joesec@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
joesec@ssh-server-example.com's password:
...
Number of key(s) added: 1

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

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.

NOTE

If you reinstall your system and want to keep previously generated key pairs, back up the ~/**.ssh**/ directory. After reinstalling, copy it back to your home directory. You can do this for all users on your system, including **root**.

Verification

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

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

Additional resources

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

32.5. USING SSH KEYS STORED ON A SMART CARD

Red Hat Enterprise Linux enables you to use RSA and ECDSA keys stored on a smart card on OpenSSH clients. Use this procedure to enable authentication using a smart card instead of using a password.

Prerequisites

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

Procedure

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

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

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

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

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

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

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

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

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

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

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

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

Additional resources

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

32.6. MAKING OPENSSH MORE SECURE

The following tips help you to increase security when using OpenSSH. Note that changes in the **/etc/ssh/sshd_config** OpenSSH configuration file require reloading the **sshd** daemon to take effect:

```
# systemctl reload sshd
```

IMPORTANT

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

Disabling insecure connection protocols

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

Enabling key-based authentication and disabling password-based authentication

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

  ```
  PasswordAuthentication no
  ```

Key types

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

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

  NOTE

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

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

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

Non-default port

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

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

  Furthermore, update **firewalld** configuration:

```
# firewall-cmd --add-port port_number/tcp
# firewall-cmd --runtime-to-permanent
```

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

Root login

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

  CAUTION

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

Using the X Security extension

- The X server in Red Hat Enterprise Linux clients does not provide the X Security extension. Therefore, clients cannot request another security layer when connecting to untrusted SSH servers with X11 forwarding. Most applications are not able to run with this extension enabled anyway.
  By default, the **ForwardX11Trusted** option in the **/etc/ssh/ssh_config.d/05-redhat.conf** file is set to **yes**, and there is no difference between the **ssh -X remote_machine** (untrusted host) and **ssh -Y remote_machine** (trusted host) command.

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

Restricting access to specific users, groups, or domains

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

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

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

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

Changing system-wide cryptographic policies

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

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

- To opt-out of the system-wide crypto policies for your OpenSSH server, uncomment the line with the **CRYPTO_POLICY=** variable in the **/etc/sysconfig/sshd** file. After this change, values that you specify in the **Ciphers**, **MACs**, **KexAlgoritms**, and **GSSAPIKexAlgorithms** sections in the **/etc/ssh/sshd_config** file are not overridden. Note that this task requires deep expertise in configuring cryptographic options.

- See Using system-wide cryptographic policies in the Security hardening title for more information.

Additional resources

- **sshd_config(5)**, **ssh-keygen(1)**, **crypto-policies(7)**, and **update-crypto-policies(8)** man pages.

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

Use this procedure for connecting your local system to a remote server through an intermediary server, also called jump host.

Prerequisites

- A jump host accepts SSH connections from your local system.

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

Procedure

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

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

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

   - The **HostName** parameter sets the actual host name or IP address of the jump host.

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

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

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

   ```
   $ ssh remote-server
   ```

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

NOTE

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

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

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

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

Additional resources

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

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

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

Prerequisites

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

For more information, see Generating SSH key pairs .

Procedure

1. Optional: Verify you can use the key to authenticate to the remote host:

   a. Connect to the remote host using SSH:

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

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

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

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

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

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

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

Verification

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

```
$ ssh example.user1@198.51.100.1

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

Note that you did not have to enter the passphrase.

32.9. 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.
- OpenSSH Home Page
- Configuring SELinux for applications and services with non-standard configurations
- Controlling network traffic using firewalld