Red Hat Enterprise Linux 9

Interactively installing RHEL over the network

Installing RHEL on several systems using network resources or on a headless system with the graphical installer

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Legal Notice

Abstract

You can install RHEL by using the graphical installer over your local network. Use this method to install RHEL on one or a few systems if you prefer the graphical interface during the installation and your systems have no peripherals, such as a display. The installation source is a server in your local network or the Red Hat content delivery network (CDN).

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PART I. PREPARING THE RHEL INSTALLATION

Before installing Red Hat Enterprise Linux (RHEL), ensure that your system meets the necessary hardware and architecture requirements. Additionally, you may want to optimize your installation experience by customizing the installation media or creating a bootable medium tailored to your environment. Registration of your RHEL system to Red Hat provides access to updates and support, which can enhance the system's stability and security. Special attention may also be needed for systems using UEFI Secure Boot, particularly when installing or booting RHEL beta releases.

CHAPTER 1. SYSTEM REQUIREMENTS AND SUPPORTED ARCHITECTURES

Red Hat Enterprise Linux 9 delivers a stable, secure, consistent foundation across hybrid cloud deployments with the tools needed to deliver workloads faster with less effort. You can deploy RHEL as a guest on supported hypervisors and Cloud provider environments as well as on physical infrastructure, so your applications can take advantage of innovations in the leading hardware architecture platforms.

Review the guidelines provided for system, hardware, security, memory, and RAID before installing.

If you want to use your system as a virtualization host, review the necessary hardware requirements for virtualization.

Red Hat Enterprise Linux supports the following architectures:

- AMD and Intel 64-bit architectures
- The 64-bit ARM architecture
- IBM Power Systems, Little Endian
- 64-bit IBM Z architectures

1.1. SUPPORTED INSTALLATION TARGETS

An installation target is a storage device that stores Red Hat Enterprise Linux and boots the system. Red Hat Enterprise Linux supports the following installation targets for IBMZ , IBM Power, AMD64, Intel 64, and 64-bit ARM systems:

- Storage connected by a standard internal interface, such as DASD, SCSI, SATA, or SAS
- BIOS/firmware RAID devices on the Intel64, AMD64 and arm64 architectures
- NVDIMM devices in sector mode on the Intel64 and AMD64 architectures, supported by the **nd_pmem** driver.
- Fibre Channel Host Bus Adapters and multipath devices. Some can require vendor-provided drivers.
- Xen block devices on Intel processors in Xen virtual machines.
- VirtIO block devices on Intel processors in KVM virtual machines.

Red Hat does not support installation to USB drives or SD memory cards. For information about support for third-party virtualization technologies, see the Red Hat Hardware Compatibility List .

1.2. DISK AND MEMORY REQUIREMENTS

If several operating systems are installed, it is important that you verify that the allocated disk space is separate from the disk space required by Red Hat Enterprise Linux. In some cases, it is important to dedicate specific partitions to Red Hat Enterprise Linux, for example, for AMD64, Intel 64, and 64-bit ARM, at least two partitions (/ and **swap**) must be dedicated to RHEL and for IBM Power Systems servers, at least three partitions (/, **swap**, and a **PReP** boot partition) must be dedicated to RHEL.

Additionally, you must have a minimum of 10 GiB of available disk space. To install Red Hat Enterprise Linux, you must have a minimum of 10 GiB of space in either unpartitioned disk space or in partitions that can be deleted.

For more information, see Partitioning reference for more information.

Table 1.1. Minimum RAM requirements

Installation type	Minimum RAM
Local media installation (USB, DVD)	• 1.5 GiB for aarch64, IBM Z and x86_64 architectures • 3 GiB for ppc64le architecture
NFS network installation	• 1.5 GiB for aarch64, IBM Z and x86_64 architectures • 3 GiB for ppc64le architecture
HTTP, HTTPS or FTP network installation	• 3 GiB for IBM Z and x86_64 architectures • 4 GiB for aarch64 and ppc64le architectures

It is possible to complete the installation with less memory than the minimum requirements. The exact requirements depend on your environment and installation path. Test various configurations to determine the minimum required RAM for your environment. Installing Red Hat Enterprise Linux using a Kickstart file has the same minimum RAM requirements as a standard installation. However, additional RAM may be required if your Kickstart file includes commands that require additional memory, or write data to the RAM disk. For more information, see the Automatically installing RHEL document.

1.3. GRAPHICS DISPLAY RESOLUTION REQUIREMENTS

Your system must have the following minimum resolution to ensure a smooth and error-free installation of Red Hat Enterprise Linux.

Table 1.2. Display resolution

Product version	Resolution
Red Hat Enterprise Linux 9	**Minimum**: 800 x 600 **Recommended**: 1026 x 768

1.4. UEFI SECURE BOOT AND BETA RELEASE REQUIREMENTS

If you plan to install a Beta release of Red Hat Enterprise Linux, on systems having UEFI Secure Boot enabled, then first disable the UEFI Secure Boot option and then begin the installation.

UEFI Secure Boot requires that the operating system kernel is signed with a recognized private key, which the system's firware verifies using the corresponding public key. For Red Hat Enterprise Linux Beta releases, the kernel is signed with a Red Hat Beta-specific public key, which the system fails to recognize by default. As a result, the system fails to even boot the installation media.

Additional resources

- For information about installing RHEL on IBM, see IBM installation documentation
- Security hardening
- Composing a customized RHEL system image
- Red Hat ecosystem catalog
- RHEL technology capabilities and limits

CHAPTER 2. THE VALUE OF REGISTERING YOUR RHEL SYSTEM TO RED HAT

Registration establishes an authorized connection between your system and Red Hat. Red Hat issues the registered system, whether a physical or virtual machine, a certificate that identifies and authenticates the system so that it can receive protected content, software updates, security patches, support, and managed services from Red Hat.

With a valid subscription, you can register a Red Hat Enterprise Linux (RHEL) system in the following ways:

- During the installation process, using an installer graphical user interface (GUI) or text user interface (TUI)
- After installation, using the command line interface (CLI)
- Automatically, during or after installation, using a kickstart script or an activation key.

The specific steps to register your system depend on the version of RHEL that you are using and the registration method that you choose.

Registering your system to Red Hat enables features and capabilities that you can use to manage your system and report data. For example, a registered system is authorized to access protected content repositories for subscribed products through the Red Hat Content Delivery Network (CDN) or a Red Hat Satellite Server. These content repositories contain Red Hat software packages and updates that are available only to customers with an active subscription. These packages and updates include security patches, bug fixes, and new features for RHEL and other Red Hat products.

IMPORTANT

The entitlement-based subscription model is deprecated and will be retired in the future. Simple content access is now the default subscription model. It provides an improved subscription experience that eliminates the need to attach a subscription to a system before you can access Red Hat subscription content on that system. If your Red Hat account uses the entitlement-based subscription model, contact your Red hat account team, for example, a technical account manager (TAM) or solution architect (SA) to prepare for migration to simple content access. For more information, see Transition of subscription services to the hybrid cloud.

CHAPTER 3. CUSTOMIZING THE INSTALLATION MEDIA

For details, see Composing a customized RHEL system image .

CHAPTER 4. INSTALLING RHEL USING SATELLITE SERVER

Red Hat Satellite is a centralized tool for provisioning, remote management, and monitoring of multiple Red Hat Enterprise Linux deployments. With Satellite, you can deploy physical and virtual hosts. This includes setting up the required network topology, configuring the necessary services, and providing necessary configuration information to provision hosts on your network. For more information, see the Red Hat Satellite .

CHAPTER 5. PREPARING NETWORK-BASED REPOSITORIES

You must prepare repositories to install RHEL from your network system.

5.1. PORTS FOR NETWORK-BASED INSTALLATION

The following table lists the ports that must be open on the server for providing the files for each type of network-based installation.

Table 5.1. Ports for network-based installation

Protocol used	Ports to open
HTTP	80
HTTPS	443
FTP	21
NFS	2049, 111, 20048
TFTP	69

Additional resources

- Securing networks

5.2. CREATING AN INSTALLATION SOURCE ON AN NFS SERVER

You can use this installation method to install multiple systems from a single source, without having to connect to physical media.

Prerequisites

- You have an administrator-level access to a server with Red Hat Enterprise Linux 9, and this server is on the same network as the system to be installed.
- You have downloaded the full installation DVD ISO from the Product Downloads page.
- You have created a bootable CD, DVD, or USB device from the image file.
- You have verified that your firewall allows the system you are installing to access the remote installation source. For more information, see Ports for network-based installation .

IMPORTANT

Ensure that you use different paths in **inst.ks** and **inst.repo**. When using NFS to host the installation source, you cannot use the same nfs share to host the Kickstart.

Procedure

1. Install the **nfs-utils** package:

```
# dnf install nfs-utils
```

2. Copy the DVD ISO image to a directory on the NFS server.
3. Open the **/etc/exports** file using a text editor and add a line with the following syntax:

```
/exported_directory/ clients
```

- Replace */exported_directory/* with the full path to the directory with the ISO image.
- Replace *clients* with one of the following:
  - The host name or IP address of the target system
  - The subnetwork that all target systems can use to access the ISO image
  - To allow any system with network access to the NFS server to use the ISO image, the asterisk sign (*)

  See the **exports(5)** man page for detailed information about the format of this field.

  For example, a basic configuration that makes the **/rhel9-install/** directory available as read-only to all clients is:

```
/rhel9-install *
```

4. Save the **/etc/exports** file and exit the text editor.
5. Start the nfs service:

```
# systemctl start nfs-server.service
```

If the service was running before you changed the **/etc/exports** file, reload the NFS server configuration:

```
# systemctl reload nfs-server.service
```

The ISO image is now accessible over NFS and ready to be used as an installation source.

When configuring the installation source, use **nfs:** as the protocol, the server host name or IP address, the colon sign **(:)**, and the directory holding the ISO image. For example, if the server host name is **myserver.example.com** and you have saved the ISO image in **/rhel9-install/**, specify **nfs:myserver.example.com:/rhel9-install/** as the installation source.

5.3. CREATING AN INSTALLATION SOURCE USING HTTP OR HTTPS

You can create an installation source for a network-based installation using an installation tree, which is a directory containing extracted contents of the DVD ISO image and a valid **.treeinfo** file. The installation source is accessed over HTTP or HTTPS.

Prerequisites

- You have an administrator-level access to a server with Red Hat Enterprise Linux 9, and this server is on the same network as the system to be installed.
- You have downloaded the full installation DVD ISO from the Product Downloads page.
- You have created a bootable CD, DVD, or USB device from the image file.
- You have verified that your firewall allows the system you are installing to access the remote installation source. For more information, see Ports for network-based installation .
- The **httpd** package is installed.
- The **mod_ssl** package is installed, if you use the **https** installation source.

WARNING

If your Apache web server configuration enables SSL security, prefer to enable the TLSv1.3 protocol. By default, TLSv1.2 (LEGACY) is enabled.

IMPORTANT

If you use an HTTPS server with a self-signed certificate, you must boot the installation program with the **noverifyssl** option.

Procedure

1. Copy the DVD ISO image to the HTTP(S) server.
2. Create a suitable directory for mounting the DVD ISO image, for example:

```
# mkdir /mnt/rhel9-install/
```

3. Mount the DVD ISO image to the directory:

```
# mount -o loop,ro -t iso9660 /image_directory/image.iso /mnt/rhel9-install/
```

   Replace */image_directory/image.iso* with the path to the DVD ISO image.

4. Copy the files from the mounted image to the HTTP(S) server root.

```
# cp -r /mnt/rhel9-install/ /var/www/html/
```

   This command creates the **/var/www/html/rhel9-install/** directory with the content of the image. Note that some other copying methods might skip the **.treeinfo** file which is required for a valid installation source. Entering the **cp** command for entire directories as shown in this procedure copies **.treeinfo** correctly.

5. Start the **httpd** service:

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

The installation tree is now accessible and ready to be used as the installation source.

NOTE

When configuring the installation source, use **http://** or **https://** as the protocol, the server host name or IP address, and the directory that contains the files from the ISO image, relative to the HTTP server root. For example, if you use HTTP, the server host name is **myserver.example.com**, and you have copied the files from the image to **/var/www/html/rhel9-install/**, specify **http://myserver.example.com/rhel9-install/** as the installation source.

Additional resources

- Deploying different types of servers

5.4. CREATING AN INSTALLATION SOURCE USING FTP

You can create an installation source for a network-based installation using an installation tree, which is a directory containing extracted contents of the DVD ISO image and a valid **.treeinfo** file. The installation source is accessed over FTP.

Prerequisites

- You have an administrator-level access to a server with Red Hat Enterprise Linux 9, and this server is on the same network as the system to be installed.
- You have downloaded the full installation DVD ISO from the Product Downloads page.
- You have created a bootable CD, DVD, or USB device from the image file.
- You have verified that your firewall allows the system you are installing to access the remote installation source. For more information, see Ports for network-based installation .
- The **vsftpd** package is installed.

Procedure

1. Open and edit the **/etc/vsftpd/vsftpd.conf** configuration file in a text editor.
   a. Change the line **anonymous_enable=NO** to **anonymous_enable=YES**
   b. Change the line **write_enable=YES** to **write_enable=NO**.
   c. Add lines **pasv_min_port=<*min_port*>** and **pasv_max_port=<*max_port*>**. Replace <*min_port*> and <*max_port*> with the port number range used by FTP server in passive mode, for example, **10021** and **10031**.
   This step might be necessary in network environments featuring various firewall/NAT setups.
   d. Optional: Add custom changes to your configuration. For available options, see the **vsftpd.conf(5)** man page. This procedure assumes that default options are used.

WARNING

If you configured SSL/TLS security in your **vsftpd.conf** file, ensure that you enable only the TLSv1 protocol, and disable SSLv2 and SSLv3. This is due to the POODLE SSL vulnerability (CVE-2014-3566). See https://access.redhat.com/solutions/1234773 for details.

2. Configure the server firewall.

   a. Enable the firewall:

   ```
   # systemctl enable firewalld
   ```

   b. Start the firewall:

   ```
   # systemctl start firewalld
   ```

   c. Configure the firewall to allow the FTP port and port range from the previous step:

   ```
   # firewall-cmd --add-port min_port-max_port/tcp --permanent
   # firewall-cmd --add-service ftp --permanent
   ```

   Replace <*min_port*> and <*max_port*> with the port numbers you entered into the **/etc/vsftpd/vsftpd.conf** configuration file.

   d. Reload the firewall to apply the new rules:

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

3. Copy the DVD ISO image to the FTP server.

4. Create a suitable directory for mounting the DVD ISO image, for example:

   ```
   # mkdir /mnt/rhel9-install
   ```

5. Mount the DVD ISO image to the directory:

   ```
   # mount -o loop,ro -t iso9660 /image-directory/image.iso /mnt/rhel9-install
   ```

   Replace ***/image-directory/image.iso*** with the path to the DVD ISO image.

6. Copy the files from the mounted image to the FTP server root:

   ```
   # mkdir /var/ftp/rhel9-install
   # cp -r /mnt/rhel9-install/ /var/ftp/
   ```

   This command creates the **/var/ftp/rhel9-install/** directory with the content of the image. Some copying methods can skip the **.treeinfo** file which is required for a valid installation source. Entering the **cp** command for whole directories as shown in this procedure will copy **.treeinfo**

correctly.

7. Make sure that the correct SELinux context and access mode is set on the copied content:

```
# restorecon -r /var/ftp/rhel9-install
# find /var/ftp/rhel9-install -type f -exec chmod 444 {} \;
# find /var/ftp/rhel9-install -type d -exec chmod 755 {} \;
```

8. Start the **vsftpd** service:

```
# systemctl start vsftpd.service
```

If the service was running before you changed the **/etc/vsftpd/vsftpd.conf** file, restart the service to load the edited file:

```
# systemctl restart vsftpd.service
```

Enable the **vsftpd** service to start during the boot process:

```
# systemctl enable vsftpd
```

The installation tree is now accessible and ready to be used as the installation source.

When configuring the installation source, use **ftp://** as the protocol, the server host name or IP address, and the directory in which you have stored the files from the ISO image, relative to the FTP server root. For example, if the server host name is **myserver.example.com** and you have copied the files from the image to **/var/ftp/rhel9-install/**, specify **ftp://myserver.example.com/rhel9-install/** as the installation source.

CHAPTER 6. PREPARING A UEFI HTTP INSTALLATION SOURCE

As an administrator of a server on a local network, you can configure an HTTP server to enable HTTP boot and network installation for other systems on your network.

6.1. NETWORK INSTALL OVERVIEW

A network installation allows you to install Red Hat Enterprise Linux to a system that has access to an installation server. At a minimum, two systems are required for a network installation:

Server

A system running a DHCP server, an HTTP, HTTPS, FTP, or NFS server, and in the PXE boot case, a TFTP server. Although each server can run on a different physical system, the procedures in this section assume a single system is running all servers.

Client

The system to which you are installing Red Hat Enterprise Linux. Once installation starts, the client queries the DHCP server, receives the boot files from the HTTP or TFTP server, and downloads the installation image from the HTTP, HTTPS, FTP or NFS server. Unlike other installation methods, the client does not require any physical boot media for the installation to start.

To boot a client from the network, enable network boot in the firmware or in a quick boot menu on the client. On some hardware, the option to boot from a network might be disabled, or not available.

The workflow steps to prepare to install Red Hat Enterprise Linux from a network using HTTP or PXE are as follows:

Procedure

1. Export the installation ISO image or the installation tree to an NFS, HTTPS, HTTP, or FTP server.
2. Configure the HTTP or TFTP server and DHCP server, and start the HTTP or TFTP service on the server.
3. Boot the client and start the installation.

You can choose between the following network boot protocols:

HTTP

Red Hat recommends using HTTP boot if your client UEFI supports it. HTTP boot is usually more reliable.

PXE (TFTP)

PXE boot is more widely supported by client systems, but sending the boot files over this protocol might be slow and result in timeout failures.

Additional resources

- Preparing network based repositories
- Red Hat Satellite product documentation

6.2. CONFIGURING THE DHCPV4 SERVER FOR NETWORK BOOT

Enable the DHCP version 4 (DHCPv4) service on your server, so that it can provide network boot functionality.

Prerequisites

- You are preparing network installation over the IPv4 protocol.
  For IPv6, see Configuring the DHCPv6 server for network boot instead.
- Find the network addresses of the server.
  In the following examples, the server has a network card with this configuration:

  IPv4 address

  192.168.124.2/24

  IPv4 gateway

  192.168.124.1

Procedure

1. Install the DHCP server:

```
dnf install dhcp-server
```

2. Set up a DHCPv4 server. Enter the following configuration in the **/etc/dhcp/dhcpd.conf** file. Replace the addresses to match your network card.

```
option architecture-type code 93 = unsigned integer 16;

subnet 192.168.124.0 netmask 255.255.255.0 {
  option routers 192.168.124.1;
  option domain-name-servers 192.168.124.1;
  range 192.168.124.100 192.168.124.200;
  class "pxeclients" {
    match if substring (option vendor-class-identifier, 0, 9) = "PXEClient";
    next-server 192.168.124.2;
          if option architecture-type = 00:07 {
            filename "redhat/EFI/BOOT/BOOTX64.EFI";
          }
          else {
            filename "pxelinux/pxelinux.0";
          }
  }
  class "httpclients" {
    match if substring (option vendor-class-identifier, 0, 10) = "HTTPClient";
    option vendor-class-identifier "HTTPClient";
    filename "http://192.168.124.2/redhat/EFI/BOOT/BOOTX64.EFI";
  }
}
```

3. Start the DHCPv4 service:

```
# systemctl enable --now dhcpd
```

6.3. CONFIGURING THE DHCPV6 SERVER FOR NETWORK BOOT

Enable the DHCP version 6 (DHCPv4) service on your server, so that it can provide network boot functionality.

Prerequisites

- You are preparing network installation over the IPv6 protocol.
  For IPv4, see Configuring the DHCPv4 server for network boot instead.
- Find the network addresses of the server.
  In the following examples, the server has a network card with this configuration:

  IPv6 address

  fd33:eb1b:9b36::2/64

  IPv6 gateway

  fd33:eb1b:9b36::1

Procedure

1. Install the DHCP server:

```
dnf install dhcp-server
```

2. Set up a DHCPv6 server. Enter the following configuration in the **/etc/dhcp/dhcpd6.conf** file. Replace the addresses to match your network card.

```
option dhcp6.bootfile-url code 59 = string;
option dhcp6.vendor-class code 16 = {integer 32, integer 16, string};

subnet6 fd33:eb1b:9b36::/64 {
        range6 fd33:eb1b:9b36::64 fd33:eb1b:9b36::c8;

        class "PXEClient" {
                match substring (option dhcp6.vendor-class, 6, 9);
        }

        subclass "PXEClient" "PXEClient" {
                option dhcp6.bootfile-url
"tftp://[fd33:eb1b:9b36::2]/redhat/EFI/BOOT/BOOTX64.EFI";
        }

        class "HTTPClient" {
                match substring (option dhcp6.vendor-class, 6, 10);
        }

        subclass "HTTPClient" "HTTPClient" {
                option dhcp6.bootfile-url
"http://[fd33:eb1b:9b36::2]/redhat/EFI/BOOT/BOOTX64.EFI";
                option dhcp6.vendor-class 0 10 "HTTPClient";
        }
}
```

3. Start the DHCPv6 service:

```
# systemctl enable --now dhcpd6
```

4. If DHCPv6 packets are dropped by the RP filter in the firewall, check its log. If the log contains the **rpfilter_DROP** entry, disable the filter using the following configuration in the **/etc/firewalld/firewalld.conf** file:

```
IPv6_rpfilter=no
```

6.4. CONFIGURING THE HTTP SERVER FOR HTTP BOOT

You must install and enable the **httpd** service on your server so that the server can provide HTTP boot resources on your network.

Prerequisites

- Find the network addresses of the server.
  In the following examples, the server has a network card with the **192.168.124.2** IPv4 address.

Procedure

1. Install the HTTP server:

```
# dnf install httpd
```

2. Create the **/var/www/html/redhat/** directory:

```
# mkdir -p /var/www/html/redhat/
```

3. Download the RHEL DVD ISO file. See All Red Hat Enterprise Linux Downloads .

4. Create a mount point for the ISO file:

```
# mkdir -p /var/www/html/redhat/iso/
```

5. Mount the ISO file:

```
# mount -o loop,ro -t iso9660 path-to-RHEL-DVD.iso /var/www/html/redhat/iso
```

6. Copy the boot loader, kernel, and **initramfs** from the mounted ISO file into your HTML directory:

```
# cp -r /var/www/html/redhat/iso/images /var/www/html/redhat/
# cp -r /var/www/html/redhat/iso/EFI /var/www/html/redhat/
```

7. Make the boot loader configuration editable:

```
# chmod 644 /var/www/html/redhat/EFI/BOOT/grub.cfg
```

8. Edit the **/var/www/html/redhat/EFI/BOOT/grub.cfg** file and replace its content with the following:

```
set default="1"

function load_video {
  insmod efi_gop
  insmod efi_uga
  insmod video_bochs
  insmod video_cirrus
  insmod all_video
}

load_video
set gfxpayload=keep
insmod gzio
insmod part_gpt
insmod ext2

set timeout=60
# END /etc/grub.d/00_header #

search --no-floppy --set=root -l 'RHEL-9-3-0-BaseOS-x86_64'

# BEGIN /etc/grub.d/10_linux #
menuentry 'Install Red Hat Enterprise Linux 9.3' --class fedora --class gnu-linux --class gnu --
class os {
    linuxefi ../../images/pxeboot/vmlinuz inst.repo=http://192.168.124.2/redhat/iso quiet
    initrdefi ../../images/pxeboot/initrd.img
}
menuentry 'Test this media & install Red Hat Enterprise Linux 9.3' --class fedora --class gnu-
linux --class gnu --class os {
    linuxefi ../../images/pxeboot/vmlinuz inst.repo=http://192.168.124.2/redhat/iso quiet
    initrdefi ../../images/pxeboot/initrd.img
}
submenu 'Troubleshooting -->' {
    menuentry 'Install Red Hat Enterprise Linux 9.3 in text mode' --class fedora --class gnu-
linux --class gnu --class os {
     linuxefi ../../images/pxeboot/vmlinuz inst.repo=http://192.168.124.2/redhat/iso inst.text
quiet
     initrdefi ../../images/pxeboot/initrd.img
    }
    menuentry 'Rescue a Red Hat Enterprise Linux system' --class fedora --class gnu-linux --
class gnu --class os {
     linuxefi ../../images/pxeboot/vmlinuz inst.repo=http://192.168.124.2/redhat/iso inst.rescue
quiet
     initrdefi ../../images/pxeboot/initrd.img
    }
}
```

In this file, replace the following strings:

RHEL-9-3-0-BaseOS-x86_64 and ***Red Hat Enterprise Linux 9.3***

Edit the version number to match the version of RHEL that you downloaded.

192.168.124.2

Replace with the IP address to your server.

9. Make the EFI boot file executable:

```
# chmod 755 /var/www/html/redhat/EFI/BOOT/BOOTX64.EFI
```

10. Open ports in the firewall to allow HTTP (80), DHCP (67, 68) and DHCPv6 (546, 547) traffic:

```
# firewall-cmd --zone public \
        --add-port={80/tcp,67/udp,68/udp,546/udp,547/udp}
```

This command enables temporary access until the next server reboot.

11. Optional: To enable permanent access, add the **--permanent** option to the command.
12. Reload firewall rules:

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

13. Start the HTTP server:

```
# systemctl enable --now httpd
```

14. Make the **html** directory and its content readable and executable:

```
# chmod -cR u=rwX,g=rX,o=rX /var/www/html
```

15. Restore the SELinux context of the **html** directory:

```
# restorecon -FvvR /var/www/html
```

CHAPTER 7. PREPARING A PXE INSTALLATION SOURCE

You must configure TFTP and DHCP on a PXE server to enable PXE boot and network installation.

7.1. NETWORK INSTALL OVERVIEW

A network installation allows you to install Red Hat Enterprise Linux to a system that has access to an installation server. At a minimum, two systems are required for a network installation:

Server

A system running a DHCP server, an HTTP, HTTPS, FTP, or NFS server, and in the PXE boot case, a TFTP server. Although each server can run on a different physical system, the procedures in this section assume a single system is running all servers.

Client

The system to which you are installing Red Hat Enterprise Linux. Once installation starts, the client queries the DHCP server, receives the boot files from the HTTP or TFTP server, and downloads the installation image from the HTTP, HTTPS, FTP or NFS server. Unlike other installation methods, the client does not require any physical boot media for the installation to start.

To boot a client from the network, enable network boot in the firmware or in a quick boot menu on the client. On some hardware, the option to boot from a network might be disabled, or not available.

The workflow steps to prepare to install Red Hat Enterprise Linux from a network using HTTP or PXE are as follows:

Procedure

1. Export the installation ISO image or the installation tree to an NFS, HTTPS, HTTP, or FTP server.
2. Configure the HTTP or TFTP server and DHCP server, and start the HTTP or TFTP service on the server.
3. Boot the client and start the installation.

You can choose between the following network boot protocols:

HTTP

Red Hat recommends using HTTP boot if your client UEFI supports it. HTTP boot is usually more reliable.

PXE (TFTP)

PXE boot is more widely supported by client systems, but sending the boot files over this protocol might be slow and result in timeout failures.

Additional resources

- Preparing network based repositories
- Red Hat Satellite product documentation

7.2. CONFIGURING THE DHCPV4 SERVER FOR NETWORK BOOT

Enable the DHCP version 4 (DHCPv4) service on your server, so that it can provide network boot functionality.

Prerequisites

- You are preparing network installation over the IPv4 protocol.
  For IPv6, see Configuring the DHCPv6 server for network boot instead.
- Find the network addresses of the server.
  In the following examples, the server has a network card with this configuration:

  IPv4 address

  192.168.124.2/24

  IPv4 gateway

  192.168.124.1

Procedure

1. Install the DHCP server:

```
dnf install dhcp-server
```

2. Set up a DHCPv4 server. Enter the following configuration in the **/etc/dhcp/dhcpd.conf** file. Replace the addresses to match your network card.

```
option architecture-type code 93 = unsigned integer 16;

subnet 192.168.124.0 netmask 255.255.255.0 {
  option routers 192.168.124.1;
  option domain-name-servers 192.168.124.1;
  range 192.168.124.100 192.168.124.200;
  class "pxeclients" {
    match if substring (option vendor-class-identifier, 0, 9) = "PXEClient";
    next-server 192.168.124.2;
          if option architecture-type = 00:07 {
            filename "redhat/EFI/BOOT/BOOTX64.EFI";
          }
          else {
            filename "pxelinux/pxelinux.0";
          }
  }
  class "httpclients" {
    match if substring (option vendor-class-identifier, 0, 10) = "HTTPClient";
    option vendor-class-identifier "HTTPClient";
    filename "http://192.168.124.2/redhat/EFI/BOOT/BOOTX64.EFI";
  }
}
```

3. Start the DHCPv4 service:

```
# systemctl enable --now dhcpd
```

7.3. CONFIGURING THE DHCPV6 SERVER FOR NETWORK BOOT

Enable the DHCP version 6 (DHCPv4) service on your server, so that it can provide network boot functionality.

Prerequisites

- You are preparing network installation over the IPv6 protocol.
  For IPv4, see Configuring the DHCPv4 server for network boot instead.
- Find the network addresses of the server.
  In the following examples, the server has a network card with this configuration:

  IPv6 address

  fd33:eb1b:9b36::2/64

  IPv6 gateway

  fd33:eb1b:9b36::1

Procedure

1. Install the DHCP server:

```
dnf install dhcp-server
```

2. Set up a DHCPv6 server. Enter the following configuration in the **/etc/dhcp/dhcpd6.conf** file. Replace the addresses to match your network card.

```
option dhcp6.bootfile-url code 59 = string;
option dhcp6.vendor-class code 16 = {integer 32, integer 16, string};

subnet6 fd33:eb1b:9b36::/64 {
        range6 fd33:eb1b:9b36::64 fd33:eb1b:9b36::c8;

        class "PXEClient" {
                match substring (option dhcp6.vendor-class, 6, 9);
        }

        subclass "PXEClient" "PXEClient" {
                option dhcp6.bootfile-url
"tftp://[fd33:eb1b:9b36::2]/redhat/EFI/BOOT/BOOTX64.EFI";
        }

        class "HTTPClient" {
                match substring (option dhcp6.vendor-class, 6, 10);
        }

        subclass "HTTPClient" "HTTPClient" {
                option dhcp6.bootfile-url
"http://[fd33:eb1b:9b36::2]/redhat/EFI/BOOT/BOOTX64.EFI";
                option dhcp6.vendor-class 0 10 "HTTPClient";
        }
}
```

3. Start the DHCPv6 service:

```
# systemctl enable --now dhcpd6
```

4. If DHCPv6 packets are dropped by the RP filter in the firewall, check its log. If the log contains the **rpfilter_DROP** entry, disable the filter using the following configuration in the **/etc/firewalld/firewalld.conf** file:

```
IPv6_rpfilter=no
```

7.4. CONFIGURING A TFTP SERVER FOR BIOS-BASED CLIENTS

You must configure a TFTP server and DHCP server and start the TFTP service on the PXE server for BIOS-based AMD and Intel 64-bit systems.

Procedure

1. As root, install the following package.

```
# dnf install tftp-server
```

2. Allow incoming connections to the **tftp service** in the firewall:

```
# firewall-cmd --add-service=tftp
```

This command enables temporary access until the next server reboot.

3. optional: To enable permanent access, add the **--permanent** option to the command. Depending on the location of the installation ISO file, you might have to allow incoming connections for HTTP or other services.

4. Access the **pxelinux.0** file from the **SYSLINUX** package in the DVD ISO image file, where *my_local_directory* is the name of the directory that you create:

```
# mount -t iso9660 /path_to_image/name_of_image.iso /mount_point -o loop,ro
```

```
# cp -pr /mount_point/AppStream/Packages/syslinux-tftpboot-version-architecture.rpm
/my_local_directory
```

```
# umount /mount_point
```

5. Extract the package:

```
# rpm2cpio syslinux-tftpboot-version-architecture.rpm | cpio -dimv
```

6. Create a **pxelinux**/ directory in **tftpboot**/ and copy all the files from the directory into the **pxelinux**/ directory:

```
# mkdir /var/lib/tftpboot/pxelinux
```

```
# cp /my_local_directory/tftpboot/* /var/lib/tftpboot/pxelinux
```

7. Create the directory **pxelinux.cfg**/ in the **pxelinux**/ directory:

```
# mkdir /var/lib/tftpboot/pxelinux/pxelinux.cfg
```

8. Create a configuration file named **default** and add it to the **pxelinux.cfg/** directory as shown in the following example:

```
default vesamenu.c32
prompt 1
timeout 600

display boot.msg

label linux
  menu label ^Install system
  menu default
  kernel images/RHEL-9/vmlinuz
  append initrd=images/RHEL-9/initrd.img ip=dhcp inst.repo=http://192.168.124.2/RHEL-
9/x86_64/iso-contents-root/
label vesa
  menu label Install system with ^basic video driver
  kernel images/RHEL-9/vmlinuz
  append initrd=images/RHEL-9/initrd.img ip=dhcp inst.xdriver=vesa nomodeset
inst.repo=http://192.168.124.2/RHEL-9/x86_64/iso-contents-root/
label rescue
  menu label ^Rescue installed system
  kernel images/RHEL-9/vmlinuz
  append initrd=images/RHEL-9/initrd.img inst.rescue
  inst.repo=http:///192.168.124.2/RHEL-8/x86_64/iso-contents-root/
label local
  menu label Boot from ^local drive
  localboot 0xffff
```

- The installation program cannot boot without its runtime image. Use the **inst.stage2** boot option to specify location of the image. Alternatively, you can use the **inst.repo=** option to specify the image as well as the installation source.
- The installation source location used with **inst.repo** must contain a valid **.treeinfo** file.
- When you select the RHEL9 installation DVD as the installation source, the **.treeinfo** file points to the BaseOS and the AppStream repositories. You can use a single **inst.repo** option to load both repositories.

9. Create a subdirectory to store the boot image files in the **/var/lib/tftpboot/** directory, and copy the boot image files to the directory. In this example, the directory is **/var/lib/tftpboot/pxelinux/images/RHEL-9/**:

```
# mkdir -p /var/lib/tftpboot/pxelinux/images/RHEL-9/
# cp /path_to_x86_64_images/pxeboot/{vmlinuz,initrd.img}
/var/lib/tftpboot/pxelinux/images/RHEL-9/
```

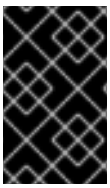
10. Start and enable the **tftp.socket** service:

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

The PXE boot server is now ready to serve PXE clients. You can start the client, which is the system to which you are installing Red Hat Enterprise Linux, select **PXE Boot** when prompted to specify a boot source, and start the network installation.

7.5. CONFIGURING A TFTP SERVER FOR UEFI-BASED CLIENTS

You must configure a TFTP server and DHCP server and start the TFTP service on the PXE server for UEFI-based AMD64, Intel 64, and 64-bit ARM systems.



IMPORTANT

Red Hat Enterprise Linux 9 UEFI PXE boot supports a lowercase file format for a MAC-based grub menu file. For example, the MAC address file format for grub2 is **grub.cfg-01-aa-bb-cc-dd-ee-ff**

Procedure

1. As root, install the following package.

```
# dnf install tftp-server
```

2. Allow incoming connections to the **tftp service** in the firewall:

```
# firewall-cmd --add-service=tftp
```

   This command enables temporary access until the next server reboot.

3. Optional: To enable permanent access, add the **--permanent** option to the command. Depending on the location of the installation ISO file, you might have to allow incoming connections for HTTP or other services.

4. Access the EFI boot image files from the DVD ISO image:

```
# mount -t iso9660 /path_to_image/name_of_image.iso /mount_point -o loop,ro
```

5. Copy the EFI boot images from the DVD ISO image:

```
# mkdir /var/lib/tftpboot/redhat
# cp -r /mount_point/EFI /var/lib/tftpboot/redhat/
# umount /mount_point
```

6. Fix the permissions of the copied files:

```
# chmod -R 755 /var/lib/tftpboot/redhat/
```

7. Replace the content of **/var/lib/tftpboot/redhat/EFI/BOOT/grub.cfg** with the following example:

```
set timeout=60
menuentry 'RHEL 9' {
  linux images/RHEL-9/vmlinuz ip=dhcp inst.repo=http://192.168.124.2/RHEL-9/x86_64/iso-
```

```
contents-root/
  initrd images/RHEL-9/initrd.img
}
```

- The installation program cannot boot without its runtime image. Use the **inst.stage2** boot option to specify location of the image. Alternatively, you can use the **inst.repo=** option to specify the image as well as the installation source.
- The installation source location used with **inst.repo** must contain a valid **.treeinfo** file.
- When you select the RHEL9 installation DVD as the installation source, the **.treeinfo** file points to the BaseOS and the AppStream repositories. You can use a single **inst.repo** option to load both repositories.

8. Create a subdirectory to store the boot image files in the **/var/lib/tftpboot/** directory, and copy the boot image files to the directory. In this example, the directory is **/var/lib/tftpboot/images/RHEL-9/**:

```
# mkdir -p /var/lib/tftpboot/images/RHEL-9/
# cp /path_to_x86_64_images/pxeboot/{vmlinuz,initrd.img}/var/lib/tftpboot/images/RHEL-9/
```

9. Start and enable the **tftp.socket** service:

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

The PXE boot server is now ready to serve PXE clients. You can start the client, which is the system to which you are installing Red Hat Enterprise Linux, select **PXE Boot** when prompted to specify a boot source, and start the network installation.

Additional resources

- Using the Shim Program

7.6. CONFIGURING A NETWORK SERVER FOR IBM POWER SYSTEMS

You can configure a network boot server for IBM Power systems by using GRUB2.

Procedure

1. As root, install the following packages:

```
# dnf install tftp-server dhcp-server
```

2. Allow incoming connections to the **tftp** service in the firewall:

```
# firewall-cmd --add-service=tftp
```

This command enables temporary access until the next server reboot.

3. Optional: To enable permanent access, add the **--permanent** option to the command. Depending on the location of the installation ISO file, you might have to allow incoming connections for HTTP or other services.

4. Create a GRUB2 network boot directory inside the TFTP root:

```
# grub2-mknetdir --net-directory=/var/lib/tftpboot
Netboot directory for powerpc-ieee1275 created. Configure your DHCP server to point to
/boot/grub2/powerpc-ieee1275/core.elf
```

The command output informs you of the file name that needs to be configured in your DHCP configuration, described in this procedure.

a. If the PXE server runs on an x86 machine, the **grub2-ppc64-modules** must be installed before creating a **GRUB2** network boot directory inside the tftp root:

```
# dnf install grub2-ppc64-modules
```

5. Create a GRUB2 configuration file: **/var/lib/tftpboot/boot/grub2/grub.cfg** as shown in the following example:

```
set default=0
set timeout=5

echo -e "\nWelcome to the Red Hat Enterprise Linux 9 installer!\n\n"

menuentry 'Red Hat Enterprise Linux 9' {
  linux grub2-ppc64/vmlinuz ro ip=dhcp inst.repo=http://192.168.124.2/RHEL-9/x86_64/iso-
contents-root/
  initrd grub2-ppc64/initrd.img
}
```

- The installation program cannot boot without its runtime image. Use the **inst.stage2** boot option to specify location of the image. Alternatively, you can use the **inst.repo=** option to specify the image as well as the installation source.
- The installation source location used with **inst.repo** must contain a valid **.treeinfo** file.
- When you select the RHEL8 installation DVD as the installation source, the **.treeinfo** file points to the BaseOS and the AppStream repositories. You can use a single **inst.repo** option to load both repositories.

6. Mount the DVD ISO image using the command:

```
# mount -t iso9660 /path_to_image/name_of_iso/ /mount_point -o loop,ro
```

7. Create a directory and copy the **initrd.img** and **vmlinuz** files from DVD ISO image into it, for example:

```
# cp /mount_point/ppc/ppc64/{initrd.img,vmlinuz} /var/lib/tftpboot/grub2-ppc64/
```

8. Configure your DHCP server to use the boot images packaged with **GRUB2** as shown in the following example. If you already have a DHCP server configured, then perform this step on the DHCP server.

```
subnet 192.168.0.1 netmask 255.255.255.0 {
  allow bootp;
  option routers 192.168.0.5;
  group { #BOOTP POWER clients
    filename "boot/grub2/powerpc-ieee1275/core.elf";
```

```
    host client1 {
    hardware ethernet 01:23:45:67:89:ab;
    fixed-address 192.168.0.112;
    }
  }
}
```

9. Adjust the sample parameters **subnet**, **netmask**, **routers**, **fixed-address** and **hardware ethernet** to fit your network configuration. The **file name** parameter; this is the file name that was outputted by the **grub2-mknetdir** command earlier in this procedure.

10. On the DHCP server, start and enable the **dhcpd** service. If you have configured a DHCP server on the localhost, then start and enable the **dhcpd** service on the localhost.

```
# systemctl enable --now dhcpd
```

11. Start and enable the **tftp.socket** service:

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

The PXE boot server is now ready to serve PXE clients. You can start the client, which is the system to which you are installing Red Hat Enterprise Linux, select **PXE Boot** when prompted to specify a boot source, and start the network installation.

CHAPTER 8. PREPARING A REMOTE INSTALLATION BY USING VNC

8.1. OVERVIEW

The graphical user interface is the recommended method of installing RHEL when you boot the system from a CD, DVD, or USB flash drive, or from a network using PXE. However, many enterprise systems, for example, IBM Power Systems and 64-bit IBM Z, are located in remote data center environments that are run autonomously and are not connected to a display, keyboard, and mouse. These systems are often referred to as *headless systems* and they are typically controlled over a network connection. The RHEL installation program includes a Virtual Network Computing (VNC) installation that runs the graphical installation on the target machine, but control of the graphical installation is handled by another system on the network. The RHEL installation program offers two VNC installation modes: **Direct** and **Connect**. Once a connection is established, the two modes do not differ. The mode you select depends on your environment.

Direct mode

In Direct mode, the RHEL installation program is configured to start on the target system and wait for a VNC viewer that is installed on another system before proceeding. As part of the Direct mode installation, the IP address and port are displayed on the target system. You can use the VNC viewer to connect to the target system remotely using the IP address and port, and complete the graphical installation.

Connect mode

In Connect mode, the VNC viewer is started on a remote system in *listening* mode. The VNC viewer waits for an incoming connection from the target system on a specified port. When the RHEL installation program starts on the target system, the system host name and port number are provided by using a boot option or a Kickstart command. The installation program then establishes a connection with the listening VNC viewer using the specified system host name and port number. To use Connect mode, the system with the listening VNC viewer must be able to accept incoming network connections.

8.2. CONSIDERATIONS

By default, the installation program has a VNC server included. Consider the following items when performing a remote RHEL installation using VNC:

- **VNC client application:** A VNC client application is required to perform both a VNC Direct and Connect installation. VNC client applications are available in the repositories of most Linux distributions, and free VNC client applications are also available for other operating systems such as Windows. The following VNC client applications are available in RHEL:
  - **tigervnc** is independent of your desktop environment and is installed as part of the **tigervnc** package.
  - **vinagre** is part of the GNOME desktop environment and is installed as part of the **vinagre** package.
- **Network and firewall:**
  - If the target system is not allowed inbound connections by a firewall, then you must use Connect mode or disable the firewall. Disabling a firewall can have security implications.
  - If the system that is running the VNC viewer is not allowed incoming connections by a firewall, then you must use Direct mode, or disable the firewall. Disabling a firewall can have

security implications. See the Security hardening document for more information about configuring the firewall.

- **Custom Boot Options:** You must specify custom boot options to start a VNC installation and the installation instructions might differ depending on your system architecture.

- **VNC in Kickstart installations:** You can use VNC-specific commands in Kickstart installations. Using only the **vnc** command runs a RHEL installation in Direct mode. Additional options are available to set up an installation using Connect mode.

CHAPTER 9. PREPARING A SYSTEM WITH UEFI SECURE BOOT ENABLED TO INSTALL AND BOOT RHEL BETA RELEASES

To enhance the security of your operating system, use the UEFI Secure Boot feature for signature verification when booting a Red Hat Enterprise Linux Beta release on systems having UEFI Secure Boot enabled.

9.1. UEFI SECURE BOOT AND RHEL BETA RELEASES

UEFI Secure Boot requires that the operating system kernel is signed with a recognized private key. UEFI Secure Boot then verifies the signature using the corresponding public key.

For Red Hat Enterprise Linux Beta releases, the kernel is signed with a Red Hat Beta-specific private key. UEFI Secure Boot attempts to verify the signature using the corresponding public key, but because the hardware does not recognize the Beta private key, Red Hat Enterprise Linux Beta release system fails to boot. Therefore, to use UEFI Secure Boot with a Beta release, add the Red Hat Beta public key to your system using the Machine Owner Key (MOK) facility.

9.2. ADDING A BETA PUBLIC KEY FOR UEFI SECURE BOOT

This section contains information about how to add a Red Hat Enterprise Linux Beta public key for UEFI Secure Boot.

Prerequisites

- The UEFI Secure Boot is disabled on the system.
- The Red Hat Enterprise Linux Beta release is installed, and Secure Boot is disabled even after system reboot.
- You are logged in to the system, and the tasks in the **Initial Setup** window are complete.

Procedure

1. Begin to enroll the Red Hat Beta public key in the system's Machine Owner Key (MOK) list:

   ```
   # mokutil --import /usr/share/doc/kernel-keys/$(uname -r)/kernel-signing-ca.cer
   ```

   $(uname -r) is replaced by the kernel version - for example, **4.18.0-80.el8.x86_64**.

2. Enter a password when prompted.
3. Reboot the system and press any key to continue the startup. The Shim UEFI key management utility starts during the system startup.
4. Select **Enroll MOK**.
5. Select **Continue**.
6. Select **Yes** and enter the password. The key is imported into the system's firmware.
7. Select **Reboot**.

8. Enable Secure Boot on the system.

9.3. REMOVING A BETA PUBLIC KEY

If you plan to remove the Red Hat Enterprise Linux Beta release, and install a Red Hat Enterprise Linux General Availability (GA) release, or a different operating system, then remove the Beta public key.

The procedure describes how to remove a Beta public key.

Procedure

1. Begin to remove the Red Hat Beta public key from the system's Machine Owner Key (MOK) list:

```
# mokutil --reset
```

2. Enter a password when prompted.
3. Reboot the system and press any key to continue the startup. The Shim UEFI key management utility starts during the system startup.
4. Select **Reset MOK**.
5. Select **Continue**.
6. Select **Yes** and enter the password that you had specified in step 2. The key is removed from the system's firmware.
7. Select **Reboot**.

CHAPTER 10. RHEL INSTALLATIONS ON IBM POWER SERVERS

You can install Red Hat Enterprise Linux on various IBM Power System servers.

10.1. SUPPORTED IBM POWER SERVERS

You can install Red Hat Enterprise Linux on IBM Power Systems. You can find the complete list of supported IBM Power servers on the Red Hat Ecosystem Catalog .

10.2. OVERVIEW OF THE INSTALLATION PROCESS ON POWERVM LPAR BY USING THE HMC

You can install RHEL on the PowerVM logical partition (LPAR) by using the Hardware Management Console. A Hardware Management Console (HMC) is a hardware appliance that you can use to administer IBM Power Systems servers.

The installation workflow involves the following general steps:

1. Download the RHEL installation ISO.
2. Prepare a bootable physical installation medium based on your installation method.
3. Verify that the Power System is added to the HMC.
   For more information, see add or remove connections to HMC in the IBM documentation.
4. Configure VIOS and LPAR on the managed system or configure full system LPAR based on the requirements.
5. Log in to the HMC console.
6. Install Red Hat Enterprise Linux.

For detailed instructions, see Installing Linux on PowerVM LPAR by using the HMC in the IBM documentation.

10.3. OVERVIEW OF THE INSTALLATION PROCESS ON IBM POWER SERVERS WITH THE GRAPHICS CARD

You can install RHEL on IBM Power Systems servers with the graphics card.

The installation workflow involves the following general steps:

1. Download the RHEL installation ISO.
2. Prepare a bootable physical installation medium based on your installation method.
3. Prepare the machine for RHEL installation.
4. Boot the installer kernel.
5. Install Red Hat Enterprise Linux.

6. Optional: Install IBM Tools Repository to use Service and Productivity tools, IBM Advance Toolchain for Linux on Power, and IBM SDK for PowerLinux.

For detailed instructions, see Installing Linux on Power Systems servers with a graphics card in the IBM documentation.

Additional resources

- For instructions to install hardware in a rack, see IBM Knowledge Center and search for your power hardware.

10.4. OVERVIEW OF THE INSTALLATION PROCESS ON IBM POWER SERVERS BY USING THE SERIAL CONSOLE

You can install RHEL on IBM Power Systems servers by using the serial console.

The installation workflow involves the following general steps:

1. Download the RHEL installation ISO.
2. Prepare a bootable physical installation medium based on your installation method.
3. Prepare your machine for the RHEL installation.
4. Boot the installer kernel.
5. Start a VNC session.
   For more information, see Preparing a remote installation by using VNC .
6. Install Red Hat Enterprise Linux.
7. Optional: Install IBM Tools Repository to use additional software. For more information, see IBM Linux on Power tools repository.

For detailed instructions, see Installing Linux on Power Systems servers by using the serial console in the IBM documentation.

CHAPTER 11. PREPARING A RHEL INSTALLATION ON 64-BIT IBM Z

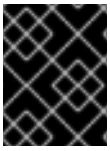
This section describes how to install Red Hat Enterprise Linux on the 64-bit IBM Z architecture.

11.1. PLANNING FOR INSTALLATION ON 64-BIT IBM Z

Red Hat Enterprise Linux 9 runs on IBM z14 or IBM LinuxONE II systems, or later.

The installation process assumes that you are familiar with the 64-bit IBM Z and can set up *logical partitions* (LPARs) and z/VM guest virtual machines.

For installation of Red Hat Enterprise Linux on 64-bit IBM Z, Red Hat supports Direct Access Storage Device (DASD), SCSI disk devices attached over Fiber Channel Protocol (FCP), and **virtio-blk** and **virtio-scsi** devices. When using FCP devices, Red Hat recommends using them in multipath configuration for better reliability.

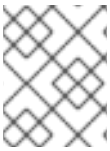


IMPORTANT

DASDs are disks that allow a maximum of three partitions per device. For example, **dasda** can have partitions **dasda1**, **dasda2**, and **dasda3**.

Pre-installation decisions

- Whether the operating system is to be run on an LPAR, KVM, or as a z/VM guest operating system.
- Network configuration. Red Hat Enterprise Linux 9 for 64-bit IBM Z supports the following network devices:
  - Real and virtual *Open Systems Adapter* (OSA)
  - Real and virtual HiperSockets
  - *LAN channel station* (LCS) for real OSA
  - **virtio-net** devices
  - RDMA over Converged Ethernet (RoCE)
- Ensure you select machine type as ***ESA*** for your z/VM VMs, because selecting any other machine types might prevent RHEL from installing. See the IBM documentation.



NOTE

When initializing swap space on a Fixed Block Architecture (FBA) DASD using the **SWAPGEN** utility, the **FBAPART** option must be used.

Additional resources

- For additional information about system requirements, see RHEL Technology Capabilities and Limits
- For additional information about 64-bit IBM Z, see IBM documentation.

- For additional information about using secure boot with Linux on IBM Z, see Secure boot for Linux on IBM Z.
- For installation instructions on IBM Power Servers, refer to *IBM installation documentation*.
- To see if your system is supported for installing RHEL, refer to https://catalog.redhat.com.

11.2. OVERVIEW OF INSTALLATION PROCESS ON 64-BIT IBM Z SERVERS

You can install Red Hat Enterprise Linux on 64-bit IBM Z interactively or in unattended mode. Installation on 64-bit IBM Z differs from other architectures as it is typically performed over a network, and not from local media. The installation consists of three phases:

1. Booting the installation
   - Connect to the mainframe
   - Customize the boot parameters
   - Perform an initial program load (IPL), or boot from the media containing the installation program
2. Connecting to the installation system
   - From a local machine, connect to the remote 64-bit IBM Z system using SSH, and start the installation program using Virtual Network Computing (VNC)
3. Completing the installation using the RHEL installation program

11.3. BOOT MEDIA FOR INSTALLING RHEL ON 64-BIT IBM Z SERVERS

After establishing a connection with the mainframe, you need to perform an initial program load (IPL), or boot, from the medium containing the installation program. This document describes the most common methods of installing Red Hat Enterprise Linux on 64-bit IBM Z. In general, any method may be used to boot the Linux installation system, which consists of a kernel (**kernel.img**) and initial RAM disk (**initrd.img**) with parameters in the **generic.prm** file supplemented by user defined parameters. Additionally, a **generic.ins** file is loaded which determines file names and memory addresses for the initrd, kernel and **generic.prm**.

The Linux installation system is also called the *installation program* in this book.

You can use the following boot media only if Linux is to run as a guest operating system under z/VM:

- z/VM reader

You can use the following boot media only if Linux is to run in LPAR mode:

- SE or HMC through a remote SFTP, FTPS or FTP server
- SE or HMC DVD

You can use the following boot media for both z/VM and LPAR:

- DASD

- SCSI disk device that is attached through an FCP channel

If you use DASD or an FCP-attached SCSI disk device as boot media, you must have a configured **zipl** boot loader.

11.4. CUSTOMIZING BOOT PARAMETERS

Before the installation can begin, you must configure some mandatory boot parameters. When installing through z/VM, these parameters must be configured before you boot into the **generic.prm** file. When installing on an LPAR, the **rd.cmdline** parameter is set to **ask** by default, meaning that you will be given a prompt on which you can enter these boot parameters. In both cases, the required parameters are the same.

All network configuration can either be specified by using a parameter file, or at the prompt.

Installation source

An installation source must always be configured.

Use the **inst.repo** option to specify the package source for the installation.

Network devices

Network configuration must be provided if network access will be required during the installation. If you plan to perform an unattended (Kickstart-based) installation by using only local media such as a disk, network configuration can be omitted.

ip=

Use the **ip=** option for basic network configuration, and other options as required.

rd.znet=

Also use the **rd.znet=** kernel option, which takes a network protocol type, a comma delimited list of sub-channels, and, optionally, comma delimited **sysfs** parameter and value pairs for qeth devices. This parameter can be specified multiple times to activate multiple network devices.
For example:

```
rd.znet=qeth,0.0.0600,0.0.0601,0.0.0602,layer2=1,portno=<number>
```

When specifying multiple **rd.znet** boot options, only the last one is passed on to the kernel command line of the installed system. This does not affect the networking of the system since all network devices configured during installation are properly activated and configured at boot.

The qeth device driver assigns the same interface name for Ethernet and Hipersockets devices: **enc*<device number>***. The bus ID is composed of the channel subsystem ID, subchannel set ID, and device number, separated by dots; the device number is the last part of the bus ID, without leading zeroes and dots. For example, the interface name will be **enca00** for a device with the bus ID **0.0.0a00**.

Storage devices

At least one storage device must always be configured for text mode installations.
The **rd.dasd=** option takes a Direct Access Storage Device (DASD) adapter device bus identifier. For multiple DASDs, specify the parameter multiple times, or use a comma separated list of bus IDs. To specify a range of DASDs, specify the first and the last bus ID.

For example:

```
rd.dasd=0.0.0200 rd.dasd=0.0.0202(ro),0.0.0203(ro:failfast),0.0.0205-0.0.0207
```

The **rd.zfcp=** option takes a SCSI over FCP (zFCP) adapter device bus identifier, a target world wide port name (WWPN), and an FCP LUN, then activates one path to a SCSI disk. This parameter needs to be specified at least twice to activate multiple paths to the same disk. This parameter can be specified multiple times to activate multiple disks, each with multiple paths. Since 9, a target world wide port name (WWPN) and an FCP LUN have to be provided only if the **zFCP** device is not configured in NPIV mode or when **auto LUN** scanning is disabled by the **zfcp.allow_lun_scan=0** kernel module parameter. It provides access to all SCSI devices found in the storage area network attached to the FCP device with the specified bus ID. This parameter needs to be specified at least twice to activate multiple paths to the same disks.

```
rd.zfcp=0.0.4000,0x5005076300C213e9,0x5022000000000000
rd.zfcp=0.0.4000
```

Kickstart options

If you are using a Kickstart file to perform an automatic installation, you must always specify the location of the Kickstart file using the **inst.ks=** option. For an unattended, fully automatic Kickstart installation, the **inst.cmdline** option is also useful.

An example customized **generic.prm** file containing all mandatory parameters look similar to the following example:

Example 11.1. Customized generic.prm file

```
ro ramdisk_size=40000 cio_ignore=all,!condev
inst.repo=http://example.com/path/to/repository
rd.znet=qeth,0.0.0600,0.0.0601,0.0.0602,layer2=1,portno=0,portname=foo
ip=192.168.17.115::192.168.17.254:24:foobar.systemz.example.com:enc600:none
nameserver=192.168.17.1
rd.dasd=0.0.0200 rd.dasd=0.0.0202
rd.zfcp=0.0.4000,0x5005076300c213e9,0x5022000000000000
rd.zfcp=0.0.5000,0x5005076300dab3e9,0x5022000000000000
inst.ks=http://example.com/path/to/kickstart
```

Some installation methods also require a file with a mapping of the location of installation data in the file system of the HMC DVD or FTP server and the memory locations where the data is to be copied.

The file is typically named **generic.ins**, and contains file names for the initial RAM disk, kernel image, and parameter file (**generic.prm**) and a memory location for each file. An example **generic.ins** will look similar to the following example:

Example 11.2. Sample generic.ins file

```
images/kernel.img 0x00000000
images/initrd.img 0x02000000
images/genericdvd.prm 0x00010480
images/initrd.addrsize 0x00010408
```

A valid **generic.ins** file is provided by Red Hat along with all other files required to boot the installer. Modify this file only if you want to, for example, load a different kernel version than default.

Additional resources

- Installation source boot options

11.5. PARAMETERS AND CONFIGURATION FILES ON 64-BIT IBM Z

This section contains information about the parameters and configuration files on 64-bit IBM Z.

11.5.1. Required configuration file parameters on 64-bit IBM Z

Several parameters are required and must be included in the parameter file. These parameters are also provided in the file **generic.prm** in directory **images/** of the installation DVD.

- **ro**
  Mounts the root file system, which is a RAM disk, read-only.

- **ramdisk_size=*size***
  Modifies the memory size reserved for the RAM disk to ensure that the Red Hat Enterprise Linux installation program fits within it. For example: **ramdisk_size=40000**.

The **generic.prm** file also contains the additional parameter **cio_ignore=all,!condev**. This setting speeds up boot and device detection on systems with many devices. The installation program transparently handles the activation of ignored devices.

11.5.2. 64-bit IBM Z/VM configuration file

Under z/VM, you can use a configuration file on a CMS-formatted disk. The purpose of the CMS configuration file is to save space in the parameter file by moving the parameters that configure the initial network setup, the DASD, and the FCP specification out of the parameter file.

Each line of the CMS configuration file contains a single variable and its associated value, in the following shell-style syntax: ***variable=value***.

You must also add the **CMSDASD** and **CMSCONFFILE** parameters to the parameter file. These parameters point the installation program to the configuration file:

CMSDASD=*cmsdasd_address*

Where *cmsdasd_address* is the device number of a CMS-formatted disk that contains the configuration file. This is usually the CMS user's **A** disk.
For example: **CMSDASD=191**

CMSCONFFILE=*configuration_file*

Where *configuration_file* is the name of the configuration file. **This value must be specified in lower case.** It is specified in a Linux file name format: ***CMS_file_name.CMS_file_type***.
The CMS file **REDHAT CONF** is specified as **redhat.conf**. The CMS file name and the file type can each be from one to eight characters that follow the CMS conventions.

For example: **CMSCONFFILE=redhat.conf**

11.5.3. Installation network, DASD and FCP parameters on 64-bit IBM Z

These parameters can be used to automatically set up the preliminary network, and can be defined in the CMS configuration file. These parameters are the only parameters that can also be used in a CMS configuration file. All other parameters in other sections must be specified in the parameter file.

NETTYPE="*type*"

Where *type* must be one of the following: **qeth**, **lcs**, or **ctc**. The default is **qeth**.
Choose **qeth** for:

- OSA-Express features
- HiperSockets
- Virtual connections on z/VM, including VSWITCH and Guest LAN
  Select **ctc** for:
- Channel-to-channel network connections

SUBCHANNELS="*device_bus_IDs*"

Where *device_bus_IDs* is a comma-separated list of two or three device bus IDs. The IDs must be specified in lowercase.
Provides required device bus IDs for the various network interfaces:

```
qeth: SUBCHANNELS="read_device_bus_id,write_device_bus_id,data_device_bus_id"
lcs or ctc: SUBCHANNELS="read_device_bus_id,write_device_bus_id"
```

For example (a sample qeth SUBCHANNEL statement):

```
SUBCHANNELS="0.0.f5f0,0.0.f5f1,0.0.f5f2"
```

PORTNO="*portnumber*"

You can add either **PORTNO="0"** (to use port 0) or **PORTNO="1"** (to use port 1 of OSA features with two ports per CHPID).

LAYER2="*value*"

Where *value* can be **0** or **1**.
Use **LAYER2="0"** to operate an OSA or HiperSockets device in layer 3 mode (**NETTYPE="qeth"**).
Use **LAYER2="1"** for layer 2 mode. For virtual network devices under z/VM this setting must match the definition of the GuestLAN or VSWITCH to which the device is coupled.

To use network services that operate on layer 2 (the Data Link Layer or its MAC sublayer) such as DHCP, layer 2 mode is a good choice.

The qeth device driver default for OSA devices is now layer 2 mode. To continue using the previous default of layer 3 mode, set **LAYER2="0"** explicitly.

VSWITCH="*value*"

Where *value* can be **0** or **1**.
Specify **VSWITCH="1"** when connecting to a z/VM VSWITCH or GuestLAN, or **VSWITCH="0"** (or nothing at all) when using directly attached real OSA or directly attached real HiperSockets.

MACADDR="*MAC_address*"

If you specify **LAYER2="1"** and **VSWITCH="0"**, you can optionally use this parameter to specify a MAC address. Linux requires six colon-separated octets as pairs lower case hex digits - for example, **MACADDR=62:a3:18:e7:bc:5f**. This is different from the notation used by z/VM.
If you specify **LAYER2="1"** and **VSWITCH="1"**, you must not specify the **MACADDR**, because z/VM assigns a unique MAC address to virtual network devices in layer 2 mode.

CTCPROT="*value*"

Where *value* can be **0**, **1**, or **3**.
Specifies the CTC protocol for **NETTYPE="ctc"**. The default is **0**.

HOSTNAME="*string*"

Where *string* is the host name of the newly-installed Linux instance.

IPADDR="*IP*"

Where *IP* is the IP address of the new Linux instance.

NETMASK="*netmask*"

Where *netmask* is the netmask.
The netmask supports the syntax of a prefix integer (from 1 to 32) as specified in IPv4 *classless interdomain routing* (CIDR). For example, you can specify **24** instead of **255.255.255.0**, or **20** instead of **255.255.240.0**.

GATEWAY="*gw*"

Where *gw* is the gateway IP address for this network device.

MTU="*mtu*"

Where *mtu* is the *Maximum Transmission Unit* (MTU) for this network device.

DNS="*server1:server2:additional_server_terms:serverN*"

Where "*server1:server2:additional_server_terms:serverN*" is a list of DNS servers, separated by colons. For example:

```
DNS="10.1.2.3:10.3.2.1"
```

SEARCHDNS="*domain1:domain2:additional_dns_terms:domainN*"

Where "*domain1:domain2:additional_dns_terms:domainN*" is a list of the search domains, separated by colons. For example:

```
SEARCHDNS="subdomain.domain:domain"
```

You only need to specify **SEARCHDNS=** if you specify the **DNS=** parameter.

DASD=

Defines the DASD or range of DASDs to configure for the installation.
The installation program supports a comma-separated list of device bus IDs, or ranges of device bus IDs with the optional attributes **ro**, **diag**, **erplog**, and **failfast**. Optionally, you can abbreviate device bus IDs to device numbers with leading zeros stripped. Any optional attributes should be separated by colons and enclosed in parentheses. Optional attributes follow a device bus ID or a range of device bus IDs.

The only supported global option is **autodetect**. This does not support the specification of non-existent DASDs to reserve kernel device names for later addition of DASDs. Use persistent DASD device names such as **/dev/disk/by-path/name** to enable transparent addition of disks later. Other

global options such as **probeonly**, **nopav**, or **nofcx** are not supported by the installation program.

Only specify those DASDs that need to be installed on your system. All unformatted DASDs specified here must be formatted after a confirmation later on in the installation program.

Add any data DASDs that are not needed for the root file system or the /**boot** partition after installation.

For example:

```
DASD="eb1c,0.0.a000-0.0.a003,eb10-eb14(diag),0.0.ab1c(ro:diag)"
```

FCP_*n*="*device_bus_ID* [*WWPN FCP_LUN*]"

For FCP-only environments, remove the **DASD=** option from the CMS configuration file to indicate no DASD is present.

```
FCP_n="device_bus_ID [WWPN FCP_LUN]"
```

Where:

- *n* is typically an integer value (for example **FCP_1** or **FCP_2**) but could be any string with alphabetic or numeric characters or underscores.
- *device_bus_ID* specifies the device bus ID of the FCP device representing the *host bus adapter* (HBA) (for example **0.0.fc00** for device fc00).
- *WWPN* is the world wide port name used for routing (often in conjunction with multipathing) and is as a 16-digit hex value (for example **0x50050763050b073d**).
- *FCP_LUN* refers to the storage logical unit identifier and is specified as a 16-digit hexadecimal value padded with zeroes to the right (for example **0x4020400100000000**).

NOTE

A target world wide port name (WWPN) and an FCP_LUN have to be provided if the **zFCP** device is not configured in NPIV mode, when auto LUN scanning is disabled by the **zfcp.allow_lun_scan=0** kernel module parameter or when installing RHEL-9.0 or older releases. Otherwise only the **device_bus_ID** value is mandatory.

- These variables can be used on systems with FCP devices to activate FCP LUNs such as SCSI disks. Additional FCP LUNs can be activated during the installation interactively or by means of a Kickstart file. An example value looks similar to the following:

```
FCP_1="0.0.fc00 0x50050763050b073d 0x4020400100000000"
FCP_2="0.0.4000"
```

Each of the values used in the FCP parameters (for example **FCP_1** or **FCP_2**) are site-specific and are normally supplied by the FCP storage administrator.

11.5.4. Parameters for kickstart installations on 64-bit IBM Z

The following parameters can be defined in a parameter file but do not work in a CMS configuration file.

inst.ks=*URL*

References a Kickstart file, which usually resides on the network for Linux installations on 64-bit IBM Z. Replace *URL* with the full path including the file name of the Kickstart file. This parameter activates automatic installation with Kickstart.

inst.cmdline

This requires installation with a Kickstart file that answers all questions, because the installation program does not support interactive user input in cmdline mode. Ensure that your Kickstart file contains all required parameters before you use the **inst.cmdline** option. If a required command is missing, the installation will fail.

11.5.5. Miscellaneous parameters on 64-bit IBM Z

The following parameters can be defined in a parameter file but do not work in a CMS configuration file.

rd.live.check

Turns on testing of an ISO-based installation source; for example, when using **inst.repo=** with an ISO on local disk or mounted with NFS.

inst.nompath

Disables support for multipath devices.

inst.proxy=[*protocol*://][*username*[:*password*]@]*host*[:*port*]

Specify a proxy to use with installation over HTTP, HTTPS or FTP.

inst.rescue

Boot into a rescue system running from a RAM disk that can be used to fix and restore an installed system.

inst.stage2=*URL*

Specifies a path to a tree containing **install.img**, not to the **install.img** directly. Otherwise, follows the same syntax as **inst.repo=**. If **inst.stage2** is specified, it typically takes precedence over other methods of finding **install.img**. However, if **Anaconda** finds **install.img** on local media, the **inst.stage2** URL will be ignored.
If **inst.stage2** is not specified and **install.img** cannot be found locally, **Anaconda** looks to the location given by **inst.repo=** or **method=**.

If only **inst.stage2=** is given without **inst.repo=** or **method=**, **Anaconda** uses whatever repos the installed system would have enabled by default for installation.

Use the option multiple times to specify multiple HTTP, HTTPS or FTP sources. The HTTP, HTTPS or FTP paths are then tried sequentially until one succeeds:

```
inst.stage2=http://hostname/path_to_install_tree/
inst.stage2=http://hostname/path_to_install_tree/
inst.stage2=http://hostname/path_to_install_tree/
```

inst.syslog=*IP/hostname*[:*port*]

Sends log messages to a remote syslog server.

The boot parameters described here are the most useful for installations and trouble shooting on 64-bit IBM Z, but only a subset of those that influence the installation program.

11.5.6. Sample parameter file and CMS configuration file on 64-bit IBM Z

To change the parameter file, begin by extending the shipped **generic.prm** file.

Example of **generic.prm** file:

```
ro ramdisk_size=40000 cio_ignore=all,!condev
CMSDASD="191" CMSCONFFILE="redhat.conf"
inst.vnc
inst.repo=http://example.com/path/to/dvd-contents
```

Example of **redhat.conf** file configuring a QETH network device (pointed to by **CMSCONFFILE** in **generic.prm**):

```
NETTYPE="qeth"
SUBCHANNELS="0.0.0600,0.0.0601,0.0.0602"
PORTNAME="FOOBAR"
PORTNO="0"
LAYER2="1"
MACADDR="02:00:be:3a:01:f3"
HOSTNAME="foobar.systemz.example.com"
IPADDR="192.168.17.115"
NETMASK="255.255.255.0"
GATEWAY="192.168.17.254"
DNS="192.168.17.1"
SEARCHDNS="systemz.example.com:example.com"
DASD="200-203"
```

11.5.7. Using parameter and configuration files on 64-bit IBM Z

The 64-bit IBM Z architecture can use a customized parameter file to pass boot parameters to the kernel and the installation program.

You need to change the parameter file if you want to:

- Install unattended with Kickstart.
- Choose non-default installation settings that are not accessible through the installation program's interactive user interface, such as rescue mode.

The parameter file can be used to set up networking non-interactively before the installation program (**Anaconda**) starts.

The kernel parameter file is limited to 895 characters plus an end-of-line character. The parameter file can be variable or fixed record format. Fixed record format increases the file size by padding each line up to the record length. Should you encounter problems with the installation program not recognizing all specified parameters in LPAR environments, you can try to put all parameters in one single line or start and end each line with a space character.

The parameter file contains kernel parameters, such as **ro**, and parameters for the installation process, such as **vncpassword=test** or **vnc**.

11.6. PREPARING AN INSTALLATION IN A Z/VM GUEST VIRTUAL MACHINE

Use the **x3270** or **c3270** terminal emulator, to log in to z/VM from other Linux systems, or use the IBM

3270 terminal emulator on the 64-bit IBM Z Hardware Management Console (HMC). If you are running Microsoft Windows operating system, there are several options available, and can be found through an internet search. A free native Windows port of **c3270** called **wc3270** also exists.

Ensure you select machine type as ***ESA*** for your z/VM VMs, because selecting any other machine types might prevent installing RHEL. See the IBM documentation.

Procedure

1. Log on to the z/VM guest virtual machine chosen for the Linux installation.
2. optional: If your 3270 connection is interrupted and you cannot log in again because the previous session is still active, you can replace the old session with a new one by entering the following command on the z/VM logon screen:

```
logon user here
```

+ Replace *user* with the name of the z/VM guest virtual machine. Depending on whether an external security manager, for example RACF, is used, the logon command might vary.

1. If you are not already running **CMS** (single-user operating system shipped with z/VM) in your guest, boot it now by entering the command:

```
cp ipl cms
```

2. Be sure not to use CMS disks such as your A disk (often device number 0191) as installation targets. To find out which disks are in use by CMS, use the following query:

```
query disk
```

3. You can use the following CP (z/VM Control Program, which is the z/VM hypervisor) query commands to find out about the device configuration of your z/VM guest virtual machine:
   a. Query the available main memory, which is called *storage* in 64-bit IBM Z terminology. Your guest should have at least 1 GiB of main memory.

```
cp query virtual storage
```

   b. Query available network devices by type:

   osa
   OSA - CHPID type OSD, real or virtual (VSWITCH or GuestLAN), both in QDIO mode

   hsi
   HiperSockets - CHPID type IQD, real or virtual (GuestLAN type Hipers)

   lcs
   LCS - CHPID type OSE

   For example, to query all of the network device types mentioned above, run:

```
cp query virtual osa
```

c. Query available DASDs. Only those that are flagged **RW** for read-write mode can be used as installation targets:

```
cp query virtual dasd
```

d. Query available FCP devices (vHBAs):

```
cp query virtual fcp
```

PART II. MANUALLY INSTALLING RED HAT ENTERPRISE LINUX

Setting up a machine for installing Red Hat Enterprise Linux (RHEL) involves several key steps, from booting the installation media to configuring system options. Once the installation ISO is booted in the VM, there are opportunities to modify boot settings and monitor installation processes through various consoles and logs. Customizing the system during installation ensures that it is tailored to specific needs, and the initial setup process finalizes the configuration for first-time use.

CHAPTER 12. CREATING A KERNEL-BASED VIRTUAL MACHINE AND BOOTING THE INSTALLATION ISO IN THE VM

This section describes how to create a kernel-based virtual machine (KVM) and staring the Red Hat Enterprise Linux installation.

Prerequisites

- On the IBM Z platform, the KVM host runs Red Hat Enterprise Linux installed in LPAR mode. See Installing in an LPAR .

Procedure

- Create virtual machine with the instance of Red Hat Enterprise Linux as a KVM guest operating system, use the following **virt-install** command on the KVM host:

```
$ virt-install --name=<guest_name> --disk size=<disksize_in_GB> --memory=
<memory_size_in_MB> --cdrom <filepath_to_iso> --graphics vnc
```

Additional resources

- **virt-install** man page on your system
- Creating virtual machines by using the command-line interface

CHAPTER 13. BOOTING THE INSTALLATION MEDIA

After you have created bootable media you are ready to boot the Red Hat Enterprise Linux installation.

You can register RHEL using the Red Hat Content Delivery Network (CDN). CDN is a geographically distributed series of web servers. These servers provide, for example, packages and updates to RHEL hosts with a valid subscription.

During the installation, registering and installing RHEL from the CDN offers following benefits:

- Utilizing the latest packages for an up-to-date system immediately after installation and
- Integrated support for connecting to Red Hat Insights and enabling System Purpose.

13.1. BOOTING THE INSTALLATION FROM A NETWORK USING HTTP

When installing Red Hat Enterprise Linux on a large number of systems simultaneously, the best approach is to boot and install from a server on the local network. Follow the steps in this procedure to boot the Red Hat Enterprise Linux installation from a network using HTTP.

IMPORTANT

To boot the installation process from a network, you must use a physical network connection, for example, Ethernet. You cannot boot the installation process with a wireless connection.

Prerequisites

- You have configured an HTTP boot server, and there is a network interface in your system. See **Additional resources** for more information.
- You have configured your system to boot from the network interface. This option is in the UEFI, and can be labeled **Network Boot** or **Boot Services**.
- You have verified that the UEFI is configured to boot from the specified network interface and supports the HTTP boot standard. For more information, see your hardware's documentation.
- Your platform is x86_64 or you install in KVM.

Procedure

1. Verify that the network cable is attached. The link indicator light on the network socket should be lit, even if the computer is not switched on.
2. Turn on the system.
   Depending on your hardware, some network setup and diagnostic information can be displayed before your system connects to an HTTP boot server. When connected, a menu is displayed according to the HTTP boot server configuration.
3. Press the number key that corresponds to the option that you require.

NOTE

In some instances, boot options are not displayed. If this occurs, press the **Enter** key on your keyboard or wait until the boot window opens.

The **Red Hat Enterprise Linux boot** window opens and displays information about a variety of available boot options.

4. Use the arrow keys on your keyboard to select the boot option that you require, and press **Enter** to select the boot option. The **Welcome to Red Hat Enterprise Linux**window opens and you can install Red Hat Enterprise Linux using the graphical user interface.
   The installation program automatically begins if no action is performed in the boot window within 60 seconds.

5. Optional: Edit the available boot options.
   Press **E** to enter edit mode. Change the predefined command line to add or remove boot options. Press **Enter** to confirm your choice.

Additional Resources

- Automatically installing RHEL
- Boot options for RHEL installer

13.2. BOOTING THE INSTALLATION FROM A NETWORK USING PXE

When installing Red Hat Enterprise Linux on a large number of systems simultaneously, the best approach is to boot and install from a server on the local network. Follow the steps in this procedure to boot the Red Hat Enterprise Linux installation from a network using PXE.

IMPORTANT

To boot the installation process from a network, you must use a physical network connection, for example, Ethernet. You cannot boot the installation process with a wireless connection.

Prerequisites

- You have configured a TFTP server, and there is a network interface in your system that supports PXE. See **Additional resources** for more information.
- You have configured your system to boot from the network interface. This option is in the BIOS, and can be labeled **Network Boot** or **Boot Services**.
- You have verified that the BIOS is configured to boot from the specified network interface and supports the PXE standard. For more information, see your hardware's documentation.
- Your platform is x86_64 or you install in KVM.

Procedure

1. Verify that the network cable is attached. The link indicator light on the network socket should be lit, even if the computer is not switched on.

2. Switch on the system.
   Depending on your hardware, some network setup and diagnostic information can be displayed before your system connects to a PXE server. When connected, a menu is displayed according to the PXE server configuration.

3. Press the number key that corresponds to the option that you require.

NOTE

In some instances, boot options are not displayed. If this occurs, press the **Enter** key on your keyboard or wait until the boot window opens.

The **Red Hat Enterprise Linux boot** window opens and displays information about a variety of available boot options.

4. Use the arrow keys on your keyboard to select the boot option that you require, and press **Enter** to select the boot option. The **Welcome to Red Hat Enterprise Linux**window opens and you can install Red Hat Enterprise Linux using the graphical user interface.
   The installation program automatically begins if no action is performed in the boot window within 60 seconds.

5. Optional: Edit the available boot options:

   UEFI-based systems

   Press **E** to enter edit mode. Change the predefined command line to add or remove boot options. Press **Enter** to confirm your choice.

   BIOS-based systems

   Press the **Tab** key on your keyboard to enter edit mode. Change the predefined command line to add or remove boot options. Press **Enter** to confirm your choice.

Additional Resources

- * Automatically installing RHEL
- Boot options for RHEL installer

13.3. BOOTING THE INSTALLATION ON IBM Z TO INSTALL RHEL IN AN LPAR

13.3.1. Booting the RHEL installation from an SFTP, FTPS, or FTP server to install in an IBM Z LPAR

You can install RHEL into an LPAR by using an SFTP, FTPS, or FTP server.

Procedure

1. Log in on the IBM Z Hardware Management Console (HMC) or the Support Element (SE) as a user with sufficient privileges to install a new operating system to an LPAR. The **SYSPROG** user is recommended.

2. On the **Systems** tab, select the mainframe you want to work with, then on the **Partitions** tab select the LPAR to which you wish to install.

3. At the bottom of the screen, under **Daily**, find **Operating System Messages**. Double-click **Operating System Messages** to show the text console on which Linux boot messages will appear.

4. Double-click **Load from Removable Media or Server**.

5. In the dialog box that follows, select **SFTP/FTPS/FTP Server**, and enter the following information:

   - **Host Computer** - Host name or IP address of the FTP server you want to install from, for example **ftp.redhat.com**
   - **User ID** - Your user name on the FTP server. Or, specify anonymous.
   - **Password** - Your password. Use your email address if you are logging in as anonymous.
   - **File location (optional)** - Directory on the FTP server holding the Red Hat Enterprise Linux for IBM Z, for example **/rhel/s390x/**.

6. Click **Continue**.

7. In the dialog that follows, keep the default selection of **generic.ins** and click **Continue**.

13.3.2. Booting the RHEL installation from a prepared DASD to install in an IBM Z LPAR

Use this procedure when installing Red Hat Enterprise Linux into an LPAR using an already prepared DASD.

Procedure

1. Log in on the IBM Z Hardware Management Console (HMC) or the Support Element (SE) as a user with sufficient privileges to install a new operating system to an LPAR. The **SYSPROG** user is recommended.

2. On the **Systems** tab, select the mainframe you want to work with, then on the **Partitions** tab select the LPAR to which you wish to install.

3. At the bottom of the screen, under **Daily**, find **Operating System Messages**. Double-click **Operating System Messages** to show the text console on which Linux boot messages will appear.

4. Double-click **Load**.

5. In the dialog box that follows, select **Normal** as the **Load type**.

6. As Load **address**, fill in the device number of the DASD.

7. As **Load parameter**, fill in the number corresponding to the **zipl** boot menu entry that you prepared for booting the Red Hat Enterprise Linux installation program.

8. Click the **OK** button.

13.3.3. Booting the RHEL installation from an FCP-attached SCSI disk to install in an IBM Z LPAR

Use this procedure when installing Red Hat Enterprise Linux into an LPAR using an already prepared FCP attached SCSI disk.

Procedure

1. Log in on the IBM Z Hardware Management Console (HMC) or the Support Element (SE) as a user with sufficient privileges to install a new operating system to an LPAR. The **SYSPROG** user is recommended.
2. On the **Systems** tab, select the mainframe you want to work with, then on the **Partitions** tab select the LPAR to which you wish to install.
3. At the bottom of the screen, under **Daily**, find **Operating System Messages**. Double-click **Operating System Messages** to show the text console on which Linux boot messages will appear.
4. Double-click **Load**.
5. In the dialog box that follows, select **SCSI** as the **Load type**.
6. As **Load address**, fill in the device number of the FCP channel connected with the SCSI disk.
7. As **World wide port name**, fill in the WWPN of the storage system containing the disk as a 16-digit hexadecimal number.
8. As **Logical unit number**, fill in the LUN of the disk as a 16-digit hexadecimal number.
9. As **Boot program selector**, fill in the number corresponding to the **zipl** boot menu entry that you prepared for booting the Red Hat Enterprise Linux installation program.
10. Leave the **Boot record logical block address** as **0** and the **Operating system specific load parameters** empty.
11. Click the **OK** button.

13.4. BOOTING THE INSTALLATION ON IBM Z TO INSTALL RHEL IN Z/VM

When installing under z/VM, you can boot from:

- The z/VM virtual reader
- A DASD or an FCP-attached SCSI disk prepared with the **zipl** boot loader

13.4.1. Booting the RHEL installation by using the z/VM Reader

You can boot from the z/VM reader.

Procedure

1. If necessary, add the device containing the z/VM TCP/IP tools to your CMS disk list. For example:

```
cp link tcpmaint 592 592
acc 592 fm
```

   Replace *fm* with any **FILEMODE** letter.

2. For a connection to an FTPS server, enter:

```
ftp <host> (secure
```

Where **host** is the host name or IP address of the FTP server that hosts the boot images (**kernel.img** and **initrd.img**).

3. Log in and execute the following commands. Use the **(repl** option if you are overwriting existing **kernel.img**, **initrd.img**, **generic.prm**, or **redhat.exec** files:

```
cd /location/of/install-tree/images/
ascii
get generic.prm (repl
get redhat.exec (repl
locsite fix 80
binary
get kernel.img (repl
get initrd.img (repl
quit
```

4. Optional: Check whether the files were transferred correctly by using the CMS command **filelist** to show the received files and their format. It is important that **kernel.img** and **initrd.img** have a fixed record length format denoted by F in the Format column and a record length of 80 in the Lrecl column. For example:

```
VMUSER FILELIST A0 V 169 Trunc=169 Size=6 Line=1 Col=1 Alt=0
Cmd Filename Filetype Fm Format Lrecl Records Blocks Date Time
REDHAT EXEC  B1 V 22 1  1 4/15/10 9:30:40
GENERIC PRM  B1 V 44 1 1 4/15/10 9:30:32
INITRD IMG  B1 F 80 118545 2316 4/15/10 9:30:25
KERNEL IMG  B1 F 80 74541 912 4/15/10 9:30:17
```

Press **PF3** to quit filelist and return to the CMS prompt.

5. Customize boot parameters in **generic.prm** as necessary. For details, see Customizing boot parameters.
Another way to configure storage and network devices is by using a CMS configuration file. In such a case, add the ***CMSDASD=*** and ***CMSCONFFILE=*** parameters to **generic.prm**. See IBM Z/VM configuration file for more details.

6. Finally, execute the REXX script redhat.exec to boot the installation program:

```
redhat
```

13.4.2. Booting the RHEL installation by using a prepared DASD

Perform the following steps to use a Prepared DASD:

Procedure

- Boot from the prepared DASD and select the **zipl** boot menu entry referring to the Red Hat Enterprise Linux installation program. Use a command of the following form:

```
cp ipl DASD_device_number loadparm boot_entry_number
```

Replace *DASD_device_number* with the device number of the boot device, and *boot_entry_number* with the **zipl** configuration menu for this device. For example:

```
cp ipl eb1c loadparm 0
```

13.4.3. Booting the RHEL installation by using a prepared FCP attached SCSI Disk

Perform the following steps to boot from a prepared FCP-attached SCSI disk:

Procedure

1. Configure the SCSI boot loader of z/VM to access the prepared SCSI disk in the FCP Storage Area Network. Select the prepared **zipl** boot menu entry referring to the Red Hat Enterprise Linux installation program. Use a command of the following form:

   ```
   cp set loaddev portname WWPN lun LUN bootprog boot_entry_number
   ```

   Replace *WWPN* with the World Wide Port Name of the storage system and *LUN* with the Logical Unit Number of the disk. The 16-digit hexadecimal numbers must be split into two pairs of eight digits each. For example:

   ```
   cp set loaddev portname 50050763 050b073d lun 40204011 00000000 bootprog 0
   ```

2. Optional: Confirm your settings with the command:

   ```
   query loaddev
   ```

3. Boot the FCP device connected with the storage system containing the disk with the following command:

   ```
   cp ipl FCP_device
   ```

   For example:

   ```
   cp ipl fc00
   ```

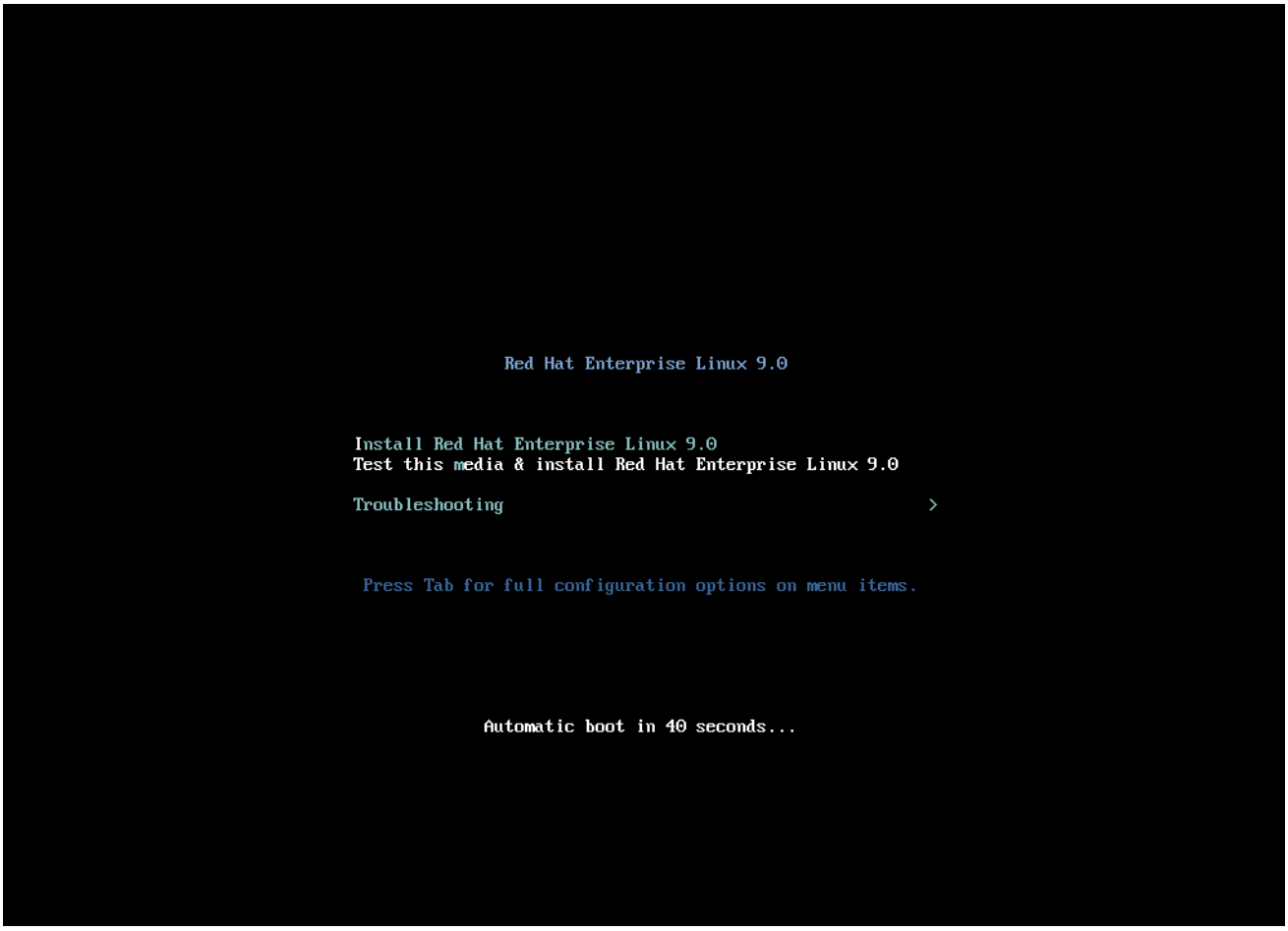
CHAPTER 14. OPTIONAL: CUSTOMIZING BOOT OPTIONS

When you are installing RHEL on **x86_64** or **ARM64** architectures, you can edit the boot options to customize the installation process based on your specific environment.

14.1. BOOT MENU

The Red Hat Enterprise Linux boot menu is displayed using **GRand Unified Bootloader version 2** (GRUB2) when your system has completed loading the boot media.

Figure 14.1. Red Hat Enterprise Linux boot menu



The boot menu provides several options in addition to launching the installation program. If you do not make a selection within 60 seconds, the default boot option (highlighted in white) is run. To select a different option, use the arrow keys on your keyboard to make your selection and press the **Enter** key.

You can customize boot options for a particular menu entry:

- **On BIOS-based systems:** Press the **Tab** key and add custom boot options to the command line. You can also access the **boot:** prompt by pressing the **Esc** key but no required boot options are preset. In this scenario, you must always specify the Linux option before using any other boot options.
- **On UEFI-based systems:** Press the **e** key and add custom boot options to the command line. When ready press **Ctrl**+**X** to boot the modified option.

Table 14.1. Boot menu options

Boot menu option	Description
Install Red Hat Enterprise Linux 9	Use this option to install Red Hat Enterprise Linux using the graphical installation program.
Test this media & install Red Hat Enterprise Linux 9	Use this option to check the integrity of the installation media.
Troubleshooting >	Use this option to resolve various installation issues. Press **Enter** to display its contents.

Table 14.2. Troubleshooting options

Troubleshooting option	Description
Troubleshooting > Install Red Hat Enterprise Linux 9 in basic graphics mode	Use this option to install Red Hat Enterprise Linux in graphical mode even if the installation program is unable to load the correct driver for your video card. If your screen is distorted when using the Install Red Hat Enterprise Linux 9 option, restart your system and use this option. For more information, see Cannot boot into graphical installation
Troubleshooting > Rescue a Red Hat Enterprise Linux system	Use this option to repair any issues that prevent you from booting. For more information, see Using a rescue mode.
Troubleshooting > Run a memory test	Use this option to run a memory test on your system. Press **Enter** to display its contents. For more information, see memtest86.
Troubleshooting > Boot from local drive	Use this option to boot the system from the first installed disk. If you booted this disk accidentally, use this option to boot from the disk immediately without starting the installation program.

14.2. TYPES OF BOOT OPTIONS

The two types of boot options are those with an equals "=" sign, and those without an equals "=" sign. Boot options are appended to the boot command line and you can append multiple options separated by space. Boot options that are specific to the installation program always start with **inst**.

Options with an equals "=" sign

You must specify a value for boot options that use the **=** symbol. For example, the **inst.vncpassword=** option must contain a value, in this example, a password. The correct syntax for this example is **inst.vncpassword=password**.

Options without an equals "=" sign

This boot option does not accept any values or parameters. For example, the **rd.live.check** option forces the installation program to verify the installation media before starting the installation. If this boot option is present, the installation program performs the verification and if the boot option is not

present, the verification is skipped.

14.3. EDITING THE BOOT: PROMPT IN BIOS

When using the **boot:** prompt, the first option must always specify the installation program image file that you want to load. In most cases, you can specify the image using the keyword. You can specify additional options according to your requirements.

Prerequisites

- You have created bootable installation media (USB, CD or DVD).
- You have booted the installation from the media, and the installation boot menu is open.

Procedure

1. With the boot menu open, press the **Esc** key on your keyboard.
2. The **boot:** prompt is now accessible.
3. Press the **Tab** key on your keyboard to display the help commands.
4. Press the **Enter** key on your keyboard to start the installation with your options. To return from the **boot:** prompt to the boot menu, restart the system and boot from the installation media again.
   The **boot:** prompt also accepts **dracut** kernel options. A list of options is available in the **dracut.cmdline(7)** man page.

14.4. EDITING PREDEFINED BOOT OPTIONS USING THE > PROMPT

In BIOS-based AMD64 and Intel 64 systems, you can use the **>** prompt to edit predefined boot options. To display a full set of options, select **Test this media and install RHEL 9** from the boot menu.

Prerequisites

- You have created bootable installation media (USB, CD or DVD).
- You have booted the installation from the media, and the installation boot menu is open.

Procedure

1. From the boot menu, select an option and press the **Tab** key on your keyboard. The **>** prompt is accessible and displays the available options.
2. Append the options that you require to the **>** prompt.
3. Press **Enter** to start the installation.
4. Press **Esc** to cancel editing and return to the boot menu.

14.5. EDITING THE GRUB2 MENU FOR THE UEFI-BASED SYSTEMS

The GRUB2 menu is available on UEFI-based AMD64, Intel 64, and 64-bit ARM systems.

Prerequisites

- You have created bootable installation media (USB, CD or DVD).
- You have booted the installation from the media, and the installation boot menu is open.

Procedure

1. From the boot menu window, select the required option and press **e**.
2. On UEFI systems, the kernel command line starts with **linuxefi**. Move the cursor to the end of the **linuxefi** kernel command line.
3. Edit the parameters as required. For example, to configure one or more network interfaces, add the **ip=** parameter at the end of the **linuxefi** kernel command line, followed by the required value.
4. When you finish editing, press **Ctrl**+**X** to start the installation using the specified options.

14.6. UPDATING DRIVERS DURING INSTALLATION

You can update drivers during the Red Hat Enterprise Linux installation process. Updating drivers is completely optional. Do not perform a driver update unless it is necessary. Ensure you have been notified by Red Hat, your hardware vendor, or a trusted third-party vendor that a driver update is required during Red Hat Enterprise Linux installation.

14.6.1. Overview

Red Hat Enterprise Linux supports drivers for many hardware devices but some newly-released drivers may not be supported. A driver update should only be performed if an unsupported driver prevents the installation from completing. Updating drivers during installation is typically only required to support a particular configuration. For example, installing drivers for a storage adapter card that provides access to your system's storage devices.

WARNING

Driver update disks may disable conflicting kernel drivers. In rare cases, unloading a kernel module may cause installation errors.

14.6.2. Types of driver update

Red Hat, your hardware vendor, or a trusted third party provides the driver update as an ISO image file. Once you receive the ISO image file, choose the type of driver update.

Types of driver update

Automatic

In this driver update method; a storage device (including a CD, DVD, or USB flash drive) labeled **OEMDRV** is physically connected to the system. If the **OEMDRV** storage device is present when the installation starts, it is treated as a driver update disk, and the installation program automatically

loads its drivers.

Assisted

The installation program prompts you to locate a driver update. You can use any local storage device with a label other than **OEMDRV**. The **inst.dd** boot option is specified when starting the installation. If you use this option without any parameters, the installation program displays all of the storage devices connected to the system, and prompts you to select a device that contains a driver update.

Manual

Manually specify a path to a driver update image or an RPM package. You can use any local storage device with a label other than **OEMDRV**, or a network location accessible from the installation system. The **inst.dd=location** boot option is specified when starting the installation, where *location* is the path to a driver update disk or ISO image. When you specify this option, the installation program attempts to load any driver updates found at the specified location. With manual driver updates, you can specify local storage devices, or a network location (HTTP, HTTPS or FTP server). You can use both **inst.dd=location** and **inst.dd** simultaneously, where *location* is the path to a driver update disk or ISO image. In this scenario, the installation program attempts to load any available driver updates from the location and also prompts you to select a device that contains the driver update.

Limitations

On UEFI systems with the Secure Boot technology enabled, all drivers must be signed with a valid certificate. Red Hat drivers are signed by one of Red Hat's private keys and authenticated by its corresponding public key in the kernel. If you load additional, separate drivers, verify that they are signed.

14.6.3. Preparing a driver update

This procedure describes how to prepare a driver update on a CD and DVD.

Prerequisites

- You have received the driver update ISO image from Red Hat, your hardware vendor, or a trusted third-party vendor.
- You have burned the driver update ISO image to a CD or DVD.

WARNING

If only a single ISO image file ending in **.iso** is available on the CD or DVD, the burn process has not been successful. See your system's burning software documentation for instructions on how to burn ISO images to a CD or DVD.

Procedure

1. Insert the driver update CD or DVD into your system's CD/DVD drive, and browse it using the system's file manager tool.
2. Verify that a single file **rhdd3** is available. **rhdd3** is a signature file that contains the driver description and a directory named **rpms**, which contains the RPM packages with the actual drivers for various architectures.

14.6.4. Performing an automatic driver update

This procedure describes how to perform an automatic driver update during installation.

Prerequisites

- You have placed the driver update image on a standard disk partition with an **OEMDRV** label or burnt the **OEMDRV** driver update image to a CD or DVD. Advanced storage, such as RAID or LVM volumes, may not be accessible during the driver update process.
- You have connected a block device with an **OEMDRV** volume label to your system, or inserted the prepared CD or DVD into your system's CD/DVD drive before starting the installation process.

Procedure

- When you complete the prerequisite steps, the drivers load automatically when the installation program starts and installs during the system's installation process.

14.6.5. Performing an assisted driver update

This procedure describes how to perform an assisted driver update during installation.

Prerequisites

- You have connected a block device without an **OEMDRV** volume label to your system and copied the driver disk image to this device, or you have prepared a driver update CD or DVD and inserted it into your system's CD or DVD drive before starting the installation process.

NOTE

If you burned an ISO image file to a CD or DVD but it does not have the **OEMDRV** volume label, you can use the **inst.dd** option with no arguments. The installation program provides an option to scan and select drivers from the CD or DVD. In this scenario, the installation program does not prompt you to select a driver update ISO image. Another scenario is to use the CD or DVD with the **inst.dd=location** boot option; this allows the installation program to automatically scan the CD or DVD for driver updates. For more information, see Performing a manual driver update.

Procedure

1. From the boot menu window, press the **Tab** key on your keyboard to display the boot command line.
2. Append the **inst.dd** boot option to the command line and press **Enter** to execute the boot process.
3. From the menu, select a local disk partition or a CD or DVD device. The installation program scans for ISO files, or driver update RPM packages.
4. Optional: Select the driver update ISO file.
   This step is not required if the selected device or partition contains driver update RPM packages rather than an ISO image file, for example, an optical drive containing a driver update CD or DVD.

5. Select the required drivers.

   a. Use the number keys on your keyboard to toggle the driver selection.

   b. Press **c** to install the selected driver. The selected driver is loaded and the installation process starts.

14.6.6. Performing a manual driver update

This procedure describes how to perform a manual driver update during installation.

Prerequisites

- You have placed the driver update ISO image file on a USB flash drive or a web server and connected it to your computer.

Procedure

1. From the boot menu window, press the **Tab** key on your keyboard to display the boot command line.
2. Append the **inst.dd=location** boot option to the command line, where location is a path to the driver update. Typically, the image file is located on a web server, for example, http://server.example.com/dd.iso, or on a USB flash drive, for example, /**dev**/**sdb1**. It is also possible to specify an RPM package containing the driver update, for example http://server.example.com/dd.rpm.
3. Press **Enter** to execute the boot process. The drivers available at the specified location are automatically loaded and the installation process starts.

Additional resources

- The **inst.dd** boot option

14.6.7. Disabling a driver

This procedure describes how to disable a malfunctioning driver.

Prerequisites

- You have booted the installation program boot menu.

Procedure

1. From the boot menu, press the **Tab** key on your keyboard to display the boot command line.
2. Append the **modprobe.blacklist=driver_name** boot option to the command line. Replace *driver_name* with the name of the driver or drivers you want to disable, for example:

   ```
   modprobe.blacklist=ahci
   ```

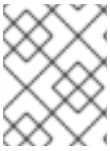
   Drivers disabled using the **modprobe.blacklist=** boot option remain disabled on the installed system and appear in the **/etc/modprobe.d/anaconda-blacklist.conf** file.

3. Press **Enter** to execute the boot process.

CHAPTER 15. STARTING A REMOTE INSTALLATION BY USING VNC

15.1. PERFORMING A REMOTE RHEL INSTALLATION IN VNC DIRECT MODE

Use this procedure to perform a remote RHEL installation in VNC Direct mode. Direct mode expects the VNC viewer to initiate a connection to the target system that is being installed with RHEL. In this procedure, the system with the VNC viewer is called the **remote** system. You are prompted by the RHEL installation program to initiate the connection from the VNC viewer on the remote system to the target system.



NOTE

This procedure uses **TigerVNC** as the VNC viewer. Specific instructions for other viewers might differ, but the general principles apply.

Prerequisites

- You have installed a VNC viewer on a remote system as a root user.
- You have set up a network boot server and booted the installation on the target system.

Procedure

1. From the RHEL boot menu on the target system, press the **Tab** key on your keyboard to edit the boot options.
2. Append the **inst.vnc** option to the end of the command line.
   - If you want to restrict VNC access to the system that is being installed, add the **inst.vncpassword=PASSWORD** boot option to the end of the command line. Replace **PASSWORD** with the password you want to use for the installation.
     - The VNC password must be between 6 and 8 characters long.
     - This is a temporary password for the **inst.vncpassword=** option and it should not be an existing or root password.
3. Press **Enter** to start the installation. The target system initializes the installation program and starts the necessary services. When the system is ready, a message is displayed providing the IP address and port number of the system.
4. Open the VNC viewer on the remote system.
5. Enter the IP address and the port number into the **VNC server** field.
6. Click **Connect**.
7. Enter the VNC password and click **OK**. A new window opens with the VNC connection established, displaying the RHEL installation menu. From this window, you can install RHEL on the target system using the graphical user interface.

15.2. PERFORMING A REMOTE RHEL INSTALLATION IN VNC CONNECT MODE

Use this procedure to perform a remote RHEL installation in VNC Connect mode. In Connect mode, the target system that is being installed with RHEL initiates a connect to the VNC viewer that is installed on another system. In this procedure, the system with the VNC viewer is called the **remote** system.

NOTE

This procedure uses **TigerVNC** as the VNC viewer. Specific instructions for other viewers might differ, but the general principles apply.

Prerequisites

- You have installed a VNC viewer on a remote system as a root user.
- You have set up a network boot server to start the installation on the target system.
- You have configured the target system to use the boot options for a VNC Connect installation.
- You have verified that the remote system with the VNC viewer is configured to accept an incoming connection on the required port. Verification is dependent on your network and system configuration. For more information, see Security hardening and Securing networks.

Procedure

1. Start the VNC viewer on the remote system in *listening mode* by running the following command:

```
$ vncviewer -listen PORT
```

2. Replace PORT with the port number used for the connection.
3. The terminal displays a message indicating that it is waiting for an incoming connection from the target system.

```
TigerVNC Viewer 64-bit v1.8.0
Built on: 2017-10-12 09:20
Copyright (C) 1999-2017 TigerVNC Team and many others (see README.txt)
See http://www.tigervnc.org for information about TigerVNC.

Thu Jun 27 11:30:57 2019
 main:       Listening on port 5500
```

4. Boot the target system from the network.
5. From the RHEL boot menu on the target system, press the **Tab** key on your keyboard to edit the boot options.
6. Append the **inst.vnc inst.vncconnect=HOST:PORT** option to the end of the command line.
7. Replace *HOST* with the IP address of the remote system that is running the listening VNC viewer, and *PORT* with the port number that the VNC viewer is listening on.

8. Press **Enter** to start the installation. The system initializes the installation program and starts the necessary services. When the initialization process is finished, the installation program attempts to connect to the IP address and port provided.

9. When the connection is successful, a new window opens with the VNC connection established, displaying the RHEL installation menu. From this window, you can install RHEL on the target system using the graphical user interface.

15.3. PERFORMING A REMOTE RHEL INSTALLATION BY USING VNC ON IBM Z

After the Initial Program Load (IPL) of the Anaconda installation program is complete, connect to the 64-bit IBM Z system from a local machine, as an **install** user, using an ssh connection.

You need to connect to the installation system to continue the installation process. Use a VNC mode to run a GUI-based installation or use the established connection to run a text mode installation.

Prerequisite

- You booted the installation media as described in Booting the installation on IBM Z to install RHEL in an LPAR.
  The initial program boot is complete on the 64-bit IBM Z system, and the command prompt displays:

  ```
  Starting installer, one moment...
        Please ssh install@my-z-system (system ip address) to begin the install.
  ```

- If you want to restrict VNC access to the installation system, then ensure **inst.vncpassword=*PASSWORD*** boot parameter is configured.

Procedure

From a local machine, run the steps below to set up a remote connection with the 64-bit IBM Z system.

1. On the command prompt, run the following command:

   ```
   $ssh install@_my-z-system-domain-name_
   ```

   or

   ```
   $ssh install@_my-z-system-IP-address_
   ```

2. Depending on whether or not have you configured the **inst.vnc** parameter, the ssh session displays the following output:
   When **inst.vnc** parameter is configured:

   ```
   Starting installer, one moment...
   Please manually connect your vnc client to my-z-system:1 (_system-ip-address:1_) to begin
   the install.
   ```

   When **inst.vnc** parameter is not configured:

   ```
   Starting installer, one moment...
   Graphical installation is not available. Starting text mode.
   ```

```
=============
Text mode provides a limited set of installation options.
It does not offer custom partitioning for full control
over the disk layout. Would you like to use VNC mode instead?
1) Start VNC
2) Use text mode
Please make your choice from above ['q' to quit | 'c' to continue | 'r' to refresh]:
```

If you have configured the **inst.vnc** parameter, proceed to step 5.

3. Enter 1 to start VNC.
4. Enter a password, if you have not set the **inst.vncpassword=** boot option, but want to secure the server connection.
5. From a new command prompt, connect to the VNC server.

```
$vncviewer _my-z-system-ip-address:display_number_
```

If you have secured the connection, use the password that you have entered in the previous step or the one that you had set for **inst.vncpassword=** boot option.

The RHEL installer is launched in the VNC client.

CHAPTER 16. CONSOLES AND LOGGING DURING INSTALLATION

The Red Hat Enterprise Linux installer uses the **tmux** terminal multiplexer to display and control several windows in addition to the main interface. Each of these windows serve a different purpose; they display several different logs, which can be used to troubleshoot issues during the installation process. One of the windows provides an interactive shell prompt with **root** privileges, unless this prompt was specifically disabled using a boot option or a Kickstart command.

The terminal multiplexer is running in virtual console 1. To switch from the actual installation environment to **tmux**, press **Ctrl**+**Alt**+**F1**. To go back to the main installation interface which runs in virtual console 6, press **Ctrl**+**Alt**+**F6**. During the text mode installation, start in virtual console 1 (**tmux**), and switching to console 6 will open a shell prompt instead of a graphical interface.

The console running **tmux** has five available windows; their contents are described in the following table, along with keyboard shortcuts. Note that the keyboard shortcuts are two-part: first press **Ctrl**+**b**, then release both keys, and press the number key for the window you want to use.

You can also use **Ctrl**+**b n**, **Alt+ Tab**, and **Ctrl**+**b p** to switch to the next or previous **tmux** window, respectively.

Table 16.1. Available tmux windows

Shortcut	Contents
Ctrl+**b 1**	Main installation program window. Contains text-based prompts (during text mode installation or if you use VNC direct mode), and also some debugging information.
Ctrl+**b 2**	Interactive shell prompt with **root** privileges.
Ctrl+**b 3**	Installation log; displays messages stored in **/tmp/anaconda.log**.
Ctrl+**b 4**	Storage log; displays messages related to storage devices and configuration, stored in **/tmp/storage.log**.
Ctrl+**b 5**	Program log; displays messages from utilities executed during the installation process, stored in **/tmp/program.log**.

CHAPTER 17. CUSTOMIZING THE SYSTEM IN THE INSTALLER

During the customization phase of the installation, you must perform certain configuration tasks to enable the installation of Red Hat Enterprise Linux. These tasks include:

- Configuring the storage and assign mount points.
- Selecting a base environment with software to be installed.
- Setting a password for the root user or create a local user.

Optionally, you can further customize the system, for example, by configuring system settings and connecting the host to a network.

17.1. SETTING THE INSTALLER LANGUAGE

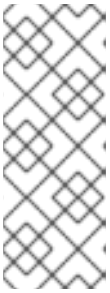
You can select the language to be used by the installation program before starting the installation.

Prerequisites

- You have created installation media.
- You have specified an installation source if you are using the Boot ISO image file.
- You have booted the installation.

Procedure

1. After you select Install **Red hat Enterprise Linux**option from the boot menu, the **Welcome to Red Hat Enterprise Screen** appears.
2. From the left-hand pane of the **Welcome to Red Hat Enterprise Linux**window, select a language. Alternatively, search the preferred language by using the text box.



NOTE

A language is pre-selected by default. If network access is configured, that is, if you booted from a network server instead of local media, the pre-selected language is determined by the automatic location detection feature of the **GeoIP** module. If you used the **inst.lang=** option on the boot command line or in your PXE server configuration, then the language that you define with the boot option is selected.

3. From the right-hand pane of the **Welcome to Red Hat Enterprise Linux**window, select a location specific to your region.
4. Click **Continue** to proceed to the graphical installations window.
5. If you are installing a pre-release version of Red Hat Enterprise Linux, a warning message is displayed about the pre-release status of the installation media.
   a. To continue with the installation, click **I want to proceed**, or
   b. To quit the installation and reboot the system, click **I want to exit**.

17.2. CONFIGURING THE STORAGE DEVICES

You can install Red Hat Enterprise Linux on a large variety of storage devices. You can configure basic, locally accessible, storage devices in the **Installation Destination** window. Basic storage devices directly connected to the local system, such as disks and solid-state drives, are displayed in the **Local Standard Disks** section of the window. On 64-bit IBM Z, this section contains activated Direct Access Storage Devices (DASDs).

WARNING

A known issue prevents DASDs configured as HyperPAV aliases from being automatically attached to the system after the installation is complete. These storage devices are available during the installation, but are not immediately accessible after you finish installing and reboot. To attach HyperPAV alias devices, add them manually to the **/etc/dasd.conf** configuration file of the system.

17.2.1. Configuring installation destination

You can use the **Installation Destination** window to configure the storage options, for example, the disks that you want to use as the installation target for your Red Hat Enterprise Linux installation. You must select at least one disk.

Prerequisites

- The **Installation Summary** window is open.
- Ensure to back up your data if you plan to use a disk that already contains data. For example, if you want to shrink an existing Microsoft Windows partition and install Red Hat Enterprise Linux as a second system, or if you are upgrading a previous release of Red Hat Enterprise Linux. Manipulating partitions always carries a risk. For example, if the process is interrupted or fails for any reason data on the disk can be lost.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. Perform the following operations in the **Installation Destination** window opens:
    a. From the **Local Standard Disks** section, select the storage device that you require; a white check mark indicates your selection. Disks without a white check mark are not used during the installation process; they are ignored if you choose automatic partitioning, and they are not available in manual partitioning.
    The **Local Standard Disks** shows all locally available storage devices, for example, SATA, IDE and SCSI disks, USB flash and external disks. Any storage devices connected after the installation program has started are not detected. If you use a removable drive to install Red Hat Enterprise Linux, your system is unusable if you remove the device.
    b. Optional: Click the **Refresh** link in the lower right-hand side of the window if you want to configure additional local storage devices to connect new disks. The **Rescan Disks** dialog box opens.
        i. Click **Rescan Disks** and wait until the scanning process completes.

All storage changes that you make during the installation are lost when you click **Rescan Disks**.

ii. Click **OK** to return to the **Installation Destination** window. All detected disks including any new ones are displayed under the **Local Standard Disks** section.

2. Optional: Click **Add a disk...** to add a specialized storage device.
The **Storage Device Selection** window opens and lists all storage devices that the installation program has access to.

3. Optional: Under **Storage Configuration**, select the **Automatic** radio button for automatic partitioning.
You can also configure custom partitioning. For more details, see Configuring manual partitioning.

4. Optional: Select **I would like to make additional space available** to reclaim space from an existing partitioning layout. For example, if a disk you want to use already has a different operating system and you want to make this system's partitions smaller to allow more room for Red Hat Enterprise Linux.

5. Optional: Select **Encrypt my data** to encrypt all partitions except the ones needed to boot the system (such as /**boot**) using *Linux Unified Key Setup* (LUKS). Encrypting your disk to add an extra layer of security.

   a. Click **Done**. The **Disk Encryption Passphrase** dialog box opens.

      i. Type your passphrase in the **Passphrase** and **Confirm** fields.

      ii. Click **Save Passphrase** to complete disk encryption.

WARNING

If you lose the LUKS passphrase, any encrypted partitions and their data is completely inaccessible. There is no way to recover a lost passphrase. However, if you perform a Kickstart installation, you can save encryption passphrases and create backup encryption passphrases during the installation. For more information, see the Automatically installing RHEL document.

6. Optional: Click the **Full disk summary and bootloader** link in the lower left-hand side of the window to select which storage device contains the boot loader. For more information, see Configuring boot loader.
In most cases it is sufficient to leave the boot loader in the default location. Some configurations, for example, systems that require chain loading from another boot loader require the boot drive to be specified manually.

7. Click **Done**.

8. Optional: The **Reclaim Disk Space** dialog box appears if you selected **automatic partitioning** and the **I would like to make additional space available** option, or if there is not enough free space on the selected disks to install Red Hat Enterprise Linux. It lists all configured disk devices

and all partitions on those devices. The dialog box displays information about the minimal disk space the system needs for an installation with the currently selected package set and how much space you have reclaimed. To start the reclaiming process:

a. Review the displayed list of available storage devices. The **Reclaimable Space** column shows how much space can be reclaimed from each entry.

b. Select a disk or partition to reclaim space.

c. Use the **Shrink** button to use free space on a partition while preserving the existing data.

d. Use the **Delete** button to delete that partition or all partitions on a selected disk including existing data.

e. Use the **Delete all** button to delete all existing partitions on all disks including existing data and make this space available to install Red Hat Enterprise Linux.

f. Click **Reclaim space** to apply the changes and return to graphical installations. No disk changes are made until you click **Begin Installation** on the **Installation Summary** window. The **Reclaim Space** dialog only marks partitions for resizing or deletion; no action is performed.

Additional resources

- How to use dm-crypt on IBM Z, LinuxONE and with the PAES cipher

17.2.2. Special cases during installation destination configuration

Following are some special cases to consider when you are configuring installation destinations:

- Some BIOS types do not support booting from a RAID card. In these instances, the **/boot** partition must be created on a partition outside of the RAID array, such as on a separate disk. It is necessary to use an internal disk for partition creation with problematic RAID cards. A **/boot** partition is also necessary for software RAID setups. If you choose to partition your system automatically, you should manually edit your **/boot** partition.

- To configure the Red Hat Enterprise Linux boot loader to *chain load* from a different boot loader, you must specify the boot drive manually by clicking the **Full disk summary and bootloader** link from the **Installation Destination** window.

- When you install Red Hat Enterprise Linux on a system with both multipath and non-multipath storage devices, the automatic partitioning layout in the installation program creates volume groups that contain a mix of multipath and non-multipath devices. This defeats the purpose of multipath storage. Select either multipath or non-multipath devices on the **Installation Destination** window. Alternatively, proceed to manual partitioning.

17.2.3. Configuring boot loader

Red Hat Enterprise Linux uses GRand Unified Bootloader version 2 (**GRUB2**) as the boot loader for AMD64 and Intel 64, IBM Power Systems, and ARM. For 64-bit IBM Z, the **zipl** boot loader is used.

The boot loader is the first program that runs when the system starts and is responsible for loading and transferring control to an operating system. **GRUB2** can boot any compatible operating system (including Microsoft Windows) and can also use chain loading to transfer control to other boot loaders for unsupported operating systems.

WARNING

Installing **GRUB2** may overwrite your existing boot loader.

If an operating system is already installed, the Red Hat Enterprise Linux installation program attempts to automatically detect and configure the boot loader to start the other operating system. If the boot loader is not detected, you can manually configure any additional operating systems after you finish the installation.

If you are installing a Red Hat Enterprise Linux system with more than one disk, you might want to manually specify the disk where you want to install the boot loader.

Procedure

1. From the **Installation Destination** window, click the **Full disk summary and bootloader** link. The **Selected Disks** dialog box opens.
   The boot loader is installed on the device of your choice, or on a UEFI system; the **EFI system partition** is created on the target device during guided partitioning.
2. To change the boot device, select a device from the list and click **Set as Boot Device**. You can set only one device as the boot device.
3. To disable a new boot loader installation, select the device currently marked for boot and click **Do not install boot loader**. This ensures **GRUB2** is not installed on any device.

WARNING

If you choose not to install a boot loader, you cannot boot the system directly and you must use another boot method, such as a standalone commercial boot loader application. Use this option only if you have another way to boot your system.

The boot loader may also require a special partition to be created, depending on if your system uses BIOS or UEFI firmware, or if the boot drive has a *GUID Partition Table* (GPT) or a **Master Boot Record** (MBR, also known as **msdos**) label. If you use automatic partitioning, the installation program creates the partition.

17.2.4. Storage device selection

The storage device selection window lists all storage devices that the installation program can access. Depending on your system and available hardware, some tabs might not be displayed. The devices are grouped under the following tabs:

Multipath Devices

Storage devices accessible through more than one path, such as through multiple SCSI controllers or Fiber Channel ports on the same system. The installation program only detects multipath storage devices with serial numbers that are 16 or 32 characters long.

Other SAN Devices

Devices available on a Storage Area Network (SAN).

Firmware RAID

Storage devices attached to a firmware RAID controller.

NVDIMM Devices

Under specific circumstances, Red Hat Enterprise Linux 9 can boot and run from (NVDIMM) devices in sector mode on the Intel 64 and AMD64 architectures.

IBM Z Devices

Storage devices, or Logical Units (LUNs), DASD, attached through the zSeries Linux FCP (Fiber Channel Protocol) driver.

17.2.5. Filtering storage devices

In the storage device selection window you can filter storage devices either by their World Wide Identifier (WWID) or by the port, target, or logical unit number (LUN).

Prerequisite

- The **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. The **Installation Destination** window opens, listing all available drives.
2. Under the **Specialized & Network Disks**section, click **Add a disk…**. The storage devices selection window opens.
3. Click the **Search by** tab to search by port, target, LUN, or WWID.
   Searching by WWID or LUN requires additional values in the corresponding input text fields.
4. Select the option that you require from the **Search** drop-down menu.
5. Click **Find** to start the search. Each device is presented on a separate row with a corresponding check box.
6. Select the check box to enable the device that you require during the installation process.
   Later in the installation process you can choose to install Red Hat Enterprise Linux on any of the selected devices, and you can choose to mount any of the other selected devices as part of the installed system automatically. Selected devices are not automatically erased by the installation process and selecting a device does not put the data stored on the device at risk.

NOTE

You can add devices to the system after installation by modifying the **/etc/fstab** file.

7. Click **Done** to return to the **Installation Destination** window.

Any storage devices that you do not select are hidden from the installation program entirely. To chain load the boot loader from a different boot loader, select all the devices present.

17.2.6. Using advanced storage options

To use an advanced storage device, you can configure an iSCSI (SCSI over TCP/IP) target or FCoE (Fibre Channel over Ethernet) SAN (Storage Area Network).

To use iSCSI storage devices for the installation, the installation program must be able to discover them as iSCSI targets and be able to create an iSCSI session to access them. Each of these steps might require a user name and password for Challenge Handshake Authentication Protocol (CHAP) authentication. Additionally, you can configure an iSCSI target to authenticate the iSCSI initiator on the system to which the target is attached (reverse CHAP), both for discovery and for the session. Used together, CHAP and reverse CHAP are called mutual CHAP or two-way CHAP. Mutual CHAP provides the greatest level of security for iSCSI connections, particularly if the user name and password are different for CHAP authentication and reverse CHAP authentication.

Repeat the iSCSI discovery and iSCSI login steps to add all required iSCSI storage. You cannot change the name of the iSCSI initiator after you attempt discovery for the first time. To change the iSCSI initiator name, you must restart the installation.

17.2.6.1. Discovering and starting an iSCSI session

The Red Hat Enterprise Linux installer can discover and log in to iSCSI disks in two ways:

iSCSI Boot Firmware Table (iBFT)

When the installer starts, it checks if the BIOS or add-on boot ROMs of the system support iBFT. It is a BIOS extension for systems that can boot from iSCSI. If the BIOS supports iBFT, the installer reads the iSCSI target information for the configured boot disk from the BIOS and logs in to this target, making it available as an installation target. To automatically connect to an iSCSI target, activate a network device for accessing the target. To do so, use **ip=ibft** boot option. For more information, see Network boot options.

Discover and add iSCSI targets manually

You can discover and start an iSCSI session to identify available iSCSI targets (network storage devices) in the installer's graphical user interface.

Prerequisites

- The **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. The **Installation Destination** window opens, listing all available drives.
2. Under the **Specialized & Network Disks**section, click **Add a disk...**. The storage devices selection window opens.
3. Click **Add iSCSI target...**. The **Add iSCSI Storage Target**window opens.

IMPORTANT

You cannot place the **/boot** partition on iSCSI targets that you have manually added using this method - an iSCSI target containing a **/boot** partition must be configured for use with iBFT. However, in instances where the installed system is expected to boot from iSCSI with iBFT configuration provided by a method other than firmware iBFT, for example using iPXE, you can remove the **/boot** partition restriction using the **inst.nonibftiscsiboot** installer boot option.

4. Enter the IP address of the iSCSI target in the **Target IP Address** field.

5. Type a name in the **iSCSI Initiator Name** field for the iSCSI initiator in iSCSI qualified name (IQN) format. A valid IQN entry contains the following information:

   - The string **iqn.** (note the period).
   - A date code that specifies the year and month in which your organization's Internet domain or subdomain name was registered, represented as four digits for the year, a dash, and two digits for the month, followed by a period. For example, represent September 2010 as **2010-09.**
   - Your organization's Internet domain or subdomain name, presented in reverse order with the top-level domain first. For example, represent the subdomain **storage.example.com** as **com.example.storage**.
   - A colon followed by a string that uniquely identifies this particular iSCSI initiator within your domain or subdomain. For example, **:diskarrays-sn-a8675309**.
     A complete IQN is as follows: **iqn.2010-09.storage.example.com:diskarrays-sn-a8675309**.
     The installation program prepopulates the **iSCSI Initiator Name** field with a name in this format to help you with the structure. For more information about IQNs, see *3.2.6. iSCSI Names* in *RFC 3720 - Internet Small Computer Systems Interface (iSCSI)* available from tools.ietf.org and *1. iSCSI Names and Addresses* in *RFC 3721 - Internet Small Computer Systems Interface (iSCSI) Naming and Discovery* available from tools.ietf.org.

6. Select the **Discovery Authentication Type** drop-down menu to specify the type of authentication to use for iSCSI discovery. The following options are available:

   - No credentials
   - CHAP pair
   - CHAP pair and a reverse pair

7. Do one of the following:

   a. If you selected **CHAP pair** as the authentication type, enter the user name and password for the iSCSI target in the **CHAP Username** and **CHAP Password** fields.

   b. If you selected **CHAP pair and a reverse pair** as the authentication type, enter the user name and password for the iSCSI target in the **CHAP Username** and **CHAP Password** field, and the user name and password for the iSCSI initiator in the **Reverse CHAP Username** and **Reverse CHAP Password** fields.

8. Optional: Select the **Bind targets to network interfaces** check box.

9. Click **Start Discovery**.

The installation program attempts to discover an iSCSI target based on the information provided. If discovery succeeds, the **Add iSCSI Storage Target** window displays a list of all iSCSI nodes discovered on the target.

10. Select the check boxes for the node that you want to use for installation.
The **Node login authentication type** menu contains the same options as the **Discovery Authentication Type** menu. However, if you need credentials for discovery authentication, use the same credentials to log in to a discovered node.

11. Click the additional **Use the credentials from discovery** drop-down menu. When you provide the proper credentials, the **Log In** button becomes available.

12. Click **Log In** to initiate an iSCSI session.

While the installer uses **iscsiadm** to find and log into iSCSI targets, **iscsiadm** automatically stores any information about these targets in the **iscsiadm** iSCSI database. The installer then copies this database to the installed system and marks any iSCSI targets that are not used for root partition, so that the system automatically logs in to them when it starts. If the root partition is placed on an iSCSI target, **initrd** logs into this target and the installer does not include this target in start up scripts to avoid multiple attempts to log into the same target.

17.2.6.2. Configuring FCoE parameters

You can discover the FCoE (Fibre Channel over Ethernet) devices from the **Installation Destination** window by configuring the FCoE parameters accordingly.

Prerequisite

- The **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. The **Installation Destination** window opens, listing all available drives.

2. Under the **Specialized & Network Disks**section, click **Add a disk…**. The storage devices selection window opens.

3. Click **Add FCoE SAN…**. A dialog box opens for you to configure network interfaces for discovering FCoE storage devices.

4. Select a network interface that is connected to an FCoE switch in the **NIC** drop-down menu.

5. Click **Add FCoE disk(s)** to scan the network for SAN devices.

6. Select the required check boxes:

   - **Use DCB:***Data Center Bridging* (DCB) is a set of enhancements to the Ethernet protocols designed to increase the efficiency of Ethernet connections in storage networks and clusters. Select the check box to enable or disable the installation program's awareness of DCB. Enable this option only for network interfaces that require a host-based DCBX client. For configurations on interfaces that use a hardware DCBX client, disable the check box.

   - **Use auto vlan:***Auto VLAN* is enabled by default and indicates whether VLAN discovery should be performed. If this check box is enabled, then the FIP (FCoE Initiation Protocol) VLAN discovery protocol runs on the Ethernet interface when the link configuration has

been validated. If they are not already configured, network interfaces for any discovered FCoE VLANs are automatically created and FCoE instances are created on the VLAN interfaces.

7. Discovered FCoE devices are displayed under the **Other SAN Devices** tab in the **Installation Destination** window.

17.2.6.3. Configuring DASD storage devices

You can discover and configure the DASD storage devices from the **Installation Destination** window.

Prerequisite

- The **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. The **Installation Destination** window opens, listing all available drives.
2. Under the **Specialized & Network Disks**section, click **Add a disk...**. The storage devices selection window opens.
3. Click **Add DASD ECKD**. The **Add DASD Storage Target**dialog box opens and prompts you to specify a device number, such as **0.0.0204**, and attach additional DASDs that were not detected when the installation started.
4. Type the device number of the DASD that you want to attach in the **Device number** field.
5. Click **Start Discovery**.
   If a DASD with the specified device number is found and if it is not already attached, the dialog box closes and the newly-discovered drives appear in the list of drives. You can then select the check boxes for the required devices and click **Done**. The new DASDs are available for selection, marked as **DASD device 0.0.*xxxx*** in the **Local Standard Disks** section of the **Installation Destination** window.

If you entered an invalid device number, or if the DASD with the specified device number is already attached to the system, an error message appears in the dialog box, explaining the error and prompting you to try again with a different device number.

17.2.6.4. Configuring FCP devices

FCP devices enable 64-bit IBM Z to use SCSI devices rather than, or in addition to, Direct Access Storage Device (DASD) devices. FCP devices provide a switched fabric topology that enables 64-bit IBM Z systems to use SCSI LUNs as disk devices in addition to traditional DASD devices.

Prerequisites

- The **Installation Summary** window is open.
- For an FCP-only installation, you have removed the **DASD=** option from the CMS configuration file or the **rd.dasd=** option from the parameter file to indicate that no DASD is present.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. The **Installation Destination** window opens, listing all available drives.

2. Under the **Specialized & Network Disks**section, click **Add a disk…**. The storage devices selection window opens.

3. Click **Add ZFCP LUN**. The **Add zFCP Storage Target** dialog box opens allowing you to add a FCP (Fibre Channel Protocol) storage device.
   64-bit IBM Z requires that you enter any FCP device manually so that the installation program can activate FCP LUNs. You can enter FCP devices either in the graphical installation, or as a unique parameter entry in the parameter or CMS configuration file. The values that you enter must be unique to each site that you configure.

4. Type the 4 digit hexadecimal device number in the **Device number** field.

5. When installing RHEL-9.0 or older releases or if the **zFCP** device is not configured in NPIV mode, or when **auto LUN** scanning is disabled by the **zfcp.allow_lun_scan=0** kernel module parameter, provide the following values:

   a. Type the 16 digit hexadecimal World Wide Port Number (WWPN) in the **WWPN** field.

   b. Type the 16 digit hexadecimal FCP LUN identifier in the **LUN** field.

6. Click **Start Discovery** to connect to the FCP device.

The newly-added devices are displayed in the **IBM Z** tab of the **Installation Destination** window.

Use only lower-case letters in hex values. If you enter an incorrect value and click **Start Discovery**, the installation program displays a warning. You can edit the configuration information and retry the discovery attempt. For more information about these values, consult the hardware documentation and check with your system administrator.

17.2.7. Installing to an NVDIMM device

Non-Volatile Dual In-line Memory Module (NVDIMM) devices combine the performance of RAM with disk-like data persistence when no power is supplied. Under specific circumstances, Red Hat Enterprise Linux 9 can boot and run from NVDIMM devices.

17.2.7.1. Criteria for using an NVDIMM device as an installation target

You can install Red Hat Enterprise Linux 9 to Non-Volatile Dual In-line Memory Module (NVDIMM) devices in sector mode on the Intel 64 and AMD64 architectures, supported by the **nd_pmem** driver.

Conditions for using an NVDIMM device as storage

To use an NVDIMM device as storage, the following conditions must be satisfied:

- The architecture of the system is Intel 64 or AMD64.
- The NVDIMM device is configured to sector mode. The installation program can reconfigure NVDIMM devices to this mode.
- The NVDIMM device must be supported by the **nd_pmem** driver.

Conditions for booting from an NVDIMM Device

Booting from an NVDIMM device is possible under the following conditions:

- All conditions for using the NVDIMM device as storage are satisfied.
- The system uses UEFI.
- The NVDIMM device must be supported by firmware available on the system, or by an UEFI driver. The UEFI driver may be loaded from an option ROM of the device itself.
- The NVDIMM device must be made available under a namespace.

Utilize the high performance of NVDIMM devices during booting, place the **/boot** and **/boot/efi** directories on the device. The Execute-in-place (XIP) feature of NVDIMM devices is not supported during booting and the kernel is loaded into conventional memory.

17.2.7.2. Configuring an NVDIMM device using the graphical installation mode

A Non-Volatile Dual In-line Memory Module (NVDIMM) device must be properly configured for use by Red Hat Enterprise Linux 9 using the graphical installation.

WARNING

Reconfiguration of a NVDIMM device process destroys any data stored on the device.

Prerequisites

- A NVDIMM device is present on the system and satisfies all the other conditions for usage as an installation target.
- The installation has booted and the **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Installation Destination**. The **Installation Destination** window opens, listing all available drives.
2. Under the **Specialized & Network Disks**section, click **Add a disk…**. The storage devices selection window opens.
3. Click the **NVDIMM Devices** tab.
4. To reconfigure a device, select it from the list.
   If a device is not listed, it is not in sector mode.
5. Click **Reconfigure NVDIMM…**. A reconfiguration dialog opens.
6. Enter the sector size that you require and click **Start Reconfiguration**.
   The supported sector sizes are 512 and 4096 bytes.
7. When reconfiguration completes click **OK**.
8. Select the device check box.

9. Click **Done** to return to the **Installation Destination** window.
   The NVDIMM device that you reconfigured is displayed in the **Specialized & Network Disks** section.

10. Click **Done** to return to the **Installation Summary** window.

The NVDIMM device is now available for you to select as an installation target. Additionally, if the device meets the requirements for booting, you can set the device as a boot device.

17.3. CONFIGURING THE ROOT USER AND CREATING LOCAL ACCOUNTS

17.3.1. Configuring a root password

You must configure a **root** password to finish the installation process and to log in to the administrator (also known as superuser or root) account that is used for system administration tasks. These tasks include installing and updating software packages and changing system-wide configuration such as network and firewall settings, storage options, and adding or modifying users, groups and file permissions.

To gain root privileges to the installed systems, you can either use a root account or create a user account with administrative privileges (member of the wheel group). The **root** account is always created during the installation. Switch to the administrator account only when you need to perform a task that requires administrator access.

WARNING

The **root** account has complete control over the system. If unauthorized personnel gain access to the account, they can access or delete users' personal files.

Procedure

1. From the **Installation Summary** window, select **User Settings > Root Password**. The **Root Password** window opens.

2. Type your password in the **Root Password** field.
   The requirements for creating a strong root password are:

   - *Must* be at least eight characters long
   - May contain numbers, letters (upper and lower case) and symbols
   - Is case-sensitive

3. Type the same password in the **Confirm** field.

4. Optional: Select the **Lock root account** option to disable the root access to the system.

5. Optional: Select the **Allow root SSH login with password** option to enable SSH access (with password) to this system as a root user. By default the password-based SSH root access is disabled.

6. Click **Done** to confirm your root password and return to the **Installation Summary** window. If you proceeded with a weak password, you must click **Done** twice.

17.3.2. Creating a user account

Create a user account to finish the installation. If you do not create a user account, you must log in to the system as **root** directly, which is **not** recommended.

Procedure

1. On the **Installation Summary** window, select **User Settings > User Creation**. The **Create User** window opens.

2. Type the user account name in to the **Full name** field, for example: John Smith.

3. Type the username in to the **User name** field, for example: jsmith.
The **User name** is used to log in from a command line; if you install a graphical environment, then your graphical login manager uses the **Full name**.

4. Select the **Make this user administrator** check box if the user requires administrative rights (the installation program adds the user to the **wheel** group).
An administrator user can use the **sudo** command to perform tasks that are only available to **root** using the user password, instead of the **root** password. This may be more convenient, but it can also cause a security risk.

5. Select the **Require a password to use this account** check box.
If you give administrator privileges to a user, ensure the account is password protected. Never give a user administrator privileges without assigning a password to the account.

6. Type a password into the **Password** field.

7. Type the same password into the **Confirm password** field.

8. Click **Done** to apply the changes and return to the **Installation Summary** window.

17.3.3. Editing advanced user settings

This procedure describes how to edit the default settings for the user account in the **Advanced User Configuration** dialog box.

Procedure

1. On the **Create User** window, click **Advanced**.

2. Edit the details in the **Home directory** field, if required. The field is populated by default with **/home/*username*** .

3. In the **User and Groups IDs** section you can:

   a. Select the **Specify a user ID manually** check box and use **+** or **-** to enter the required value. The default value is 1000. User IDs (UIDs) 0-999 are reserved by the system so they cannot be assigned to a user.

b. Select the **Specify a group ID manually** check box and use **+** or **-** to enter the required value.
The default group name is the same as the user name, and the default Group ID (GID) is 1000. GIDs 0-999 are reserved by the system so they can not be assigned to a user group.

4. Specify additional groups as a comma-separated list in the **Group Membership** field. Groups that do not already exist are created; you can specify custom GIDs for additional groups in parentheses. If you do not specify a custom GID for a new group, the new group receives a GID automatically.
The user account created always has one default group membership (the user's default group with an ID set in the **Specify a group ID manually** field).

5. Click **Save Changes** to apply the updates and return to the **Create User** window.

17.4. CONFIGURING MANUAL PARTITIONING

You can use manual partitioning to configure your disk partitions and mount points and define the file system that Red Hat Enterprise Linux is installed on. Before installation, you should consider whether you want to use partitioned or unpartitioned disk devices. For more information about the advantages and disadvantages to using partitioning on LUNs, either directly or with LVM, see the article at https://access.redhat.com/solutions/163853.

You have different partitioning and storage options available, including **Standard Partitions**, **LVM**, and **LVM thin provisioning**. These options provide various benefits and configurations for managing your system's storage effectively.

Standard partition

A standard partition contains a file system or swap space. Standard partitions are most commonly used for **/boot** and the **BIOS Boot** and **EFI System partitions**. You can use the LVM logical volumes in most other uses.

LVM

Choosing **LVM** (or Logical Volume Management) as the device type creates an LVM logical volume. LVM improves performance when using physical disks, and it allows for advanced setups such as using multiple physical disks for one mount point, and setting up software RAID for increased performance, reliability, or both.

LVM thin provisioning

Using thin provisioning, you can manage a storage pool of free space, known as a thin pool, which can be allocated to an arbitrary number of devices when needed by applications. You can dynamically expand the pool when needed for cost-effective allocation of storage space.

An installation of Red Hat Enterprise Linux requires a minimum of one partition but use at least the following partitions or volumes: /, **/home**, **/boot**, and **swap**. You can also create additional partitions and volumes as you require.

To prevent data loss it is recommended that you back up your data before proceeding. If you are upgrading or creating a dual-boot system, you should back up any data you want to keep on your storage devices.

17.4.1. Recommended partitioning scheme

Create separate file systems at the following mount points. However, if required, you can also create the file systems at **/usr**, **/var**, and **/tmp** mount points.

- **/boot**

- / (root)
- **/home**
- **swap**
- **/boot/efi**
- **PReP**

This partition scheme is recommended for bare metal deployments and it does not apply to virtual and cloud deployments.

/boot partition - recommended size at least 1 GiB

The partition mounted on **/boot** contains the operating system kernel, which allows your system to boot Red Hat Enterprise Linux 9, along with files used during the bootstrap process. Due to the limitations of most firmwares, create a small partition to hold these. In most scenarios, a 1 GiB boot partition is adequate. Unlike other mount points, using an LVM volume for **/boot** is not possible - **/boot** must be located on a separate disk partition.

If you have a RAID card, be aware that some BIOS types do not support booting from the RAID card. In such a case, the **/boot** partition must be created on a partition outside of the RAID array, such as on a separate disk.

WARNING

- Normally, the **/boot** partition is created automatically by the installation program. However, if the / (root) partition is larger than 2 TiB and (U)EFI is used for booting, you need to create a separate **/boot** partition that is smaller than 2 TiB to boot the machine successfully.
- Ensure the **/boot** partition is located within the first 2 TB of the disk while manual partitioning. Placing the **/boot** partition beyond the 2 TB boundary might result in a successful installation, but the system fails to boot because BIOS cannot read the **/boot** partition beyond this limit.

root - recommended size of 10 GiB

This is where "/", or the root directory, is located. The root directory is the top-level of the directory structure. By default, all files are written to this file system unless a different file system is mounted in the path being written to, for example, **/boot** or **/home**.
While a 5 GiB root file system allows you to install a minimal installation, it is recommended to allocate at least 10 GiB so that you can install as many package groups as you want.

Do not confuse the / directory with the **/root** directory. The **/root** directory is the home directory of the root user. The **/root** directory is sometimes referred to as *slash root* to distinguish it from the root directory.

/home - recommended size at least 1 GiB

To store user data separately from system data, create a dedicated file system for the **/home**

directory. Base the file system size on the amount of data that is stored locally, number of users, and so on. You can upgrade or reinstall Red Hat Enterprise Linux 9 without erasing user data files. If you select automatic partitioning, it is recommended to have at least 55 GiB of disk space available for the installation, to ensure that the **/home** file system is created.

swap partition - recommended size at least 1 GiB

Swap file systems support virtual memory; data is written to a swap file system when there is not enough RAM to store the data your system is processing. Swap size is a function of system memory workload, not total system memory and therefore is not equal to the total system memory size. It is important to analyze what applications a system will be running and the load those applications will serve in order to determine the system memory workload. Application providers and developers can provide guidance.
When the system runs out of swap space, the kernel terminates processes as the system RAM memory is exhausted. Configuring too much swap space results in storage devices being allocated but idle and is a poor use of resources. Too much swap space can also hide memory leaks. The maximum size for a swap partition and other additional information can be found in the **mkswap(8)** manual page.

The following table provides the recommended size of a swap partition depending on the amount of RAM in your system and if you want sufficient memory for your system to hibernate. If you let the installation program partition your system automatically, the swap partition size is established using these guidelines. Automatic partitioning setup assumes hibernation is not in use. The maximum size of the swap partition is limited to 10 percent of the total size of the disk, and the installation program cannot create swap partitions more than 1TiB. To set up enough swap space to allow for hibernation, or if you want to set the swap partition size to more than 10 percent of the system's storage space, or more than 1TiB, you must edit the partitioning layout manually.

Table 17.1. Recommended system swap space

Amount of RAM in the system	Recommended swap space	Recommended swap space if allowing for hibernation
Less than 2 GiB	2 times the amount of RAM	3 times the amount of RAM
2 GiB - 8 GiB	Equal to the amount of RAM	2 times the amount of RAM
8 GiB - 64 GiB	4 GiB to 0.5 times the amount of RAM	1.5 times the amount of RAM
More than 64 GiB	Workload dependent (at least 4GiB)	Hibernation not recommended

/boot/efi partition - recommended size of 200 MiB

UEFI-based AMD64, Intel 64, and 64-bit ARM require a 200 MiB EFI system partition. The recommended minimum size is 200 MiB, the default size is 600 MiB, and the maximum size is 600 MiB. BIOS systems do not require an EFI system partition.

At the border between each range, for example, a system with 2 GiB, 8 GiB, or 64 GiB of system RAM, discretion can be exercised with regard to chosen swap space and hibernation support. If your system resources allow for it, increasing the swap space can lead to better performance.

Distributing swap space over multiple storage devices - particularly on systems with fast drives, controllers and interfaces - also improves swap space performance.

Many systems have more partitions and volumes than the minimum required. Choose partitions based on your particular system needs. If you are unsure about configuring partitions, accept the automatic default partition layout provided by the installation program.

NOTE

Only assign storage capacity to those partitions you require immediately. You can allocate free space at any time, to meet needs as they occur.

PReP boot partition - recommended size of 4 to 8 MiB

When installing Red Hat Enterprise Linux on IBM Power System servers, the first partition of the disk should include a **PReP** boot partition. This contains the GRUB2 boot loader, which allows other IBM Power Systems servers to boot Red Hat Enterprise Linux.

17.4.2. Supported hardware storage

It is important to understand how storage technologies are configured and how support for them may have changed between major versions of Red Hat Enterprise Linux.

Hardware RAID

Any RAID functions provided by the mainboard of your computer, or attached controller cards, need to be configured before you begin the installation process. Each active RAID array appears as one drive within Red Hat Enterprise Linux.

Software RAID

On systems with more than one disk, you can use the Red Hat Enterprise Linux installation program to operate several of the drives as a Linux software RAID array. With a software RAID array, RAID functions are controlled by the operating system rather than the dedicated hardware.

NOTE

When a pre-existing RAID array's member devices are all unpartitioned disks/drives, the installation program treats the array as a disk and there is no method to remove the array.

USB Disks

You can connect and configure external USB storage after installation. Most devices are recognized by the kernel, but some devices may not be recognized. If it is not a requirement to configure these disks during installation, disconnect them to avoid potential problems.

NVDIMM devices

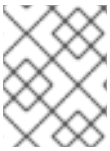
To use a Non-Volatile Dual In-line Memory Module (NVDIMM) device as storage, the following conditions must be satisfied:

- The architecture of the system is Intel 64 or AMD64.
- The device is configured to sector mode. Anaconda can reconfigure NVDIMM devices to this mode.
- The device must be supported by the nd_pmem driver.

Booting from an NVDIMM device is possible under the following additional conditions:

- The system uses UEFI.
- The device must be supported by firmware available on the system, or by a UEFI driver. The UEFI driver may be loaded from an option ROM of the device itself.
- The device must be made available under a namespace.

To take advantage of the high performance of NVDIMM devices during booting, place the **/boot** and **/boot/efi** directories on the device.



NOTE

The Execute-in-place (XIP) feature of NVDIMM devices is not supported during booting and the kernel is loaded into conventional memory.

Considerations for Intel BIOS RAID Sets

Red Hat Enterprise Linux uses **mdraid** for installing on Intel BIOS RAID sets. These sets are automatically detected during the boot process and their device node paths can change across several booting processes. Replace device node paths (such as **/dev/sda**) with file system labels or device UUIDs. You can find the file system labels and device UUIDs using the **blkid** command.

17.4.3. Starting manual partitioning

You can partition the disks based on your requirements by using manual partitioning.

Prerequisites

- The **Installation Summary** screen is open.
- All disks are available to the installation program.

Procedure

1. Select disks for installation:
   a. Click **Installation Destination** to open the **Installation Destination** window.
   b. Select the disks that you require for installation by clicking the corresponding icon. A selected disk has a check-mark displayed on it.
   c. Under **Storage Configuration**, select the **Custom** radio-button.
   d. Optional: To enable storage encryption with LUKS, select the **Encrypt my data** check box.
   e. Click **Done**.
2. If you selected to encrypt the storage, a dialog box for entering a disk encryption passphrase opens. Type in the LUKS passphrase:
   a. Enter the passphrase in the two text fields. To switch keyboard layout, use the keyboard icon.

WARNING

In the dialog box for entering the passphrase, you cannot change the keyboard layout. Select the English keyboard layout to enter the passphrase in the installation program.

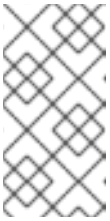
b. Click **Save Passphrase**. The **Manual Partitioning** window opens.

3. Detected mount points are listed in the left-hand pane. The mount points are organized by detected operating system installations. As a result, some file systems may be displayed multiple times if a partition is shared among several installations.

   a. Select the mount points in the left pane; the options that can be customized are displayed in the right pane.

   b. Optional: If your system contains existing file systems, ensure that enough space is available for the installation. To remove any partitions, select them in the list and click the **-** button. The dialog has a check box that you can use to remove all other partitions used by the system to which the deleted partition belongs.

   c. Optional: If there are no existing partitions and you want to create a set of partitions as a starting point, select your preferred partitioning scheme from the left pane (default for Red Hat Enterprise Linux is LVM) and click the **Click here to create them automatically** link.



NOTE

A **/boot** partition, a / (root) volume, and a **swap** volume proportionate to the size of the available storage are created and listed in the left pane. These are the file systems for a typical installation, but you can add additional file systems and mount points.

   d. Click **Done** to confirm any changes and return to the **Installation Summary** window.

17.4.4. Supported file systems

When configuring manual partitioning, you can optimize performance, ensure compatibility, and effectively manage disk space by utilizing the various file systems and partition types available in Red Hat Enterprise Linux.

xfs

XFS is a highly scalable, high-performance file system that supports file systems up to 16 exabytes (approximately 16 million terabytes), files up to 8 exabytes (approximately 8 million terabytes), and directory structures containing tens of millions of entries. **XFS** also supports metadata journaling, which facilitates quicker crash recovery. The maximum supported size of a single XFS file system is 500 TB. **XFS** is the default file system on Red Hat Enterprise Linux. The XFS filesystem cannot be shrunk to get free space.

ext4

The **ext4** file system is based on the **ext3** file system and features a number of improvements. These include support for larger file systems and larger files, faster and more efficient allocation of disk

space, no limit on the number of subdirectories within a directory, faster file system checking, and more robust journaling. The maximum supported size of a single **ext4** file system is 50 TB.

ext3

The **ext3** file system is based on the **ext2** file system and has one main advantage - journaling. Using a journaling file system reduces the time spent recovering a file system after it terminates unexpectedly, as there is no need to check the file system for metadata consistency by running the fsck utility every time.

ext2

An **ext2** file system supports standard Unix file types, including regular files, directories, or symbolic links. It provides the ability to assign long file names, up to 255 characters.

swap

Swap partitions are used to support virtual memory. In other words, data is written to a swap partition when there is not enough RAM to store the data your system is processing.

vfat

The **VFAT** file system is a Linux file system that is compatible with Microsoft Windows long file names on the FAT file system.

NOTE

Support for **VFAT** file system is not available for Linux system partitions. For example, /, /**var**, /**usr** and so on.

BIOS Boot

A very small partition required for booting from a device with a GUID partition table (GPT) on BIOS systems and UEFI systems in BIOS compatibility mode.

EFI System Partition

A small partition required for booting a device with a GUID partition table (GPT) on a UEFI system.

PReP

This small boot partition is located on the first partition of the disk. The **PReP** boot partition contains the GRUB2 boot loader, which allows other IBM Power Systems servers to boot Red Hat Enterprise Linux.

17.4.5. Adding a mount point file system

You can add multiple mount point file systems. You can use any of the file systems and partition types available, such as XFS, ext4, ext3, ext2, swap, VFAT, and specific partitions like BIOS Boot, EFI System Partition, and PReP to effectively configure your system's storage.

Prerequisites

- You have planned your partitions.
- Ensure you haven't specified mount points at paths with symbolic links, such as /**var**/**mail**, /**usr**/**tmp**, /**lib**, /**sbin**, /**lib64**, and /**bin**. The payload, including RPM packages, depends on creating symbolic links to specific directories.

Procedure

1. Click **+** to create a new mount point file system. The **Add a New Mount Point** dialog opens.

2. Select one of the preset paths from the **Mount Point** drop-down menu or type your own; for example, select / for the root partition or **/boot** for the boot partition.

3. Enter the size of the file system in to the **Desired Capacity** field; for example, **2GiB**.
   If you do not specify a value in **Desired Capacity**, or if you specify a size bigger than available space, then all remaining free space is used.

4. Click **Add mount point** to create the partition and return to the **Manual Partitioning** window.

17.4.6. Configuring storage for a mount point file system

You can set the partitioning scheme for each mount point that was created manually. The available options are **Standard Partition**, **LVM**, and **LVM Thin Provisioning**. Btfrs support has been removed in Red Hat Enterprise Linux 9.

NOTE

The **/boot** partition is always located on a standard partition, regardless of the value selected.

Procedure

1. To change the devices that a single non-LVM mount point should be located on, select the required mount point from the left-hand pane.

2. Under the **Device(s)** heading, click **Modify...**. The **Configure Mount Point** dialog opens.

3. Select one or more devices and click **Select** to confirm your selection and return to the **Manual Partitioning** window.

4. Click **Update Settings** to apply the changes.

5. In the lower left-hand side of the **Manual Partitioning** window, click the **storage device selected** link to open the **Selected Disks** dialog and review disk information.

6. Optional: Click the **Rescan** button (circular arrow button) to refresh all local disks and partitions; this is only required after performing advanced partition configuration outside the installation program. Clicking the **Rescan Disks** button resets all configuration changes made in the installation program.

17.4.7. Customizing a mount point file system

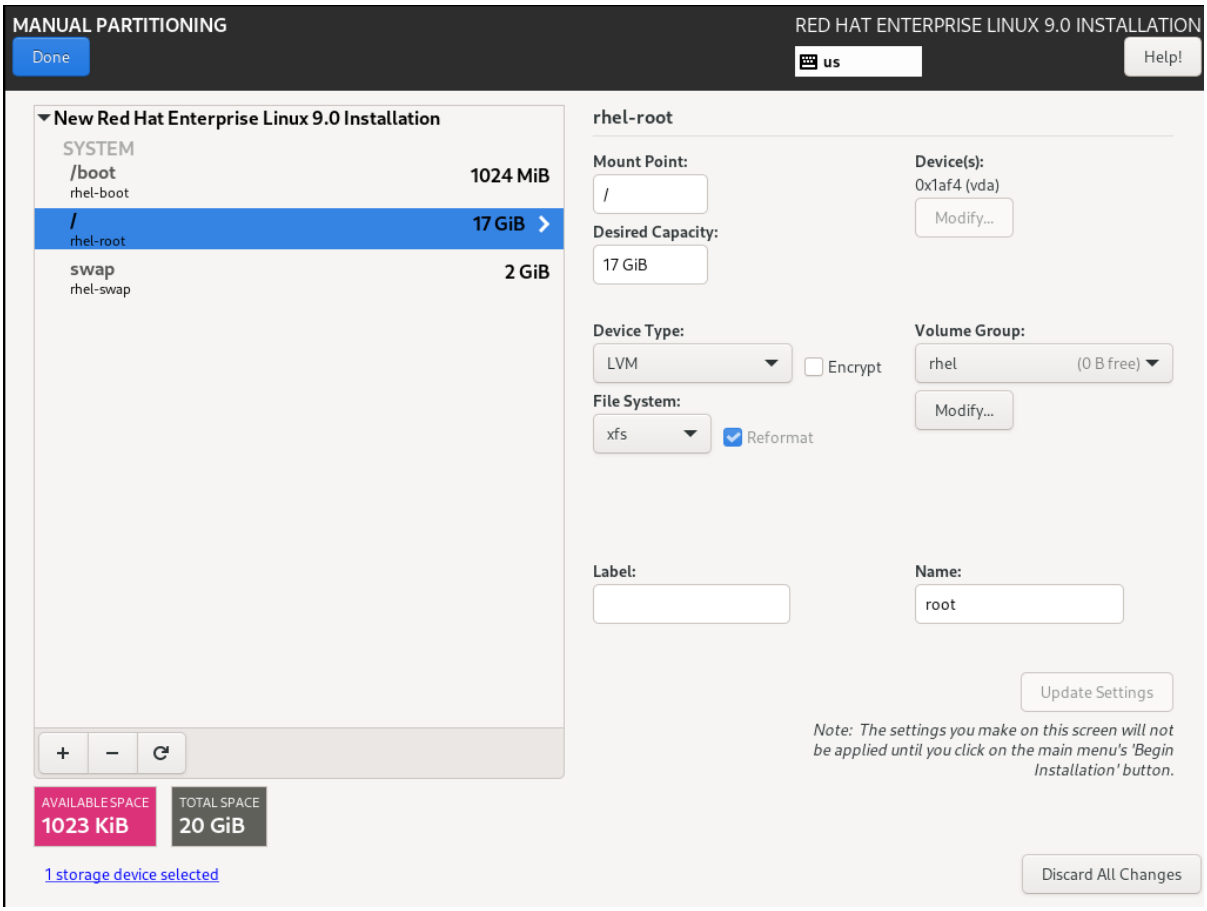
You can customize a partition or volume if you want to set specific settings. If **/usr** or **/var** is partitioned separately from the rest of the root volume, the boot process becomes much more complex as these directories contain critical components. In some situations, such as when these directories are placed on an iSCSI drive or an FCoE location, the system is unable to boot, or hangs with a **Device is busy** error when powering off or rebooting.

This limitation only applies to **/usr** or **/var**, not to directories below them. For example, a separate partition for **/var/www** works successfully.

Procedure

1. From the left pane, select the mount point.

Figure 17.1. Customizing Partitions

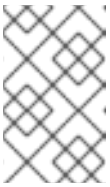


2. From the right-hand pane, you can customize the following options:

   a. Enter the file system mount point into the **Mount Point** field. For example, if a file system is the root file system, enter /; enter /**boot** for the /**boot** file system, and so on. For a swap file system, do not set the mount point as setting the file system type to **swap** is sufficient.

   b. Enter the size of the file system in the **Desired Capacity** field. You can use common size units such as KiB or GiB. The default is MiB if you do not set any other unit.

   c. Select the device type that you require from the drop-down **Device Type** menu: **Standard Partition**, **LVM**, or **LVM Thin Provisioning**.



NOTE

RAID is available only if two or more disks are selected for partitioning. If you choose **RAID**, you can also set the **RAID Level**. Similarly, if you select **LVM**, you can specify the **Volume Group**.

   d. Select the **Encrypt** check box to encrypt the partition or volume. You must set a password later in the installation program. The **LUKS Version** drop-down menu is displayed.

   e. Select the LUKS version that you require from the drop-down menu.

   f. Select the appropriate file system type for this partition or volume from the **File system** drop-down menu.

NOTE

Support for **VFAT** file system is not available for Linux system partitions. For example, /, /**var**, /**usr**, and so on.

g. Select the **Reformat** check box to format an existing partition, or clear the **Reformat** check box to retain your data. The newly-created partitions and volumes must be reformatted, and the check box cannot be cleared.

h. Type a label for the partition in the **Label** field. Use labels to easily recognize and address individual partitions.

i. Type a name in the **Name** field. The standard partitions are named automatically when they are created and you cannot edit the names of standard partitions. For example, you cannot edit the /**boot** name **sda1**.

3. Click **Update Settings** to apply your changes and if required, select another partition to customize. Changes are not applied until you click **Begin Installation** from the **Installation Summary** window.

4. Optional: Click **Reset All** to discard your partition changes.

5. Click **Done** when you have created and customized all file systems and mount points. If you choose to encrypt a file system, you are prompted to create a passphrase.
A **Summary of Changes** dialog box opens, displaying a summary of all storage actions for the installation program.

6. Click **Accept Changes** to apply the changes and return to the **Installation Summary** window.

17.4.8. Preserving the /home directory

In a Red Hat Enterprise Linux 9 graphical installation, you can preserve the /**home** directory that was used on your RHEL 8 system. Preserving /**home** is only possible if the /**home** directory is located on a separate /**home** partition on your RHEL 8 system.

Preserving the /**home** directory that includes various configuration settings, makes it possible that the GNOME Shell environment on the new Red Hat Enterprise Linux 9 system is set in the same way as it was on your RHEL 8 system. Note that this applies only for users on Red Hat Enterprise Linux 9 with the same user name and ID as on the previous RHEL 8 system.

Prerequisites

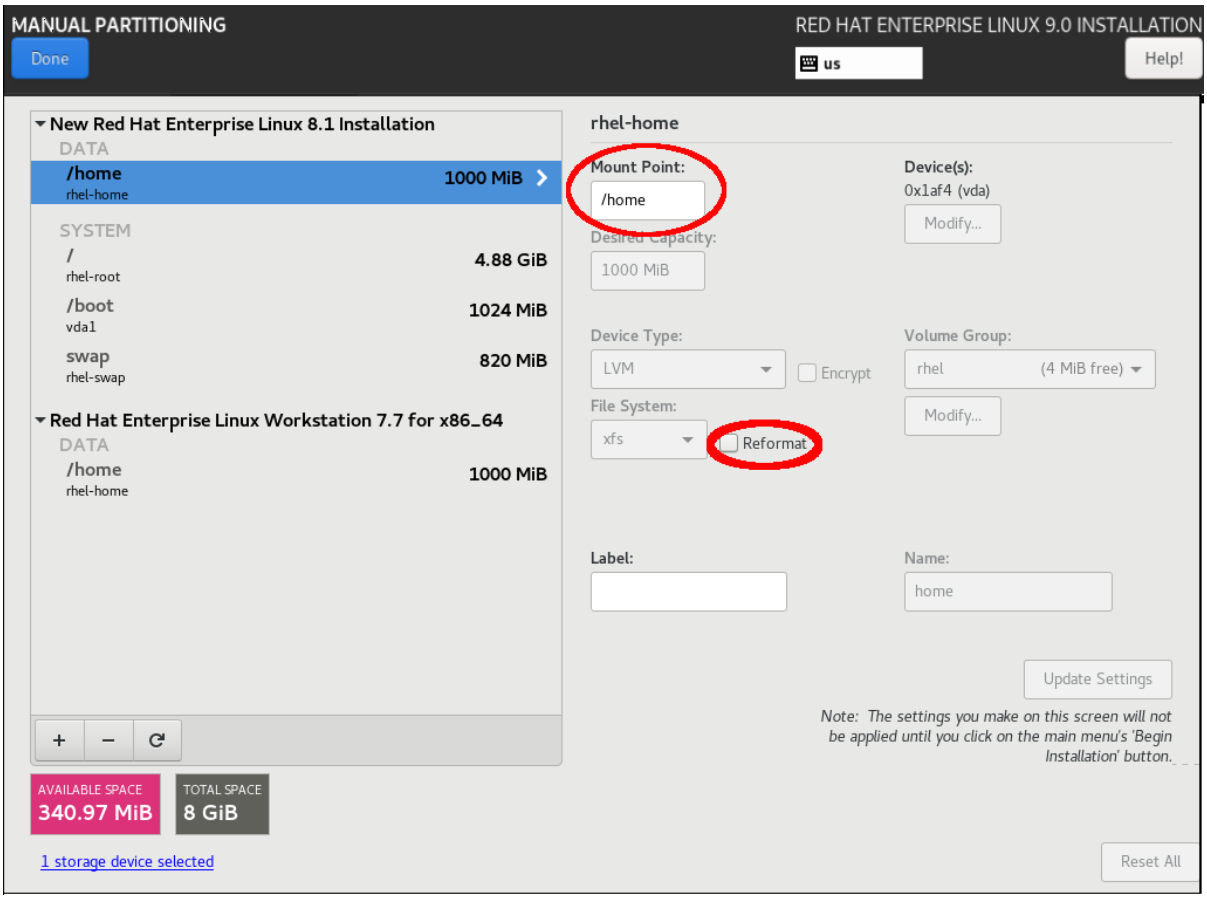
- You have RHEL 8 installed on your computer.
- The /**home** directory is located on a separate /**home** partition on your RHEL 8 system.
- The Red Hat Enterprise Linux 9 **Installation Summary** window is open.

Procedure

1. Click **Installation Destination** to open the **Installation Destination** window.
2. Under **Storage Configuration**, select the **Custom** radio button. Click **Done**.
3. Click **Done**, the **Manual Partitioning** window opens.

4. Choose the /**home** partition, fill in /**home** under **Mount Point:** and clear the **Reformat** check box.

Figure 17.2. Ensuring that /home is not formatted



5. Optional: You can also customize various aspects of the /**home** partition required for your Red Hat Enterprise Linux 9 system as described in Customizing a mount point file system . However, to preserve /**home** from your RHEL 8 system, it is necessary to clear the **Reformat** check box.

6. After you customized all partitions according to your requirements, click **Done**. The **Summary of changes** dialog box opens.

7. Verify that the **Summary of changes** dialog box does not show any change for /**home**. This means that the /**home** partition is preserved.

8. Click **Accept Changes** to apply the changes, and return to the **Installation Summary** window.

17.4.9. Creating a software RAID during the installation

Redundant Arrays of Independent Disks (RAID) devices are constructed from multiple storage devices that are arranged to provide increased performance and, in some configurations, greater fault tolerance. A RAID device is created in one step and disks are added or removed as necessary. You can configure one RAID partition for each physical disk in your system, so that the number of disks available to the installation program determines the levels of RAID device available. For example, if your system has two disks, you cannot create a **RAID 10** device, as it requires a minimum of three separate disks. To optimize your system's storage performance and reliability, RHEL supports software **RAID 0**, **RAID 1**, **RAID 4**, **RAID 5**, **RAID 6**, and **RAID 10** types with LVM and LVM Thin Provisioning to set up storage on the installed system.

NOTE

On 64-bit IBM Z, the storage subsystem uses RAID transparently. You do not have to configure software RAID manually.

Prerequisites

- You have selected two or more disks for installation before RAID configuration options are visible. Depending on the RAID type you want to create, at least two disks are required.
- You have created a mount point. By configuring a mount point, you can configure the RAID device.
- You have selected the **Custom** radio button on the **Installation Destination** window.

Procedure

1. From the left pane of the **Manual Partitioning** window, select the required partition.
2. Under the **Device(s)** section, click **Modify**. The **Configure Mount Point** dialog box opens.
3. Select the disks that you want to include in the RAID device and click **Select**.
4. Click the **Device Type** drop-down menu and select **RAID**.
5. Click the **File System** drop-down menu and select your preferred file system type.
6. Click the **RAID Level** drop-down menu and select your preferred level of RAID.
7. Click **Update Settings** to save your changes.
8. Click **Done** to apply the settings to return to the **Installation Summary** window.

Additional resources

- *Creating a RAID LV with DM integrity*
- *Managing RAID*

17.4.10. Creating an LVM logical volume

Logical Volume Manager (LVM) presents a simple logical view of underlying physical storage space, such as disks or LUNs. Partitions on physical storage are represented as physical volumes that you can group together into volume groups. You can divide each volume group into multiple logical volumes, each of which is analogous to a standard disk partition. Therefore, LVM logical volumes function as partitions that can span multiple physical disks.

IMPORTANT

- LVM configuration is available only in the graphical installation program. During text-mode installation, LVM configuration is not available.
- To create an LVM configuration, press **Ctrl**+**Alt**+**F2** to use a shell prompt in a different virtual console. You can run **vgcreate** and **lvm** commands in this shell. To return to the text-mode installation, press **Ctrl**+**Alt**+**F1**.

Procedure

1. From the **Manual Partitioning** window, create a new mount point by using any of the following options:
   - Use the **Click here to create them automatically** option or click the + button.
   - Select Mount Point from the drop-down list or enter manually.
   - Enter the size of the file system in to the **Desired Capacity** field; for example, 70 GiB for /, 1 GiB for **/boot**.
     Note: Skip this step to use the existing mount point.
2. Select the mount point.
3. Select **LVM** in the drop-down menu. The **Volume Group** drop-down menu is displayed with the newly-created volume group name.

NOTE

You cannot specify the size of the volume group's physical extents in the configuration dialog. The size is always set to the default value of 4 MiB. If you want to create a volume group with different physical extents, you must create it manually by switching to an interactive shell and using the **vgcreate** command, or use a Kickstart file with the **volgroup --pesize=*size*** command. For more information about Kickstart, see the Automatically installing RHEL.

4. Click **Done** to return to the **Installation Summary** window.

Additional resources

- Configuring and managing logical volumes

17.4.11. Configuring an LVM logical volume

You can configure a newly-created LVM logical volume based on your requirements.

WARNING

Placing the **/boot** partition on an LVM volume is not supported.

Procedure

1. From the **Manual Partitioning** window, create a mount point by using any of the following options:
   - Use the **Click here to create them automatically** option or click the + button.
   - Select Mount Point from the drop-down list or enter manually.

- Enter the size of the file system in to the **Desired Capacity** field; for example, 70 GiB for /, 1 GiB for **/boot**.
  Note: Skip this step to use the existing mount point.

2. Select the mount point.
3. Click the **Device Type** drop-down menu and select **LVM**. The **Volume Group** drop-down menu is displayed with the newly-created volume group name.
4. Click **Modify** to configure the newly-created volume group. The **Configure Volume Group** dialog box opens.

NOTE

You cannot specify the size of the volume group's physical extents in the configuration dialog. The size is always set to the default value of 4 MiB. If you want to create a volume group with different physical extents, you must create it manually by switching to an interactive shell and using the **vgcreate** command, or use a Kickstart file with the **volgroup --pesize=*size*** command. For more information, see the Automatically installing RHEL document.

5. Optional: From the **RAID Level** drop-down menu, select the RAID level that you require.
   The available RAID levels are the same as with actual RAID devices.
6. Select the **Encrypt** check box to mark the volume group for encryption.
7. From the **Size policy** drop-down menu, select any of the following size policies for the volume group:
   The available policy options are:

   Automatic

   The size of the volume group is set automatically so that it is large enough to contain the configured logical volumes. This is optimal if you do not need free space within the volume group.

   As large as possible

   The volume group is created with maximum size, regardless of the size of the configured logical volumes it contains. This is optimal if you plan to keep most of your data on LVM and later need to increase the size of some existing logical volumes, or if you need to create additional logical volumes within this group.

   Fixed

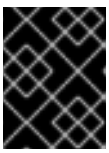
   You can set an exact size of the volume group. Any configured logical volumes must then fit within this fixed size. This is useful if you know exactly how large you need the volume group to be.

8. Click **Save** to apply the settings and return to the **Manual Partitioning** window.
9. Click **Update Settings** to save your changes.
10. Click **Done** to return to the **Installation Summary** window.

17.4.12. Advice on partitions

There is no best way to partition every system; the optimal setup depends on how you plan to use the system being installed. However, the following tips may help you find the optimal layout for your needs:

- Create partitions that have specific requirements first, for example, if a particular partition must be on a specific disk.
- Consider encrypting any partitions and volumes which might contain sensitive data. Encryption prevents unauthorized people from accessing the data on the partitions, even if they have access to the physical storage device. In most cases, you should at least encrypt the **/home** partition, which contains user data.
- In some cases, creating separate mount points for directories other than /, **/boot** and **/home** may be useful; for example, on a server running a **MySQL** database, having a separate mount point for **/var/lib/mysql** allows you to preserve the database during a re-installation without having to restore it from backup afterward. However, having unnecessary separate mount points will make storage administration more difficult.
- Some special restrictions apply to certain directories with regards on which partitioning layouts can they be placed. Notably, the **/boot** directory must always be on a physical partition (not on an LVM volume).
- If you are new to Linux, consider reviewing the Linux Filesystem Hierarchy Standard for information about various system directories and their contents.
- Each kernel requires approximately: 60MiB (initrd 34MiB, 11MiB vmlinuz, and 5MiB System.map)
- For rescue mode: 100MiB (initrd 76MiB, 11MiB vmlinuz, and 5MiB System map)
- When **kdump** is enabled in system it will take approximately another 40MiB (another initrd with 33MiB)
  The default partition size of 1 GiB for **/boot** should suffice for most common use cases. However, increase the size of this partition if you are planning on retaining multiple kernel releases or errata kernels.
- The **/var** directory holds content for a number of applications, including the Apache web server, and is used by the DNF package manager to temporarily store downloaded package updates. Make sure that the partition or volume containing **/var** has at least 5 GiB.
- The **/usr** directory holds the majority of software on a typical Red Hat Enterprise Linux installation. The partition or volume containing this directory should therefore be at least 5 GiB for minimal installations, and at least 10 GiB for installations with a graphical environment.
- If **/usr** or **/var** is partitioned separately from the rest of the root volume, the boot process becomes much more complex because these directories contain boot-critical components. In some situations, such as when these directories are placed on an iSCSI drive or an FCoE location, the system may either be unable to boot, or it may hang with a **Device is busy** error when powering off or rebooting.
  This limitation only applies to **/usr** or **/var**, not to directories under them. For example, a separate partition for **/var/www** works without issues.



IMPORTANT

Some security policies require the separation of **/usr** and **/var**, even though it makes administration more complex.

- Consider leaving a portion of the space in an LVM volume group unallocated. This unallocated space gives you flexibility if your space requirements change but you do not wish to remove data from other volumes. You can also select the **LVM Thin Provisioning** device type for the partition to have the unused space handled automatically by the volume.

- The size of an XFS file system cannot be reduced - if you need to make a partition or volume with this file system smaller, you must back up your data, destroy the file system, and create a new, smaller one in its place. Therefore, if you plan to alter your partitioning layout later, you should use the ext4 file system instead.

- Use Logical Volume Manager (LVM) if you anticipate expanding your storage by adding more disks or expanding virtual machine disks after the installation. With LVM, you can create physical volumes on the new drives, and then assign them to any volume group and logical volume as you see fit - for example, you can easily expand your system's /**home** (or any other directory residing on a logical volume).

- Creating a BIOS Boot partition or an EFI System Partition may be necessary, depending on your system's firmware, boot drive size, and boot drive disk label. Note that you cannot create a BIOS Boot or EFI System Partition in graphical installation if your system does **not** require one - in that case, they are hidden from the menu.

Additional resources

- How to use dm-crypt on IBM Z, LinuxONE and with the PAES cipher

17.5. SELECTING THE BASE ENVIRONMENT AND ADDITIONAL SOFTWARE

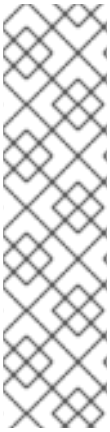
Use the **Software Selection** window to select the software packages that you require. The packages are organized by Base Environment and Additional Software.

- **Base Environment** contains predefined packages. You can select only one base environment, for example, Server with GUI (default), Server, Minimal Install, Workstation, Custom operating system, Virtualization Host. The availability is dependent on the installation ISO image that is used as the installation source.

- **Additional Software for Selected Environment** contains additional software packages for the base environment. You can select multiple software packages.

Use a predefined environment and additional software to customize your system. However, in a standard installation, you cannot select individual packages to install. To view the packages contained in a specific environment, see the ***repository*/repodata/*-comps-*repository.architecture*.xml** file on your installation source media (DVD, CD, USB). The XML file contains details of the packages installed as part of a base environment. Available environments are marked by the **<environment>** tag, and additional software packages are marked by the **<group>** tag.

If you are unsure about which packages to install, select the **Minimal Install** base environment. Minimal install installs a basic version of Red Hat Enterprise Linux with only a minimal amount of additional software. After the system finishes installing and you log in for the first time, you can use the **DNF** package manager to install additional software. For more information about **DNF** package manager, see the *Configuring basic system settings* document.



NOTE

- Use the **dnf group list** command from any RHEL 9 system to view the list of packages being installed on the system as a part of software selection. For more information, see *Configuring basic system settings*.
- If you need to control which packages are installed, you can use a Kickstart file and define the packages in the **%packages** section.
- By default, RHEL 9 does not install the TuneD package. You can manually install the TuneD package using the **dnf install tuned** command. For more information, see the Automatically installing RHEL document.

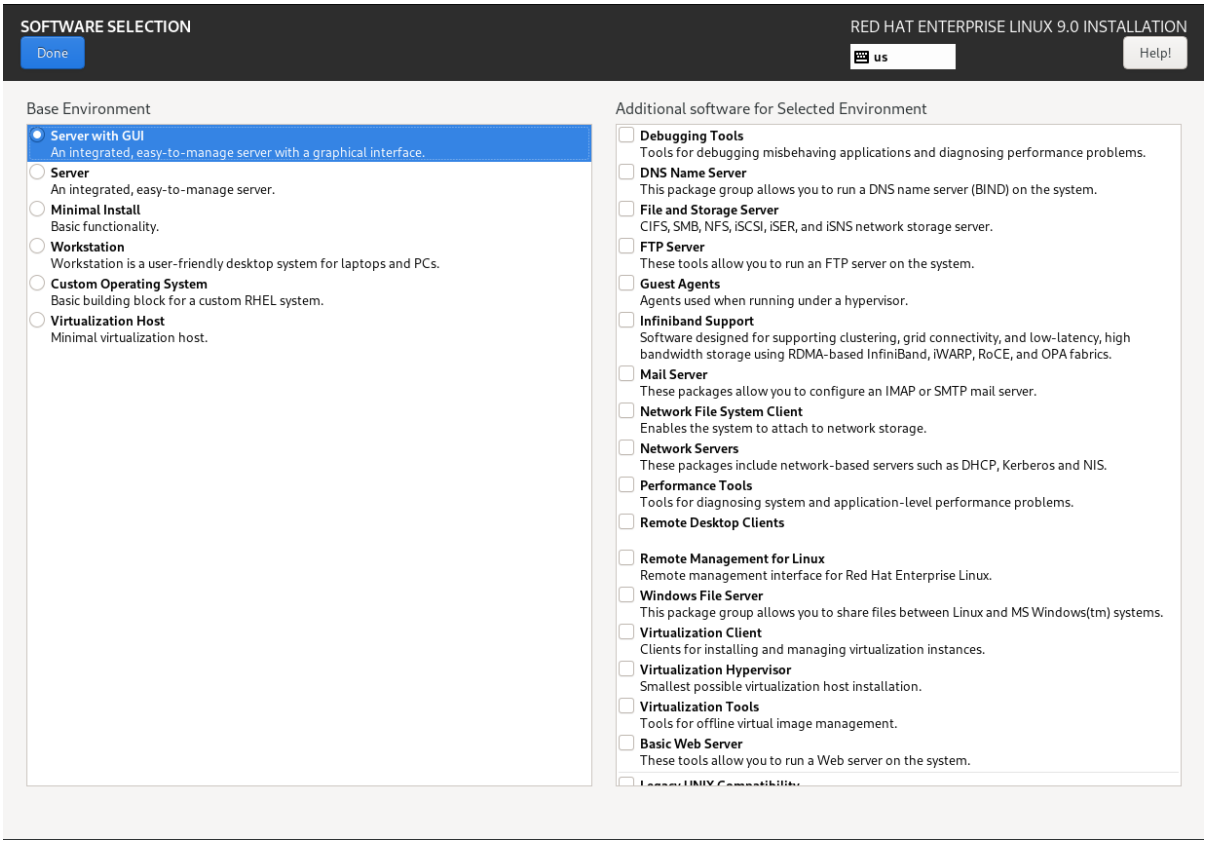
Prerequisites

- You have configured the installation source.
- The installation program has downloaded package metadata.
- The **Installation Summary** window is open.

Procedure

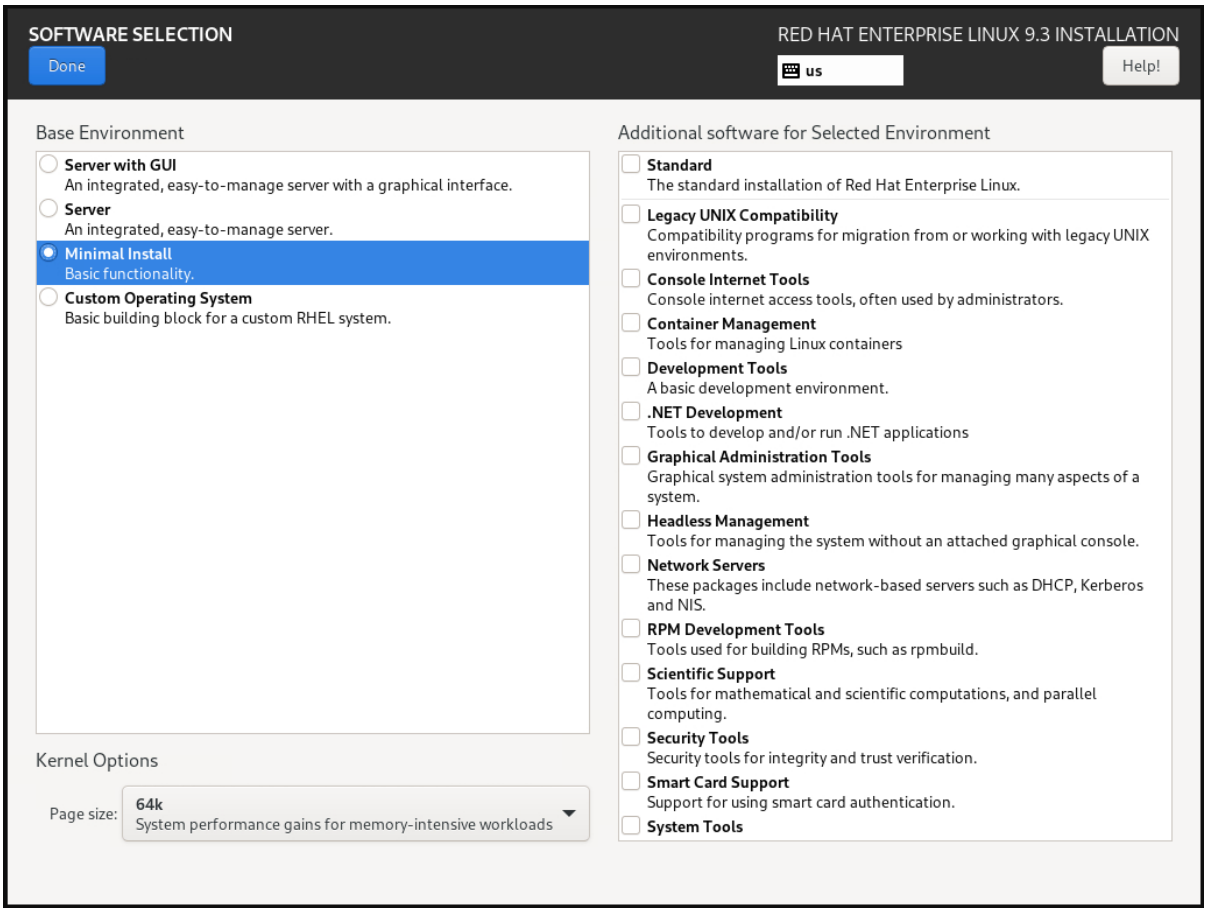
1. From the **Installation Summary** window, click **Software Selection**. The **Software Selection** window opens.
2. From the **Base Environment** pane, select a base environment. You can select only one base environment, for example, Server with GUI (default), Server, Minimal Install, Workstation, Custom Operating System, Virtualization Host. By default, the **Server with GUI** base environment is selected.

Figure 17.3. Red Hat Enterprise Linux Software Selection



3. Optional: For installations on ARM based systems, select desired **Page size** from **Kernel Options**.
   By default, it selects Kernel with a **4k** page size.

> **WARNING**
>
> If you want to use the Kernel with **64k** page size, ensure you select **Minimal Install** under **Base Environment** to use this option. You can install additional software after you login to the system for the first time post installation using the **DNF** package manager.



4. From the **Additional Software for Selected Environment**pane, select one or more options.

5. Click **Done** to apply the settings and return to graphical installations.

Additional resources

- The 4k and 64k page size Kernel Options

17.6. OPTIONAL: CONFIGURING THE NETWORK AND HOST NAME

Use the **Network and Host name**window to configure network interfaces. Options that you select here are available both during the installation for tasks such as downloading packages from a remote location, and on the installed system.

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

Procedure

1. From the **Installation Summary** window, click **Network and Host Name**.
2. From the list in the left-hand pane, select an interface. The details are displayed in the right-hand pane.
3. Toggle the **ON/OFF** switch to enable or disable the selected interface.
   You cannot add or remove interfaces manually.
4. Click **+** to add a virtual network interface, which can be either: Team (deprecated), Bond, Bridge, or VLAN.
5. Click **-** to remove a virtual interface.
6. Click **Configure** to change settings such as IP addresses, DNS servers, or routing configuration for an existing interface (both virtual and physical).
7. Type a host name for your system in the **Host Name** field.
   The host name can either be a fully qualified domain name (FQDN) in the format ***hostname.domainname***, or a short host name without the domain. Many networks have a Dynamic Host Configuration Protocol (DHCP) service that automatically supplies connected systems with a domain name. To allow the DHCP service to assign the domain name to this system, specify only the short host name.

   Host names can only contain alphanumeric characters and **-** or **.**. Host name should be equal to or less than 64 characters. Host names cannot start or end with **-** and **.**. To be compliant with DNS, each part of a FQDN should be equal to or less than 63 characters and the FQDN total length, including dots, should not exceed 255 characters.

   The value **localhost** means that no specific static host name for the target system is configured, and the actual host name of the installed system is configured during the processing of the network configuration, for example, by NetworkManager using DHCP or DNS.

   When using static IP and host name configuration, it depends on the planned system use case whether to use a short name or FQDN. Red Hat Identity Management configures FQDN during provisioning but some 3rd party software products may require short name. In either case, to ensure availability of both forms in all situations, add an entry for the host in **/etc/hosts** in the format **IP FQDN short-alias**.
8. Click **Apply** to apply the host name to the installer environment.
9. Alternatively, in the **Network and Hostname** window, you can choose the Wireless option. Click **Select network** in the right-hand pane to select your wifi connection, enter the password if required, and click **Done**.

Additional resources

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

17.6.1. Adding a virtual network interface

You can add a virtual network interface.

Procedure

1. From the **Network & Host name** window, click the **+** button to add a virtual network interface. The **Add a device** dialog opens.
2. Select one of the four available types of virtual interfaces:
   - **Bond**: NIC (*Network Interface Controller*) Bonding, a method to bind multiple physical network interfaces together into a single bonded channel.
   - **Bridge**: Represents NIC Bridging, a method to connect multiple separate networks into one aggregate network.
   - **Team**: NIC Teaming, a new implementation to aggregate links, designed to provide a small kernel driver to implement the fast handling of packet flows, and various applications to do everything else in user space.
     NIC teaming is deprecated in Red Hat Enterprise Linux 9. Consider using the network bonding driver as an alternative. For details, see Configuring a network bond.
   - **Vlan** (*Virtual LAN*): A method to create multiple distinct broadcast domains which are mutually isolated.
3. Select the interface type and click **Add**. An editing interface dialog box opens, allowing you to edit any available settings for your chosen interface type.
   For more information, see Editing network interface.
4. Click **Save** to confirm the virtual interface settings and return to the **Network & Host name** window.
5. Optional: To change the settings of a virtual interface, select the interface and click **Configure**.

17.6.2. Editing network interface configuration

You can edit the configuration of a typical wired connection used during installation. Configuration of other types of networks is broadly similar, although the specific configuration parameters might be different.

NOTE

On 64-bit IBM Z, you cannot add a new connection as the network subchannels need to be grouped and set online beforehand, and this is currently done only in the booting phase.

Procedure

- To configure a network connection manually, select the interface from the **Network and Host name** window and click **Configure**.
  An editing dialog specific to the selected interface opens.

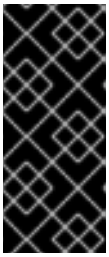
The options present depend on the connection type - the available options are slightly different depending on whether the connection type is a physical interface (wired or wireless network interface controller) or a virtual interface (Bond, Bridge, Team (deprecated), or Vlan) that was previously configured in Adding a virtual interface.

17.6.3. Enabling or Disabling the Interface Connection

You can enable or disable specific interface connections.

Procedure

1. Click the **General** tab.
2. Select the **Connect automatically with priority** check box to enable connection by default. Keep the default priority setting at **0**.
3. Optional: Enable or disable all users on the system from connecting to this network by using the **All users may connect to this network** option. If you disable this option, only **root** will be able to connect to this network.



IMPORTANT

When enabled on a wired connection, the system automatically connects during startup or reboot. On a wireless connection, the interface attempts to connect to any known wireless networks in range. For further information about NetworkManager, including the **nm-connection-editor** tool, see the *Configuring and managing networking* document.

4. Click **Save** to apply the changes and return to the **Network and Host name** window. It is not possible to only allow a specific user other than **root** to use this interface, as no other users are created at this point during the installation. If you need a connection for a different user, you must configure it after the installation.

17.6.4. Setting up Static IPv4 or IPv6 Settings

By default, both IPv4 and IPv6 are set to automatic configuration depending on current network settings. This means that addresses such as the local IP address, DNS address, and other settings are detected automatically when the interface connects to a network. In many cases, this is sufficient, but you can also provide static configuration in the **IPv4 Settings** and **IPv6 Settings** tabs. Complete the following steps to configure IPv4 or IPv6 settings:

Procedure

1. To set static network configuration, navigate to one of the IPv Settings tabs and from the **Method** drop-down menu, select a method other than **Automatic**, for example, **Manual**. The **Addresses** pane is enabled.
2. Optional: In the **IPv6 Settings** tab, you can also set the method to **Ignore** to disable IPv6 on this interface.
3. Click **Add** and enter your address settings.
4. Type the IP addresses in the **Additional DNS servers** field; it accepts one or more IP addresses of DNS servers, for example, **10.0.0.1,10.0.0.8**.
5. Select the **Require IPv*X* addressing for this connection to complete** check box. Selecting this option in the **IPv4 Settings** or **IPv6 Settings** tabs allow this connection only if IPv4 or IPv6 was successful. If this option remains disabled for both IPv4 and IPv6, the interface is able to connect if configuration succeeds on either IP protocol.
6. Click **Save** to apply the changes and return to the **Network & Host name** window.

17.6.5. Configuring Routes

You can control the access of specific connections by configuring routes.

Procedure

1. In the **IPv4 Settings** and **IPv6 Settings** tabs, click **Routes** to configure routing settings for a specific IP protocol on an interface. An editing routes dialog specific to the interface opens.
2. Click **Add** to add a route.
3. Select the **Ignore automatically obtained routes** check box to configure at least one static route and to disable all routes not specifically configured.
4. Select the **Use this connection only for resources on its network** check box to prevent the connection from becoming the default route.
   This option can be selected even if you did not configure any static routes. This route is used only to access certain resources, such as intranet pages that require a local or VPN connection. Another (default) route is used for publicly available resources. Unlike the additional routes configured, this setting is transferred to the installed system. This option is useful only when you configure more than one interface.
5. Click **OK** to save your settings and return to the editing routes dialog that is specific to the interface.
6. Click **Save** to apply the settings and return to the **Network and Host Name** window.

17.7. OPTIONAL: CONFIGURING THE KEYBOARD LAYOUT

You can configure the keyboard layout from the **Installation Summary** screen.

IMPORTANT

If you use a layout that cannot accept Latin characters, such as **Russian**, add the **English (United States)** layout and configure a keyboard combination to switch between the two layouts. If you select a layout that does not have Latin characters, you might be unable to enter a valid **root** password and user credentials later in the installation process. This might prevent you from completing the installation.

Procedure

1. From the **Installation Summary** window, click **Keyboard**.
2. Click **+** to open the **Add a Keyboard Layout** window to change to a different layout.
3. Select a layout by browsing the list or use the **Search** field.
4. Select the required layout and click **Add**. The new layout appears under the default layout.
5. Click **Options** to optionally configure a keyboard switch that you can use to cycle between available layouts. The **Layout Switching Options** window opens.
6. To configure key combinations for switching, select one or more key combinations and click **OK** to confirm your selection.

7. Optional: When you select a layout, click the **Keyboard** button to open a new dialog box displaying a visual representation of the selected layout.

8. Click **Done** to apply the settings and return to graphical installations.

17.8. OPTIONAL: CONFIGURING THE LANGUAGE SUPPORT

You can change the language settings from the **Installation Summary** screen.

Procedure

1. From the **Installation Summary** window, click **Language Support**. The **Language Support** window opens. The left pane lists the available language groups. If at least one language from a group is configured, a check mark is displayed and the supported language is highlighted.

2. From the left pane, click a group to select additional languages, and from the right pane, select regional options. Repeat this process for all the languages that you want to configure.

3. Optional: Search the language group by typing in the text box, if required.

4. Click **Done** to apply the settings and return to graphical installations.

17.9. OPTIONAL: CONFIGURING THE DATE AND TIME-RELATED SETTINGS

You can configure the date and time-related settings from the **Installation Summary** screen.

Procedure

1. From the **Installation Summary** window, click **Time & Date**. The **Time & Date** window opens. The list of cities and regions come from the Time Zone Database (**tzdata**) public domain that is maintained by the Internet Assigned Numbers Authority (IANA). Red Hat can not add cities or regions to this database. You can find more information at the IANA official website.

2. From the **Region** drop-down menu, select a region. Select **Etc** as your region to configure a time zone relative to Greenwich Mean Time (GMT) without setting your location to a specific region.

3. From the **City** drop-down menu, select the city, or the city closest to your location in the same time zone.

4. Toggle the **Network Time** switch to enable or disable network time synchronization using the Network Time Protocol (NTP).
   Enabling the Network Time switch keeps your system time correct as long as the system can access the internet. By default, one NTP pool is configured.

5. Optional: Use the **gear wheel** button next to the **Network Time** switch to add a new NTP, or disable or remove the default options.

6. Click **Done** to apply the settings and return to graphical installations.

7. Optional: Disable the network time synchronization to activate controls at the bottom of the page to set time and date manually.

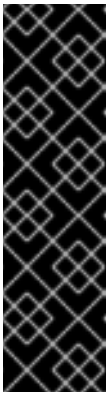
17.10. OPTIONAL: SUBSCRIBING THE SYSTEM AND ACTIVATING RED HAT INSIGHTS

Red Hat Insights is a Software-as-a-Service (SaaS) offering that provides continuous, in-depth analysis of registered Red Hat-based systems to proactively identify threats to security, performance and stability across physical, virtual and cloud environments, and container deployments. By *registering* your RHEL system in Red Hat Insights, you gain access to predictive analytics, security alerts, and performance optimization tools, enabling you to maintain a secure, efficient, and stable IT environment.

You can register to Red Hat by using either your Red Hat account or your activation key details. You can connect your system to Red hat Insights by using the **Connect to Red Hat** option.

Procedure

1. From the **Installation Summary** screen, under **Software**, click **Connect to Red Hat**
2. Select **Account** or **Activation Key**.
   a. If you select **Account**, enter your Red Hat Customer Portal username and password details.
   b. If you select **Activation Key**, enter your organization ID and activation key.
   You can enter more than one activation key, separated by a comma, as long as the activation keys are registered to your subscription.
3. Select the **Set System Purpose** check box.
   - If the account has Simple content access mode enabled, setting the system purpose values is still important for accurate reporting of consumption in the subscription services.
   - If your account is in the entitlement mode, system purpose enables the entitlement server to determine and automatically attach the most appropriate subscription to satisfy the intended use of the Red Hat Enterprise Linux 9 system.
4. Select the required **Role**, **SLA**, and **Usage** from the corresponding drop-down lists.
5. The **Connect to Red Hat Insights** check box is enabled by default. Clear the check box if you do not want to connect to Red Hat Insights.
6. Optional: Expand **Options**.
   a. Select the **Use HTTP proxy** check box if your network environment only allows external Internet access or access to content servers through an HTTP proxy. Clear the **Use HTTP proxy** check box if an HTTP proxy is not used.
   b. If you are running Satellite Server or performing internal testing, select the **Satellite URL** and **Custom base URL** check boxes and enter the required details.



IMPORTANT

- RHEL 9 is supported only with Satellite 6.11 or later. Check the version prior registering the system.
- The **Satellite URL** field does not require the HTTP protocol, for example **nameofhost.com**. However, the **Custom base URL** field requires the HTTP protocol.
- To change the **Custom base URL** after registration, you must unregister, provide the new details, and then re-register.

7. Click **Register** to register the system. When the system is successfully registered and subscriptions are attached, the **Connect to Red Hat** window displays the attached subscription details.
   Depending on the amount of subscriptions, the registration and attachment process might take up to a minute to complete.

8. Click **Done** to return to the **Installation Summary** window.
   A *Registered* message is displayed under **Connect to Red Hat**

Additional resources

- About Red Hat Insights

17.11. OPTIONAL: USING NETWORK-BASED REPOSITORIES FOR THE INSTALLATION

You can configure an installation source from either auto-detected installation media, Red Hat CDN, or the network. When the **Installation Summary** window first opens, the installation program attempts to configure an installation source based on the type of media that was used to boot the system. The full Red Hat Enterprise Linux Server DVD configures the source as local media.

Prerequisites

- You have downloaded the full installation DVD ISO or minimal installation Boot ISO image from the Product Downloads page.
- You have created bootable installation media.
- The **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Installation Source**. The **Installation Source** window opens.
   a. Review the **Auto-detected installation media** section to verify the details. This option is selected by default if you started the installation program from media containing an installation source, for example, a DVD.
   b. Click **Verify** to check the media integrity.
   c. Review the **Additional repositories** section and note that the **AppStream** check box is selected by default.

The BaseOS and AppStream repositories are installed as part of the full installation image. Do not disable the AppStream repository check box if you want a full Red Hat Enterprise Linux 9 installation.

2. Optional: Select the **Red Hat CDN** option to register your system, attach RHEL subscriptions, and install RHEL from the Red Hat Content Delivery Network (CDN).

3. Optional: Select the **On the network** option to download and install packages from a network location instead of local media. This option is available only when a network connection is active. See Configuring network and host name options for information about how to configure network connections in the GUI.

NOTE

If you do not want to download and install additional repositories from a network location, proceed to Configuring software selection.

   a. Select the **On the network** drop-down menu to specify the protocol for downloading packages. This setting depends on the server that you want to use.

   b. Type the server address (without the protocol) into the address field. If you choose NFS, a second input field opens where you can specify custom **NFS mount options**. This field accepts options listed in the **nfs(5)** man page on your system.

   c. When selecting an NFS installation source, specify the address with a colon (**:**) character separating the host name from the path. For example, **server.example.com:/path/to/directory**.
   The following steps are optional and are only required if you use a proxy for network access.

   d. Click **Proxy setup...** to configure a proxy for an HTTP or HTTPS source.

   e. Select the **Enable HTTP proxy** check box and type the URL into the **Proxy Host** field.

   f. Select the **Use Authentication** check box if the proxy server requires authentication.

   g. Type in your user name and password.

   h. Click **OK** to finish the configuration and exit the **Proxy Setup...** dialog box.

NOTE

If your HTTP or HTTPS URL refers to a repository mirror, select the required option from the **URL type** drop-down list. All environments and additional software packages are available for selection when you finish configuring the sources.

4. Click **+** to add a repository.

5. Click **-** to delete a repository.

6. Click the **arrow** icon to revert the current entries to the setting when you opened the **Installation Source** window.

7. To activate or deactivate a repository, click the check box in the **Enabled** column for each entry in the list.

You can name and configure your additional repository in the same way as the primary repository on the network.

8. Click **Done** to apply the settings and return to the **Installation Summary** window.

17.12. OPTIONAL: CONFIGURING KDUMP KERNEL CRASH-DUMPING MECHANISM

Kdump is a kernel crash-dumping mechanism. In the event of a system crash, **Kdump** captures the contents of the system memory at the moment of failure. This captured memory can be analyzed to find the cause of the crash. If **Kdump** is enabled, it must have a small portion of the system's memory (RAM) reserved to itself. This reserved memory is not accessible to the main kernel.

Procedure

1. From the **Installation Summary** window, click **Kdump**. The **Kdump** window opens.
2. Select the **Enable kdump** check box.
3. Select either the **Automatic** or **Manual** memory reservation setting.
4. If you select **Manual**, enter the amount of memory (in megabytes) that you want to reserve in the **Memory to be reserved**field using the **+** and **-** buttons. The **Usable System Memory** readout below the reservation input field shows how much memory is accessible to your main system after reserving the amount of RAM that you select.
5. Click **Done** to apply the settings and return to graphical installations.

The amount of memory that you reserve is determined by your system architecture (AMD64 and Intel 64 have different requirements than IBM Power) as well as the total amount of system memory. In most cases, automatic reservation is satisfactory.

Additional settings, such as the location where kernel crash dumps will be saved, can only be configured after the installation using either the **system-config-kdump** graphical interface, or manually in the **/etc/kdump.conf** configuration file.

17.13. OPTIONAL: SELECTING A SECURITY PROFILE

You can apply security policy during your Red Hat Enterprise Linux 9 installation and configure it to use on your system before the first boot.

17.13.1. About security policy

The Red Hat Enterprise Linux includes OpenSCAP suite to enable automated configuration of the system in alignment with a particular security policy. The policy is implemented using the Security Content Automation Protocol (SCAP) standard. The packages are available in the AppStream repository. However, by default, the installation and post-installation process does not enforce any policies and therefore does not involve any checks unless specifically configured.

Applying a security policy is not a mandatory feature of the installation program. If you apply a security policy to the system, it is installed using restrictions defined in the profile that you selected. The **openscap-scanner** and **scap-security-guide** packages are added to your package selection, providing a preinstalled tool for compliance and vulnerability scanning.

When you select a security policy, the Anaconda GUI installer requires the configuration to adhere to the policy's requirements. There might be conflicting package selections, as well as separate partitions defined. Only after all the requirements are met, you can start the installation.

At the end of the installation process, the selected OpenSCAP security policy automatically hardens the system and scans it to verify compliance, saving the scan results to the **/root/openscap_data** directory on the installed system.

By default, the installer uses the content of the **scap-security-guide** package bundled in the installation image. You can also load external content from an HTTP, HTTPS, or FTP server.

17.13.2. Configuring a security profile

You can configure a security policy from the **Installation Summary** window.

Prerequisite

- The **Installation Summary** window is open.

Procedure

1. From the **Installation Summary** window, click **Security Profile**. The **Security Profile** window opens.
2. To enable security policies on the system, toggle the **Apply security policy** switch to **ON**.
3. Select one of the profiles listed in the top pane.
4. Click **Select profile**.
   Profile changes that you must apply before installation appear in the bottom pane.
5. Click **Change content** to use a custom profile.
   A separate window opens allowing you to enter a URL for valid security content.
   a. Click **Fetch** to retrieve the URL.
      You can load custom profiles from an **HTTP**, **HTTPS**, or **FTP** server. Use the full address of the content including the protocol, such as **http://**. A network connection must be active before you can load a custom profile. The installation program detects the content type automatically.
   b. Click **Use SCAP Security Guide** to return to the **Security Profile** window.
6. Click **Done** to apply the settings and return to the **Installation Summary** window.

17.13.3. Profiles not compatible with Server with GUI

Certain security profiles provided as part of the **SCAP Security Guide** are not compatible with the extended package set included in the **Server with GUI** base environment. Therefore, do not select **Server with GUI** when installing systems compliant with one of the following profiles:

Table 17.2. Profiles not compatible with Server with GUI

Profile name	Profile ID	Justification	Notes
[DRAFT] CIS Red Hat Enterprise Linux 9 Benchmark for Level 2 - Server	**xccdf_org.ssgproject.content_profile_cis**	Packages **xorg-x11-server-Xorg**, **xorg-x11-server-common**, **xorg-x11-server-utils**, and **xorg-x11-server-Xwayland** are part of the **Server with GUI** package set, but the policy requires their removal.	
[DRAFT] CIS Red Hat Enterprise Linux 9 Benchmark for Level 1 - Server	**xccdf_org.ssgproject.content_profile_cis_server_l1**	Packages **xorg-x11-server-Xorg**, **xorg-x11-server-common**, **xorg-x11-server-utils**, and **xorg-x11-server-Xwayland** are part of the **Server with GUI** package set, but the policy requires their removal.	
DISA STIG for Red Hat Enterprise Linux 9	**xccdf_org.ssgproject.content_profile_stig**	Packages **xorg-x11-server-Xorg**, **xorg-x11-server-common**, **xorg-x11-server-utils**, and **xorg-x11-server-Xwayland** are part of the **Server with GUI** package set, but the policy requires their removal.	To install a RHEL system as a **Server with GUI** aligned with DISA STIG, you can use the **DISA STIG with GUI** profile BZ#1648162

17.13.4. Deploying baseline-compliant RHEL systems using Kickstart

You can deploy RHEL systems that are aligned with a specific baseline. This example uses Protection Profile for General Purpose Operating System (OSPP).

Prerequisites

- The **scap-security-guide** package is installed on your RHEL 9 system.

Procedure

1. Open the **/usr/share/scap-security-guide/kickstart/ssg-rhel9-ospp-ks.cfg** Kickstart file in an editor of your choice.

2. Update the partitioning scheme to fit your configuration requirements. For OSPP compliance, the separate partitions for **/boot**, **/home**, **/var**, **/tmp**, **/var/log**, **/var/tmp**, and **/var/log/audit** must be preserved, and you can only change the size of the partitions.

3. Start a Kickstart installation as described in Performing an automated installation using Kickstart.

IMPORTANT

Passwords in Kickstart files are not checked for OSPP requirements.

Verification

- To check the current status of the system after installation is complete, reboot the system and start a new scan:

```
# oscap xccdf eval --profile ospp --report eval_postinstall_report.html
/usr/share/xml/scap/ssg/content/ssg-rhel9-ds.xml
```

Additional resources

- OSCAP Anaconda Add-on
- Kickstart commands and options reference: %addon org_fedora_oscap

17.13.5. Additional resources

- **scap-security-guide(8)** - The manual page for the **scap-security-guide** project contains information about SCAP security profiles, including examples on how to utilize the provided benchmarks using the OpenSCAP utility.
- Red Hat Enterprise Linux security compliance information is available in the *Security hardening* document.

CHAPTER 18. COMPLETING INITIAL SETUP

This section contains information about how to complete initial setup on a Red Hat Enterprise Linux 9 system. If you have selected the **Server with GUI** base environment during installation, the **Initial Setup** window opens the first time you reboot your system after the installation process is complete. If you have registered and installed RHEL from the CDN, the Subscription Manager option displays a note that all installed products are covered by valid entitlements.

The information displayed in the **Initial Setup** window might vary depending on what was configured during installation. At a minimum, the **Licensing** and **Subscription Manager** options are displayed.

Prerequisites

- You have completed the graphical installation.
- You have an active, non-evaluation Red Hat Enterprise Linux subscription.

Procedure

1. From the **Initial Setup** window, select **Licensing Information**.
   The **License Agreement** window opens and displays the licensing terms for Red Hat Enterprise Linux.
2. Review the license agreement and select the **I accept the license agreement** checkbox.
   You must accept the license agreement to proceed. Exiting **Initial Setup** without accepting license agreement causes a system restart. When the restart process is complete, you are prompted to accept the license agreement again.
3. Click **Done** to apply the settings and return to the **Initial Setup** window.
4. Optional: Click **Finish Configuration**, if you did not configure network settings earlier as you cannot register your system immediately.
   Red Hat Enterprise Linux 9 starts and you can login, activate access to the network, and register your system. See Subscription manager post installation for more information.

   If you have configured network settings, as described in Network hostname, you can register your system immediately, as shown in the following steps.
5. From the **Initial Setup** window, select **Subscription Manager**.
6. The **Subscription Manager** graphical interface opens and displays the option you are going to register, which is: ***subscription.rhsm.redhat.com***.
7. Click **Next**.
8. Enter your **Login** and **Password** details and click **Register**.
9. Confirm the Subscription details and click **Attach**. You must receive the following confirmation message: **Registration with Red Hat Subscription Management is Done!**
10. Click **Done**. The **Initial Setup** window opens.
11. Click **Finish Configuration**. The login window opens.
12. Configure your system. See the *Configuring basic system settings* document for more information.

Methods to register RHEL

Depending on your requirements, there are five methods to register your system:

- Using the Red Hat Content Delivery Network (CDN) to register your system, attach RHEL subscriptions, and install Red Hat Enterprise Linux.
- During installation using **Initial Setup**.
- After installation using the command line.
- After installation using the Subscription Manager user interface.
- After installation using Registration Assistant. Registration Assistant is designed to help you choose the most suitable registration option for your Red Hat Enterprise Linux environment. See https://access.redhat.com/labs/registrationassistant/ for more information.

PART III. POST-INSTALLATION TASKS

Managing subscriptions and securing a Red Hat Enterprise Linux (RHEL) system are essential steps for maintaining system compliance and functionality. Registering RHEL ensures access to software updates and services. Additionally, setting a system purpose aligns the system's usage with the appropriate subscriptions, while adjusting security settings helps safeguard critical infrastructure. When needed, subscription services can be updated or changed to meet evolving system requirements.

CHAPTER 19. REGISTERING RHEL BY USING SUBSCRIPTION MANAGER

Post-installation, you must register your system to get continuous updates.

19.1. REGISTERING RHEL 9 USING THE INSTALLER GUI

You can register a Red Hat Enterprise Linux 9 by using the RHEL installer GUI.

Prerequisites

- You have a valid user account on the Red Hat Customer Portal. See the Create a Red Hat Login page.
- You have a valid Activation Key and Organization id.

Procedure

1. From the **Installation Summary** screen, under **Software**, click **Connect to Red Hat**
2. Authenticate your Red Hat account using the **Account** or **Activation Key** option.
3. Optional: In the **Set System Purpose** field select the **Role**, **SLA**, and **Usage** attribute that you want to set from the drop-down menu.
   At this point, your Red Hat Enterprise Linux 9 system has been successfully registered.

19.2. REGISTRATION ASSISTANT

Registration Assistant is designed to help you choose the most suitable registration option for your Red Hat Enterprise Linux environment.

Additional resources

- For assistance with using a username and password to register RHEL with the Subscription Manager client, see the RHEL registration assistant on the Customer Portal.
- For assistance with registering your RHEL system to Red Hat Insights, see the Insights registration assistant on the Hybrid Cloud Console.

19.3. REGISTERING YOUR SYSTEM USING THE COMMAND LINE

You can register your Red Hat Enterprise Linux 9 subscription by using the command line.

For an improved and simplified experience registering your hosts to Red Hat, use remote host configuration (RHC). The RHC client registers your system to Red Hat making your system ready for Insights data collection and enabling direct issue remediation from Insights for Red Hat Enterprise Linux. For more information, see RHC registration.

Prerequisites

- You have an active, non-evaluation Red Hat Enterprise Linux subscription.
- Your Red Hat subscription status is verified.

- You have not previously received a Red Hat Enterprise Linux 9 subscription.
- You have successfully installed Red Hat Enterprise Linux 9 and logged into the system as root.

Procedure

1. Open a terminal window as a root user.
2. Register your Red Hat Enterprise Linux system by using the activation key:

```
# subscription-manager register --activationkey=<activation_key_name> --
org=<organization_ID>
```

When the system is successfully registered, an output similar to the following is displayed:

```
The system has been registered with id:
62edc0f8-855b-4184-b1b8-72a9dc793b96
```

Additional resources

- Using an activation key to register a system with Red Hat Subscription Manager
- Getting Started with RHEL System Registration

CHAPTER 20. CONFIGURING SYSTEM PURPOSE USING THE SUBSCRIPTION-MANAGER COMMAND-LINE TOOL

System purpose is a feature of the Red Hat Enterprise Linux installation to help RHEL customers get the benefit of our subscription experience and services offered in the Red Hat Hybrid Cloud Console, a dashboard-based, Software-as-a-Service (SaaS) application that enables you to view subscription usage in your Red Hat account.

You can configure system purpose attributes either on the activation keys or by using the subscription manager tool.

Prerequisites

- You have installed and registered your Red Hat Enterprise Linux 9 system, but system purpose is not configured.
- You are logged in as a **root** user.

NOTE

In the entitlement mode, if your system is registered but has subscriptions that do not satisfy the required purpose, you can run the **subscription-manager remove --all** command to remove attached subscriptions. You can then use the command-line subscription-manager syspurpose {role, usage, service-level} tools to set the required purpose attributes, and lastly run **subscription-manager attach --auto** to re-entitle the system with considerations for the updated attributes. Whereas, in the SCA enabled account, you can directly update the system purpose details post registration without making an update to the subscriptions in the system.

Procedure

1. From a terminal window, run the following command to set the intended role of the system:

```
# subscription-manager syspurpose role --set "VALUE"
```

   Replace **VALUE** with the role that you want to assign:

   - **Red Hat Enterprise Linux Server**
   - **Red Hat Enterprise Linux Workstation**
   - **Red Hat Enterprise Linux Compute Node**

   For example:

```
# subscription-manager syspurpose role --set "Red Hat Enterprise Linux Server"
```

   a. Optional: Before setting a value, see the available roles supported by the subscriptions for your organization:

```
# subscription-manager syspurpose role --list
```

   b. Optional: Run the following command to unset the role:

```
# subscription-manager syspurpose role --unset
```

2. Run the following command to set the intended Service Level Agreement (SLA) of the system:

```
# subscription-manager syspurpose service-level --set "VALUE"
```

Replace **VALUE** with the SLA that you want to assign:

- **Premium**
- **Standard**
- **Self-Support**

For example:

```
# subscription-manager syspurpose service-level --set "Standard"
```

a. Optional: Before setting a value, see the available service-levels supported by the subscriptions for your organization:

```
# subscription-manager syspurpose service-level --list
```

b. Optional: Run the following command to unset the SLA:

```
# subscription-manager syspurpose service-level --unset
```

3. Run the following command to set the intended usage of the system:

```
# subscription-manager syspurpose usage --set "VALUE"
```

Replace **VALUE** with the usage that you want to assign:

- **Production**
- **Disaster Recovery**
- **Development/Test**

For example:

```
# subscription-manager syspurpose usage --set "Production"
```

a. Optional: Before setting a value, see the available usages supported by the subscriptions for your organization:

```
# subscription-manager syspurpose usage --list
```

b. Optional: Run the following command to unset the usage:

```
# subscription-manager syspurpose usage --unset
```

4. Run the following command to show the current system purpose properties:

```
# subscription-manager syspurpose --show
```

a. Optional: For more detailed syntax information run the following command to access the **subscription-manager** man page and browse to the SYSPURPOSE OPTIONS:

```
# man subscription-manager
```

Verification

- To verify the system's subscription status in a system registered with an account having entitlement mode enabled:

```
# subscription-manager status
+-------------------------------------------+
   System Status Details
+-------------------------------------------+
Overall Status: Current

System Purpose Status: Matched
```

  - An overall status **Current** means that all of the installed products are covered by the subscription(s) attached and entitlements to access their content set repositories has been granted.
  - A system purpose status **Matched** means that all of the system purpose attributes (role, usage, service-level) that were set on the system are satisfied by the subscription(s) attached.
  - When the status information is not ideal, additional information is displayed to help the system administrator decide what corrections to make to the attached subscriptions to cover the installed products and intended system purpose.

- To verify the system's subscription status in a system registered with an account having SCA mode enabled:

```
# subscription-manager status
+-------------------------------------------+
   System Status Details
+-------------------------------------------+
Overall Status: Disabled
Content Access Mode is set to Simple Content Access. This host has access to content,
regardless of subscription status.
System Purpose Status: Disabled
```

  - In SCA mode, subscriptions are no longer required to be attached to individual systems. Hence, both the overall status and system purpose status are displayed as Disabled . However, the technical, business, and operational use cases supplied by system purpose attributes are important to the subscriptions service. Without these attributes, the subscriptions service data is less accurate.

Additional resources

- To learn more about the subscriptions service, see the Getting Started with the Subscriptions Service guide.

CHAPTER 21. CHANGING A SUBSCRIPTION SERVICE

To manage the subscriptions, you can register a RHEL system with either Red Hat Subscription Management Server or Red Hat Satellite Server. If required, you can change the subscription service at a later point. To change the subscription service under which you are registered, unregister the system from the current service and then register it with a new service.

To receive the system updates, register your system with either of the management server.

This section contains information about how to unregister your RHEL system from the Red Hat Subscription Management Server and Red Hat Satellite Server.

Prerequisites

You have registered your system with any one of the following:

- Red Hat Subscription Management Server
- Red Hat Satellite Server version 6.11

To receive the system updates, register your system with either of the management server.

21.1. UNREGISTERING FROM SUBSCRIPTION MANAGEMENT SERVER

This section contains information about how to unregister a RHEL system from Red Hat Subscription Management Server, using a command line and the Subscription Manager user interface.

21.1.1. Unregistering using command line

Use the **unregister** command to unregister a RHEL system from Red Hat Subscription Management Server.

Procedure

1. Run the unregister command as a root user, without any additional parameters.

```
# subscription-manager unregister
```

2. When prompted, provide a root password.

The system is unregistered from the Subscription Management Server, and the status 'The system is currently not registered' is displayed with the **Register** button enabled.

To continue uninterrupted services, re-register the system with either of the management services. If you do not register the system with a management service, you may fail to receive the system updates. For more information about registering a system, see Registering your system using the command line .

Additional resources

- *Using and Configuring Red Hat Subscription Manager*

21.1.2. Unregistering using Subscription Manager user interface

This section contains information about how to unregister a RHEL system from Red Hat Subscription Management Server, using Subscription Manager user interface.

Procedure

1. Log in to your system.
2. From the top left-hand side of the window, click **Activities**.
3. From the menu options, click the **Show Applications** icon.
4. Click the **Red Hat Subscription Manager** icon, or enter **Red Hat Subscription Manager** in the search.
5. Enter your administrator password in the **Authentication Required** dialog box. The **Subscriptions** window appears and displays the current status of Subscriptions, System Purpose, and installed products. Unregistered products display a red X.
   Authentication is required to perform privileged tasks on the system.
6. Click the **Unregister** button.

The system is unregistered from the Subscription Management Server, and the status 'The system is currently not registered' is displayed with the **Register** button enabled.

To continue uninterrupted services, re-register the system with either of the management services. If you do not register the system with a management service, you may fail to receive the system updates. For more information about registering a system, see Registering your system using the Subscription Manager User Interface.

Additional resources

- *Using and Configuring Red Hat Subscription Manager*

21.2. UNREGISTERING FROM SATELLITE SERVER

To unregister a Red Hat Enterprise Linux system from Satellite Server, remove the system from Satellite Server.

For more information, see Removing a Host from Red Hat Satellite .

CHAPTER 22. CONFIGURING A LINUX INSTANCE ON 64-BIT IBM Z

This section describes most of the common tasks for installing Red Hat Enterprise Linux on 64-bit IBM Z.

22.1. ADDING DASDS

Direct Access Storage Devices (DASDs) are a type of storage commonly used with 64-bit IBM Z. For more information, see Working with DASDs in the IBM Knowledge Center. The following example is how to set a DASD online, format it, and make the change persistent.

Verify that the device is attached or linked to the Linux system if running under z/VM.

```
CP ATTACH EB1C TO *
```

To link a mini disk to which you have access, run the following commands:

```
CP LINK RHEL7X 4B2E 4B2E MR
DASD 4B2E LINKED R/W
```

22.2. DYNAMICALLY SETTING DASDS ONLINE

This section contains information about setting a DASD online.

Procedure

1. Use the **cio_ignore** utility to remove the DASD from the list of ignored devices and make it visible to Linux:

   ```
   # cio_ignore -r device_number
   ```

   Replace *device_number* with the device number of the DASD. For example:

   ```
   # cio_ignore -r 4b2e
   ```

2. Set the device online. Use a command of the following form:

   ```
   # chccwdev -e device_number
   ```

   Replace *device_number* with the device number of the DASD. For example:

   ```
   # chccwdev -e 4b2e
   ```

   As an alternative, you can set the device online using sysfs attributes:

   a. Use the **cd** command to change to the /sys/ directory that represents that volume:

      ```
      # cd /sys/bus/ccw/drivers/dasd-eckd/0.0.4b2e/
      # ls -l
      total 0
      ```

```
-r--r--r--  1 root root 4096 Aug 25 17:04 availability
-rw-r--r--  1 root root 4096 Aug 25 17:04 cmb_enable
-r--r--r--  1 root root 4096 Aug 25 17:04 cutype
-rw-r--r--  1 root root 4096 Aug 25 17:04 detach_state
-r--r--r--  1 root root 4096 Aug 25 17:04 devtype
-r--r--r--  1 root root 4096 Aug 25 17:04 discipline
-rw-r--r--  1 root root 4096 Aug 25 17:04 online
-rw-r--r--  1 root root 4096 Aug 25 17:04 readonly
-rw-r--r--  1 root root 4096 Aug 25 17:04 use_diag
```

b. Check to see if the device is already online:

```
# cat online
0
```

c. If it is not online, enter the following command to bring it online:

```
# echo 1 > online
# cat online
1
```

3. Verify which block devnode it is being accessed as:

```
# ls -l
total 0
-r--r--r--  1 root root 4096 Aug 25 17:04 availability
lrwxrwxrwx  1 root root    0 Aug 25 17:07 block -> ../../../../block/dasdb
-rw-r--r--  1 root root 4096 Aug 25 17:04 cmb_enable
-r--r--r--  1 root root 4096 Aug 25 17:04 cutype
-rw-r--r--  1 root root 4096 Aug 25 17:04 detach_state
-r--r--r--  1 root root 4096 Aug 25 17:04 devtype
-r--r--r--  1 root root 4096 Aug 25 17:04 discipline
-rw-r--r--  1 root root    0 Aug 25 17:04 online
-rw-r--r--  1 root root 4096 Aug 25 17:04 readonly
-rw-r--r--  1 root root 4096 Aug 25 17:04 use_diag
```

As shown in this example, device 4B2E is being accessed as /dev/dasdb.

These instructions set a DASD online for the current session, but this is not persistent across reboots.

For instructions on how to set a DASD online persistently, see Persistently setting DASDs online. When you work with DASDs, use the persistent device symbolic links under **/dev/disk/by-path/**.

22.3. PREPARING A NEW DASD WITH LOW-LEVEL FORMATTING

Once the disk is online, change back to the **/root** directory and low-level format the device. This is only required once for a DASD during its entire lifetime:

```
# cd /root
# dasdfmt -b 4096 -d cdl -p /dev/disk/by-path/ccw-0.0.4b2e
Drive Geometry: 10017 Cylinders * 15 Heads =  150255 Tracks

I am going to format the device /dev/disk/by-path/ccw-0.0.4b2e in the following way:
Device number of device : 0x4b2e
```

```
Labelling device        : yes
Disk label              : VOL1
Disk identifier         : 0X4B2E
Extent start (trk no)   : 0
Extent end (trk no)     : 150254
Compatible Disk Layout  : yes
Blocksize               : 4096

--->> ATTENTION! <<---
All data of that device will be lost.
Type "yes" to continue, no will leave the disk untouched: yes
cyl    97 of  3338 |#----------------------------------------------|   2%
```

When the progress bar reaches the end and the format is complete, **dasdfmt** prints the following output:

```
Rereading the partition table...
Exiting...
```

Now, use **fdasd** to partition the DASD. You can create up to three partitions on a DASD. In our example here, we create one partition spanning the whole disk:

```
# fdasd -a /dev/disk/by-path/ccw-0.0.4b2e
reading volume label ..: VOL1
reading vtoc .........: ok

auto-creating one partition for the whole disk...
writing volume label...
writing VTOC...
rereading partition table...
```

After a (low-level formatted) DASD is online, it can be used like any other disk under Linux. For example, you can create file systems, LVM physical volumes, or swap space on its partitions, for example **/dev/disk/by-path/ccw-0.0.4b2e-part1**. Never use the full DASD device (**dev/dasdb**) for anything but the commands **dasdfmt** and **fdasd**. If you want to use the entire DASD, create one partition spanning the entire drive as in the **fdasd** example above.

To add additional disks later without breaking existing disk entries in, for example, **/etc/fstab**, use the persistent device symbolic links under **/dev/disk/by-path/**.

22.4. PERSISTENTLY SETTING DASDS ONLINE

The above instructions described how to activate DASDs dynamically in a running system. However, such changes are not persistent and do not survive a reboot. Making changes to the DASD configuration persistent in your Linux system depends on whether the DASDs belong to the root file system. Those DASDs required for the root file system need to be activated very early during the boot process by the **initramfs** to be able to mount the root file system.

The **cio_ignore** commands are handled transparently for persistent device configurations and you do not need to free devices from the ignore list manually.

22.5. DASDS THAT ARE PART OF THE ROOT FILE SYSTEM

The file you have to modify to add DASDs that are part of the root file system has changed in Red Hat Enterprise Linux 9. Instead of editing the **/etc/zipl.conf** file, the new file to be edited, and its location, may be found by running the following commands:

```
# machine_id=$(cat /etc/machine-id)
# kernel_version=$(uname -r)
# ls /boot/loader/entries/$machine_id-$kernel_version.conf
```

There is one boot option to activate DASDs early in the boot process: **rd.dasd=**. This option takes a Direct Access Storage Device (DASD) adapter device bus identifier. For multiple DASDs, specify the parameter multiple times, or use a comma separated list of bus IDs. To specify a range of DASDs, specify the first and the last bus ID. Below is an example of the **/boot/loader/entries/4ab74e52867b4f998e73e06cf23fd761-4.18.0-80.el8.s390x.conf** file for a system that uses physical volumes on partitions of two DASDs for an LVM volume group **vg_devel1** that contains a logical volume **lv_root** for the root file system.

```
title Red Hat Enterprise Linux (4.18.0-80.el8.s390x) 8.0 (Ootpa)
version 4.18.0-80.el8.s390x
linux /boot/vmlinuz-4.18.0-80.el8.s390x
initrd /boot/initramfs-4.18.0-80.el8.s390x.img
options root=/dev/mapper/vg_devel1-lv_root crashkernel=auto rd.dasd=0.0.0200 rd.dasd=0.0.0207
rd.lvm.lv=vg_devel1/lv_root rd.lvm.lv=vg_devel1/lv_swap cio_ignore=all,!condev
rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0
id rhel-20181027190514-4.18.0-80.el8.s390x
grub_users $grub_users
grub_arg --unrestricted
grub_class kernel
```

To add another physical volume on a partition of a third DASD with device bus ID **0.0.202b**. To do this, add **rd.dasd=0.0.202b** to the parameters line of your boot kernel in **/boot/loader/entries/4ab74e52867b4f998e73e06cf23fd761-4.18.0-32.el8.s390x.conf**:

```
title Red Hat Enterprise Linux (4.18.0-80.el8.s390x) 8.0 (Ootpa)
version 4.18.0-80.el8.s390x
linux /boot/vmlinuz-4.18.0-80.el8.s390x
initrd /boot/initramfs-4.18.0-80.el8.s390x.img
options root=/dev/mapper/vg_devel1-lv_root crashkernel=auto rd.dasd=0.0.0200 rd.dasd=0.0.0207
rd.dasd=0.0.202b rd.lvm.lv=vg_devel1/lv_root rd.lvm.lv=vg_devel1/lv_swap cio_ignore=all,!condev
rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0
id rhel-20181027190514-4.18.0-80.el8.s390x
grub_users $grub_users
grub_arg --unrestricted
grub_class kernel
```

WARNING

Make sure the length of the kernel command line in the configuration file does not exceed 896 bytes. Otherwise, the boot loader cannot be saved, and the installation fails.

Run **zipl** to apply the changes of the configuration file for the next IPL:

```
# zipl -V
Using config file '/etc/zipl.conf'
Using BLS config file '/boot/loader/entries/4ab74e52867b4f998e73e06cf23fd761-4.18.0-
80.el8.s390x.conf'
Target device information
  Device.....: 5e:00
  Partition.....: 5e:01
  Device name.....: dasda
  Device driver name.....: dasd
  DASD device number.....: 0201
  Type.....: disk partition
  Disk layout.....: ECKD/compatible disk layout
  Geometry - heads.....: 15
  Geometry - sectors.....: 12
  Geometry - cylinders.....: 13356
  Geometry - start.....: 24
  File system block size.....: 4096
  Physical block size.....: 4096
  Device size in physical blocks..: 262152
Building bootmap in '/boot'
Building menu 'zipl-automatic-menu'
Adding #1: IPL section '4.18.0-80.el8.s390x' (default)
  initial ramdisk...: /boot/initramfs-4.18.0-80.el8.s390x.img
  kernel image.....: /boot/vmlinuz-4.18.0-80.el8.s390x
  kernel parmline...: 'root=/dev/mapper/vg_devel1-lv_root crashkernel=auto rd.dasd=0.0.0200
rd.dasd=0.0.0207 rd.dasd=0.0.202b rd.lvm.lv=vg_devel1/lv_root rd.lvm.lv=vg_devel1/lv_swap
cio_ignore=all,!condev rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0'
  component address:
    kernel image....: 0x00010000-0x0049afff
    parmline.....: 0x0049b000-0x0049bfff
    initial ramdisk.: 0x004a0000-0x01a26fff
    internal loader.: 0x0000a000-0x0000cfff
Preparing boot menu
  Interactive prompt.....: enabled
  Menu timeout.....: 5 seconds
  Default configuration...: '4.18.0-80.el8.s390x'
Preparing boot device: dasda (0201).
Syncing disks...
Done.
```

22.6. DASDS THAT ARE NOT PART OF THE ROOT FILE SYSTEM

Direct Access Storage Devices (DASDs) that are not part of the root file system, that is, *data disks*, are persistently configured in the **/etc/dasd.conf** file. This file contains one DASD per line, where each line begins with the DASD's bus ID.

When adding a DASD to the **/etc/dasd.conf** file, use key-value pairs to specify the options for each entry. Separate the key and its value with an equal (=) sign. When adding multiple options, use a space or a tab to separate each option.

Example /etc/dasd.conf file

```
0.0.0207
0.0.0200 use_diag=1 readonly=1
```

Changes to the **/etc/dasd.conf** file take effect after a system reboot or after a new DASD is dynamically added by changing the system's I/O configuration (that is, the DASD is attached under z/VM).

Alternatively, to activate a DASD that you have added to the **/etc/dasd.conf** file, complete the following steps:

1. Remove the DASD from the list of ignored devices and make it visible using the **cio_ignore** utility:

   ```
   # cio_ignore -r device_number
   ```

   where ***device_number*** is the DASD device number.

   For example, if the device number is **021a**, run:

   ```
   # cio_ignore -r 021a
   ```

2. Activate the DASD by writing to the device's **uevent** attribute:

   ```
   # echo add > /sys/bus/ccw/devices/dasd-bus-ID/uevent
   ```

   where ***dasd-bus-ID*** is the DASD's bus ID.

   For example, if the bus ID is **0.0.021a**, run:

   ```
   # echo add > /sys/bus/ccw/devices/0.0.021a/uevent
   ```

22.7. FCP LUNS THAT ARE PART OF THE ROOT FILE SYSTEM

The only file you have to modify for adding FCP LUNs that are part of the root file system has changed in Red Hat Enterprise Linux 9. Instead of editing the **/etc/zipl.conf** file, the new file to be edited, and its location, may be found by running the following commands:

```
# machine_id=$(cat /etc/machine-id)
# kernel_version=$(uname -r)
# ls /boot/loader/entries/$machine_id-$kernel_version.conf
```

Red Hat Enterprise Linux provides a parameter to activate FCP LUNs early in the boot process: **rd.zfcp=**. The value is a comma-separated list containing the FCP device bus ID, the target WWPN as 16 digit hexadecimal number prefixed with **0x**, and the FCP LUN prefixed with 0x and padded with zeroes to the right to have 16 hexadecimal digits.

The WWPN and FCP LUN values are only necessary if the **zFCP** device is not configured in NPIV mode, when auto LUN scanning is disabled by the **zfcp.allow_lun_scan=0** kernel module parameter or when installing RHEL-9.0 or older releases. Otherwise they can be omitted, for example, **rd.zfcp=0.0.4000**. Below is an example of the **/boot/loader/entries/4ab74e52867b4f998e73e06cf23fd761-5.14.0-55.el9.s390x.conf** file for a system that uses a physical volume on a partition of an FCP-attached SCSI disk, with two paths, for an LVM volume group **vg_devel1** that contains a logical volume **lv_root** for the root file system.

```
title Red Hat Enterprise Linux (5.14.0-55.el9.s390x) 9.0 (Plow)
version 5.14.0-55.el9.s390x
linux /boot/vmlinuz-5.14.0-55.el9.s390x
initrd /boot/initramfs-5.14.0-55.el9.s390x.img
options root=/dev/mapper/vg_devel1-lv_root crashkernel=auto
rd.zfcp=0.0.fc00,0x5105074308c212e9,0x401040a000000000
rd.zfcp=0.0.fcd0,0x5105074308c2aee9,0x401040a000000000 rd.lvm.lv=vg_devel1/lv_root
rd.lvm.lv=vg_devel1/lv_swap cio_ignore=all,!condev
rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0
id rhel-20181027190514-5.14.0-55.el9.s390x
grub_users $grub_users
grub_arg --unrestricted
grub_class kernel
```

1. To add another physical volume on a partition of a second FCP-attached SCSI disk with FCP LUN **0x401040a300000000** using the same two paths as the already existing physical volume, add **rd.zfcp=0.0.fc00,0x5105074308c212e9,0x401040a300000000** and **rd.zfcp=0.0.fcd0,0x5105074308c2aee9,0x401040a300000000** to the parameters line of your boot kernel in **/boot/loader/entries/4ab74e52867b4f998e73e06cf23fd761-5.14.0-55.el9.s390x.conf**. For example:

```
title Red Hat Enterprise Linux (5.14.0-55.el9.s390x) 9.0 (Plow)
version 5.14.0-55.el9.s390x
linux /boot/vmlinuz-5.14.0-55.el9.s390x
initrd /boot/initramfs-5.14.0-55.el9.s390x.img
options root=/dev/mapper/vg_devel1-lv_root crashkernel=auto
rd.zfcp=0.0.fc00,0x5105074308c212e9,0x401040a000000000
rd.zfcp=0.0.fcd0,0x5105074308c2aee9,0x401040a000000000
rd.zfcp=0.0.fc00,0x5105074308c212e9,0x401040a300000000
rd.zfcp=0.0.fcd0,0x5105074308c2aee9,0x401040a300000000 rd.lvm.lv=vg_devel1/lv_root
rd.lvm.lv=vg_devel1/lv_swap cio_ignore=all,!condev
rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0
id rhel-20181027190514-5.14.0-55.el9.s390x
grub_users $grub_users
grub_arg --unrestricted
grub_class kernel
```

WARNING

Make sure the length of the kernel command line in the configuration file does not exceed 896 bytes. Otherwise, the boot loader cannot be saved, and the installation fails.

- Run **dracut -f** to update the initial RAM disk of your target kernel.
- Run **zipl** to apply the changes of the configuration file for the next IPL:

```
# zipl -V
Using config file '/etc/zipl.conf'
Using BLS config file '/boot/loader/entries/4ab74e52867b4f998e73e06cf23fd761-5.14.0-
```

```
55.el9.s390x.conf'
Run /lib/s390-tools/zipl_helper.device-mapper /boot
Target device information
Device.....: fd:00
Partition.....: fd:01
Device name.....: dm-0
Device driver name.....: device-mapper
Type.....: disk partition
Disk layout.....: SCSI disk layout
Geometry - start.....: 2048
File system block size.....: 4096
Physical block size.....: 512
Device size in physical blocks..: 10074112
Building bootmap in '/boot/'
Building menu 'zipl-automatic-menu'
Adding #1: IPL section '5.14.0-55.el9.s390x' (default)
kernel image.....: /boot/vmlinuz-5.14.0-55.el9.s390x
kernel parmline...: 'root=/dev/mapper/vg_devel1-lv_root crashkernel=auto
rd.zfcp=0.0.fc00,0x5105074308c212e9,0x401040a000000000
rd.zfcp=0.0.fcd0,0x5105074308c2aee9,0x401040a000000000
rd.zfcp=0.0.fc00,0x5105074308c212e9,0x401040a300000000
rd.zfcp=0.0.fcd0,0x5105074308c2aee9,0x401040a300000000 rd.lvm.lv=vg_devel1/lv_root
rd.lvm.lv=vg_devel1/lv_swap cio_ignore=all,!condev
rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0'
initial ramdisk...: /boot/initramfs-5.14.0-55.el9.s390x.img component address:
kernel image....: 0x00010000-0x007a21ff
parmline.....: 0x00001000-0x000011ff
initial ramdisk.: 0x02000000-0x028f63ff
internal loader.: 0x0000a000-0x0000a3ff
Preparing boot device: dm-0.
Detected SCSI PCBIOS disk layout.
Writing SCSI master boot record.
Syncing disks...
Done.
```

22.8. FCP LUNS THAT ARE NOT PART OF THE ROOT FILE SYSTEM

FCP LUNs that are not part of the root file system, such as data disks, are persistently configured in the file **/etc/zfcp.conf**. It contains one FCP LUN per line. Each line contains the device bus ID of the FCP adapter, the target WWPN as 16 digit hexadecimal number prefixed with **0x**, and the FCP LUN prefixed with **0x** and padded with zeroes to the right to have 16 hexadecimal digits, separated by a space or tab.

The WWPN and FCP LUN values are only necessary if the **zFCP** device is not configured in NPIV mode, when **auto LUN** scanning is disabled by the **zfcp.allow_lun_scan=0** kernel module parameter or when installing RHEL-9.0 or older releases. Otherwise they can be omitted and only the device bus ID is mandatory.

Entries in **/etc/zfcp.conf** are activated and configured by udev when an FCP adapter is added to the system. At boot time, all FCP adapters visible to the system are added and trigger **udev**.

Example content of **/etc/zfcp.conf**:

```
0.0.fc00 0x5105074308c212e9 0x401040a000000000
0.0.fc00 0x5105074308c212e9 0x401040a100000000
0.0.fc00 0x5105074308c212e9 0x401040a300000000
```

```
0.0.fcd0 0x5105074308c2aee9 0x401040a000000000
0.0.fcd0 0x5105074308c2aee9 0x401040a100000000
0.0.fcd0 0x5105074308c2aee9 0x401040a300000000
0.0.4000
0.0.5000
```

Modifications of **/etc/zfcp.conf** only become effective after a reboot of the system or after the dynamic addition of a new FCP channel by changing the system's I/O configuration (for example, a channel is attached under z/VM). Alternatively, you can trigger the activation of a new entry in **/etc/zfcp.conf** for an FCP adapter which was previously not active, by executing the following commands:

1. Use the **zfcp_cio_free** utility to remove the FCP adapters from the list of ignored devices and make them visible to Linux:

```
# zfcp_cio_free
```

2. To apply the additions from **/etc/zfcp.conf** to the running system, issue:

```
# zfcpconf.sh
```

22.9. ADDING A QETH DEVICE

The **qeth** network device driver supports 64-bit IBM Z OSA-Express features in QDIO mode, HiperSockets, z/VM guest LAN, and z/VM VSWITCH.

For more information about the qeth device driver naming scheme, see Customizing boot parameters.

22.10. DYNAMICALLY ADDING A QETH DEVICE

This section contains information about how to add a **qeth** device dynamically.

Procedure

1. Determine whether the **qeth** device driver modules are loaded. The following example shows loaded **qeth** modules:

```
# lsmod | grep qeth
qeth_l3               69632  0
qeth_l2               49152  1
qeth                 131072  2 qeth_l3,qeth_l2
qdio                  65536  3 qeth,qeth_l3,qeth_l2
ccwgroup              20480  1 qeth
```

If the output of the **lsmod** command shows that the **qeth** modules are not loaded, run the **modprobe** command to load them:

```
# modprobe qeth
```

2. Use the **cio_ignore** utility to remove the network channels from the list of ignored devices and make them visible to Linux:

```
# cio_ignore -r read_device_bus_id,write_device_bus_id,data_device_bus_id
```

Replace *read_device_bus_id*,*write_device_bus_id*,*data_device_bus_id* with the three device bus IDs representing a network device. For example, if the *read_device_bus_id* is **0.0.f500**, the *write_device_bus_id* is **0.0.f501**, and the *data_device_bus_id* is **0.0.f502**:

```
# cio_ignore -r 0.0.f500,0.0.f501,0.0.f502
```

3. Use the **znetconf** utility to sense and list candidate configurations for network devices:

```
# znetconf -u
Scanning for network devices...
Device IDs                Type    Card Type      CHPID Drv.
------------------------------------------------------------
0.0.f500,0.0.f501,0.0.f502 1731/01 OSA (QDIO)       00 qeth
0.0.f503,0.0.f504,0.0.f505 1731/01 OSA (QDIO)       01 qeth
0.0.0400,0.0.0401,0.0.0402 1731/05 HiperSockets     02 qeth
```

4. Select the configuration you want to work with and use **znetconf** to apply the configuration and to bring the configured group device online as network device.

```
# znetconf -a f500
Scanning for network devices...
Successfully configured device 0.0.f500 (encf500)
```

5. Optional: You can also pass arguments that are configured on the group device before it is set online:

```
# znetconf -a f500 -o portname=myname
Scanning for network devices...
Successfully configured device 0.0.f500 (encf500)
```

Now you can continue to configure the **encf500** network interface.

Alternatively, you can use **sysfs** attributes to set the device online as follows:

1. Create a **qeth** group device:

```
# echo read_device_bus_id,write_device_bus_id,data_device_bus_id >
/sys/bus/ccwgroup/drivers/qeth/group
```

For example:

```
# echo 0.0.f500,0.0.f501,0.0.f502 > /sys/bus/ccwgroup/drivers/qeth/group
```

2. Next, verify that the **qeth** group device was created properly by looking for the read channel:

```
# ls /sys/bus/ccwgroup/drivers/qeth/0.0.f500
```

You can optionally set additional parameters and features, depending on the way you are setting up your system and the features you require, such as:

- **portno**
- **layer2**

- **portname**

3. Bring the device online by writing **1** to the online **sysfs** attribute:

```
# echo 1 > /sys/bus/ccwgroup/drivers/qeth/0.0.f500/online
```

4. Then verify the state of the device:

```
# cat /sys/bus/ccwgroup/drivers/qeth/0.0.f500/online
1
```

A return value of **1** indicates that the device is online, while a return value **0** indicates that the device is offline.

5. Find the interface name that was assigned to the device:

```
# cat /sys/bus/ccwgroup/drivers/qeth/0.0.f500/if_name
encf500
```

Now you can continue to configure the **encf500** network interface.

The following command from the **s390utils** package shows the most important settings of your **qeth** device:

```
# lsqeth encf500
Device name                    : encf500
------------------------------------------------
card_type               : OSD_1000
cdev0                   : 0.0.f500
cdev1                   : 0.0.f501
cdev2                   : 0.0.f502
chpid                   : 76
online                  : 1
portname                : OSAPORT
portno                  : 0
state                   : UP (LAN ONLINE)
priority_queueing       : always queue 0
buffer_count            : 16
layer2                  : 1
isolation               : none
```

22.11. PERSISTENTLY ADDING A QETH DEVICE

To make a new **qeth** device persistent, create a configuration file for the new interface. The network interface configuration files are placed in the **/etc/NetworkManager/system-connections/** directory.

The network configuration files use the naming convention *device*.nmconnection, where *device* is the value found in the interface-name file in the *qeth* group device that was created earlier, for example *enc9a0*. The *cio_ignore* commands are handled transparently for persistent device configurations and you do not need to free devices from the ignore list manually.

If a configuration file for another device of the same type already exists, copy it to the new name and edit it:

```
# cd /etc/NetworkManager/system-connections/
# cp enc9a0.nmconnection enc600.nmconnection
```

To learn IDs of your network devices, use the *lsqeth* utility:

```
# lsqeth -p
devices                  CHPID interface        cardtype       port chksum prio-q'ing rtr4 rtr6 lay'2 cnt
-------------------------- ----- ---------------- -------------- ---- ------ ---------- ---- ---- ----- -----
0.0.09a0/0.0.09a1/0.0.09a2 x00   enc9a0    Virt.NIC QDIO  0    sw     always_q_2 n/a  n/a  1     64
0.0.0600/0.0.0601/0.0.0602 x00   enc600    Virt.NIC QDIO  0    sw     always_q_2 n/a  n/a  1     64
```

If you do not have a similar device defined, create a new file. Use this example:

```
[connection]
type=ethernet
interface-name=enc600

[ipv4]
address1=10.12.20.136/24,10.12.20.1
dns=10.12.20.53;
method=manual

[ethernet]
mac-address=00:53:00:8f:fa:66
```

Edit the new *enc600.nmconnection* file as follows:

1. Ensure the new connection file is owned by **root:root**:

   ```
   # chown root:root /etc/NetworkManager/system-connections/enc600.nmconnection
   ```

2. Add more details in this file or modify these parameters based on your connection requirements.

3. Save the file.

4. Reload the connection profile:

   ```
   # nmcli connection reload
   ```

5. To view complete details of the connection newly added, enter:

   ```
   # nmcli connection show enc600
   ```

Changes to the *enc600.nmconnection* file become effective after either rebooting the system, dynamic addition of new network device channels by changing the system's I/O configuration (for example, attaching under z/VM), or reloading network connections. Alternatively, you can trigger the activation of *enc600.nmconnection* for network channels, which were previously not active yet, by executing the following commands:

1. Use the **cio_ignore** utility to remove the network channels from the list of ignored devices and make them visible to Linux:

   ```
   # cio_ignore -r read_device_bus_id,write_device_bus_id,data_device_bus_id
   ```

Replace *read_device_bus_id*, *write_device_bus_id*, *data_device_bus_id* with the three device bus IDs representing a network device. For example, if the *read_device_bus_id* is **0.0.0600**, the *write_device_bus_id* is **0.0.0601**, and the *data_device_bus_id* is **0.0.0602**:

```
#  cio_ignore -r 0.0.0600,0.0.0601,0.0.0602
```

2. To trigger the uevent that activates the change, issue:

```
# echo add > /sys/bus/ccw/devices/read-channel/uevent
```

For example:

```
# echo add > /sys/bus/ccw/devices/0.0.0600/uevent
```

3. Check the status of the network device:

```
# lsqeth
```

4. If the default route information has changed, you must also update the *ipaddress1* parameters in both the **[ipv4]** and **[ipv6]** sections of the **/etc/NetworkManager/system-connections/<profile_name>.nmconnection** file accordingly:

```
[ipv4]
address1=10.12.20.136/24,10.12.20.1
[ipv6]
address1=2001:db8:1::1,2001:db8:1::fffe
```

5. Now start the new interface:

```
# nmcli connection up enc600
```

6. Check the status of the interface:

```
# ip addr show enc600
3: enc600:  <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state
UP group default qlen 1000
link/ether 3c:97:0e:51:38:17 brd ff:ff:ff:ff:ff:ff
10.12.20.136/24 brd 10.12.20.1 scope global dynamic enc600
valid_lft 81487sec preferred_lft 81487sec
inet6 1574:12:5:1185:3e97:eff:fe51:3817/64 scope global noprefixroute dynamic
valid_lft 2591994sec preferred_lft 604794sec
inet6 fe45::a455:eff:d078:3847/64 scope link
valid_lft forever preferred_lft forever
```

7. Check the routing for the new interface:

```
# ip route
default via 10.12.20.136 dev enc600 proto dhcp src
```

8. Verify your changes by using the **ping** utility to ping the gateway or another host on the subnet of the new device:

```
# ping -c 1 10.12.20.136
PING 10.12.20.136 (10.12.20.136) 56(84) bytes of data.
64 bytes from 10.12.20.136: icmp_seq=0 ttl=63 time=8.07 ms
```

9. If the default route information has changed, you must also update **/etc/sysconfig/network** accordingly.

Additional resources

- **nm-settings-keyfile** man page on your system

22.12. CONFIGURING AN 64-BIT IBM Z NETWORK DEVICE FOR NETWORK ROOT FILE SYSTEM

To add a network device that is required to access the root file system, you only have to change the boot options. The boot options can be in a parameter file, however, the **/etc/zipl.conf** file no longer contains specifications of the boot records. The file that needs to be modified can be located using the following commands:

```
# machine_id=$(cat /etc/machine-id)
# kernel_version=$(uname -r)
# ls /boot/loader/entries/$machine_id-$kernel_version.conf
```

Dracut, the **mkinitrd** successor that provides the functionality in the initramfs that in turn replaces **initrd**, provides a boot parameter to activate network devices on 64-bit IBM Z early in the boot process: **rd.znet=**.

As input, this parameter takes a comma-separated list of the **NETTYPE** (qeth, lcs, ctc), two (lcs, ctc) or three (qeth) device bus IDs, and optional additional parameters consisting of key-value pairs corresponding to network device sysfs attributes. This parameter configures and activates the 64-bit IBM Z network hardware. The configuration of IP addresses and other network specifics works the same as for other platforms. See the **dracut** documentation for more details.

The **cio_ignore** commands for the network channels are handled transparently on boot.

Example boot options for a root file system accessed over the network through NFS:

```
root=10.16.105.196:/nfs/nfs_root cio_ignore=all,!condev
rd.znet=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0,portname=OSAPORT
ip=10.16.105.197:10.16.105.196:10.16.111.254:255.255.248.0:nfs-server.subdomain.domain:enc9a0:n
one rd_NO_LUKS rd_NO_LVM rd_NO_MD rd_NO_DM LANG=en_US.UTF-8
SYSFONT=latarcyrheb-sun16 KEYTABLE=us
```

CHAPTER 23. SECURING YOUR SYSTEM

You must secure your Red Hat Enterprise Linux system after completing the installation process.

Prerequisites

- You have completed the graphical installation.

Procedure

1. To update your system, run the following command as root:

```
# dnf update
```

2. Even though the firewall service, **firewalld**, is automatically enabled with the installation of Red Hat Enterprise Linux, there are scenarios where it might be explicitly disabled, for example in a Kickstart configuration. In that scenario, you re-enable the firewall.
To start **firewalld**, run the following commands as root:

```
# systemctl start firewalld
# systemctl enable firewalld
```

3. To enhance security, disable services that you do not need. For example, if your system has no printers installed, disable the cups service using the following command:

```
# systemctl mask cups
```

To review active services, run the following command:

```
$ systemctl list-units | grep service
```

PART IV. APPENDICES

Tools and techniques to help identify, analyze, and address potential problems. It also covers best practices for reporting bugs, ensuring that issues are clearly communicated for prompt resolution.

APPENDIX A. TOOLS AND TIPS FOR TROUBLESHOOTING AND BUG REPORTING

The troubleshooting information in the following sections might be helpful when diagnosing issues at the start of the installation process. The following sections are for all supported architectures. However, if an issue is for a particular architecture, it is specified at the start of the section.

A.1. DRACUT

Dracut is a tool that manages the **initramfs** image during the Linux operating system boot process. The **dracut** emergency shell is an interactive mode that can be initiated while the **initramfs** image is loaded. You can run basic troubleshooting commands from the **dracut** emergency shell. For more information, see the **Troubleshooting** section of the **dracut** man page on your system.

A.2. USING INSTALLATION LOG FILES

For debugging purposes, the installation program logs installation actions in files that are located in the **/tmp** directory. These log files are listed in the following table.

Table A.1. Log files generated during the installation

Log file	Contents
/tmp/anaconda.log	General messages.
/tmp/program.log	All external programs run during the installation.
/tmp/storage.log	Extensive storage module information.
/tmp/packaging.log	dnf and rpm package installation messages.
/tmp/dbus.log	Information about the **dbus** session that is used for installation program modules.
/tmp/sensitive-info.log	Configuration information that is not part of other logs and not copied to the installed system.
/tmp/syslog	Hardware-related system messages. This file contains messages from other Anaconda files.

If the installation fails, the messages are consolidated into **/tmp/anaconda-tb-identifier**, where identifier is a random string. After a successful installation, these files are copied to the installed system under the directory **/var/log/anaconda/**. However, if the installation is unsuccessful, or if the **inst.nosave=all** or **inst.nosave=logs** options are used when booting the installation system, these logs only exist in the installation program's RAM disk. This means that the logs are not saved permanently and are lost when the system is powered down. To store them permanently, copy the files to another system on the network or copy them to a mounted storage device such as a USB flash drive.

A.2.1. Creating pre-installation log files

Use this procedure to set the **inst.debug** option to create log files before the installation process starts. These log files contain, for example, the current storage configuration.

Prerequisites

- The Red Hat Enterprise Linux boot menu is open.

Procedure

1. Select the **Install Red Hat Enterprise Linux**option from the boot menu.
2. Press the **Tab** key on BIOS-based systems or the **e** key on UEFI-based systems to edit the selected boot options.
3. Append **inst.debug** to the options. For example:

```
vmlinuz ... inst.debug
```

4. Press the **Enter** key on your keyboard. The system stores the pre-installation log files in the **/tmp/pre-anaconda-logs/** directory before the installation program starts.
5. To access the log files, switch to the console.
6. Change to the **/tmp/pre-anaconda-logs/** directory:

```
# cd /tmp/pre-anaconda-logs/
```

Additional resources

- Boot options reference
- Console logging during installation

A.2.2. Transferring installation log files to a USB drive

Use this procedure to transfer installation log files to a USB drive.

Prerequisites

- You have backed up data from the USB drive.
- You are logged into a root account and you have access to the installation program's temporary file system.

Procedure

1. Press **Ctrl** + **Alt** + **F2** to access a shell prompt on the system you are installing.
2. Connect a USB flash drive to the system and run the **dmesg** command:

```
# dmesg
```

A log detailing all recent events is displayed. At the end of this log, a set of messages is displayed. For example:

```
[ 170.171135] sd 5:0:0:0: [sdb] Attached SCSI removable disk
```

3. Note the name of the connected device. In the above example, it is **sdb**.
4. Navigate to the **/mnt** directory and create a new directory that serves as the mount target for the USB drive. This example uses the name **usb**:

```
# mkdir usb
```

5. Mount the USB flash drive onto the newly created directory. In most cases, you do not want to mount the whole drive, but a partition on it. Do not use the name **sdb**, use the name of the partition you want to write the log files to. In this example, the name **sdb1** is used:

```
# mount /dev/sdb1 /mnt/usb
```

6. Verify that you mounted the correct device and partition by accessing it and listing its contents:

```
# cd /mnt/usb
```

```
# ls
```

7. Copy the log files to the mounted device.

```
# cp /tmp/*log /mnt/usb
```

8. Unmount the USB flash drive. If you receive an error message that the target is busy, change your working directory to outside the mount (for example, /).

```
# umount /mnt/usb
```

A.2.3. Transferring installation log files over the network

Use this procedure to transfer installation log files over the network.

Prerequisites

- You are logged into a root account and you have access to the installation program's temporary file system.

Procedure

1. Press **Ctrl** + **Alt** + **F2** to access a shell prompt on the system you are installing.
2. Switch to the **/tmp** directory where the log files are located:

```
# cd /tmp
```

3. Copy the log files onto another system on the network using the **scp** command:

```
# scp *log user@address:path
```

a. Replace **user** with a valid user name on the target system, **address** with the target system's address or host name, and **path** with the path to the directory where you want to save the log files. For example, if you want to log in as **john** on a system with an IP address of 192.168.0.122 and place the log files into the /**home**/**john**/**logs**/ directory on that system, the command is as follows:

```
# scp *log john@192.168.0.122:/home/john/logs/
```

When connecting to the target system for the first time, the SSH client asks you to confirm that the fingerprint of the remote system is correct and that you want to continue:

```
The authenticity of host '192.168.0.122 (192.168.0.122)' can't be established.
ECDSA key fingerprint is a4:60:76:eb:b2:d0:aa:23:af:3d:59:5c:de:bb:c4:42.
Are you sure you want to continue connecting (yes/no)?
```

b. Type **yes** and press **Enter** to continue. Provide a valid password when prompted. The files are transferred to the specified directory on the target system.

A.3. DETECTING MEMORY FAULTS USING THE MEMTEST86 APPLICATION

Faults in memory (RAM) modules can cause your system to fail unpredictably. In certain situations, memory faults might only cause errors with particular combinations of software. For this reason, you should test your system's memory before you install Red Hat Enterprise Linux.

Red Hat Enterprise Linux includes the **Memtest86+** memory testing application for BIOS systems only. Support for UEFI systems is currently unavailable.

A.3.1. Running Memtest86

Use this procedure to run the **Memtest86** application to test your system's memory for faults before you install Red Hat Enterprise Linux.

Prerequisites

- You have accessed the Red Hat Enterprise Linux boot menu.

Procedure

1. From the Red Hat Enterprise Linux boot menu, select **Troubleshooting > Run a memory test** The **Memtest86** application window is displayed and testing begins immediately. By default, **Memtest86** performs ten tests in every pass. After the first pass is complete, a message is displayed in the lower part of the window informing you of the current status. Another pass starts automatically.
   If **Memtest86+** detects an error, the error is displayed in the central pane of the window and is highlighted in red. The message includes detailed information such as which test detected a problem, the memory location that is failing, and others. In most cases, a single successful pass of all 10 tests is sufficient to verify that your RAM is in good condition. In rare circumstances, however, errors that went undetected during the first pass might appear on subsequent passes. To perform a thorough test on important systems, run the tests overnight or for a few days to complete multiple passes.

The amount of time it takes to complete a single full pass of **Memtest86+** varies depending on your system's configuration, notably the RAM size and speed. For example, on a system with 2 GiB of DDR2 memory at 667 MHz, a single pass takes 20 minutes to complete.

2. Optional: Follow the on-screen instructions to access the **Configuration** window and specify a different configuration.

3. To halt the tests and reboot your computer, press the **Esc** key at any time.

Additional resources

- How to use **Memtest86**

A.4. VERIFYING BOOT MEDIA

Verifying ISO images helps to avoid problems that are sometimes encountered during installation. These sources include DVD and ISO images stored on a disk or NFS server. Use this procedure to test the integrity of an ISO-based installation source before using it to install Red Hat Enterprise Linux.

Prerequisites

- You have accessed the Red Hat Enterprise Linux boot menu.

Procedure

1. From the boot menu, select **Test this media & install Red Hat Enterprise Linux 9**to test the boot media.

2. The boot process tests the media and highlights any issues.

3. Optional: You can start the verification process by appending **rd.live.check** to the boot command line.

A.5. CONSOLES AND LOGGING DURING INSTALLATION

The Red Hat Enterprise Linux installer uses the **tmux** terminal multiplexer to display and control several windows in addition to the main interface. Each of these windows serve a different purpose; they display several different logs, which can be used to troubleshoot issues during the installation process. One of the windows provides an interactive shell prompt with **root** privileges, unless this prompt was specifically disabled using a boot option or a Kickstart command.

The terminal multiplexer is running in virtual console 1. To switch from the actual installation environment to **tmux**, press **Ctrl**+**Alt**+**F1**. To go back to the main installation interface which runs in virtual console 6, press **Ctrl**+**Alt**+**F6**. During the text mode installation, start in virtual console 1 (**tmux**), and switching to console 6 will open a shell prompt instead of a graphical interface.

The console running **tmux** has five available windows; their contents are described in the following table, along with keyboard shortcuts. Note that the keyboard shortcuts are two-part: first press **Ctrl**+**b**, then release both keys, and press the number key for the window you want to use.

You can also use **Ctrl**+**b n**, **Alt+ Tab**, and **Ctrl**+**b p** to switch to the next or previous **tmux** window, respectively.

Table A.2. Available tmux windows

Shortcut	Contents
Ctrl+b 1	Main installation program window. Contains text-based prompts (during text mode installation or if you use VNC direct mode), and also some debugging information.
Ctrl+b 2	Interactive shell prompt with **root** privileges.
Ctrl+b 3	Installation log; displays messages stored in **/tmp/anaconda.log**.
Ctrl+b 4	Storage log; displays messages related to storage devices and configuration, stored in **/tmp/storage.log**.
Ctrl+b 5	Program log; displays messages from utilities executed during the installation process, stored in **/tmp/program.log**.

A.6. SAVING SCREENSHOTS

You can press **Shift+Print Screen** at any time during the graphical installation to capture the current screen. The screenshots are saved to **/tmp/anaconda-screenshots**.

A.7. DISPLAY SETTINGS AND DEVICE DRIVERS

Some video cards have trouble booting into the Red Hat Enterprise Linux graphical installation program. If the installation program does not run using its default settings, it attempts to run in a lower resolution mode. If that fails, the installation program attempts to run in text mode.

There are several possible solutions to resolve display issues, most of which involve specifying custom boot options:

For more information, see Console boot options.

Table A.3. Solutions

Solution	Description
Use the text mode	You can attempt to perform the installation using the text mode. For details, refer to Installing RHEL in text mode.
Specify the display resolution manually	If the installation program fails to detect your screen resolution, you can override the automatic detection and specify it manually. To do this, append the **inst.resolution=x** option at the boot menu, where **x** is your display's resolution, for example, 1024x768.

Solution	Description
Use an alternate video driver	You can attempt to specify a custom video driver, overriding the installation program's automatic detection. To specify a driver, use the **inst.xdriver=x** option, where **x** is the device driver you want to use (for example, nouveau)*.
Perform the installation using VNC	If the above options fail, you can use a separate system to access the graphical installation over the network, using the Virtual Network Computing (VNC) protocol. For details on installing using VNC, see the *Preparing a remote installation by using VNC*.

- If specifying a custom video driver solves your problem, you should report it as a bug in Jira. The installation program should be able to detect your hardware automatically and use the appropriate driver without intervention.

APPENDIX B. TROUBLESHOOTING

The troubleshooting information in the following sections might be helpful when diagnosing issues after the installation process. The following sections are for all supported architectures. However, if an issue is for a particular architecture, it is specified at the start of the section.

B.1. RESUMING AN INTERRUPTED DOWNLOAD ATTEMPT

You can resume an interrupted download using the **curl** command.

Prerequisite

- You have navigated to the **Product Downloads** section of the Red Hat Customer Portal at https://access.redhat.com/downloads, and selected the required variant, version, and architecture.
- You have right-clicked on the required ISO file, and selected **Copy Link Location** to copy the URL of the ISO image file to your clipboard.

Procedure

1. Download the ISO image from the new link. Add the **--continue-at -** option to automatically resume the download:

```
$ curl --output directory-path/filename.iso 'new_copied_link_location' --continue-at -
```

2. Use a checksum utility such as **sha256sum** to verify the integrity of the image file after the download finishes:

```
$ sha256sum rhel-x.x-x86_64-dvd.iso
  `85a...46c rhel-x.x-x86_64-dvd.iso`
```

   Compare the output with reference checksums provided on the Red Hat Enterprise Linux **Product Download** web page.

Example B.1. Resuming an interrupted download attempt

The following is an example of a **curl** command for a partially downloaded ISO image:

```
$ curl --output _rhel-x.x-x86_64-dvd.iso
'https://access.cdn.redhat.com//content/origin/files/sha256/85/85a...46c/rhel-x.x-x86_64-dvd.iso?
_auth=141...963' --continue-at -
```

B.2. DISKS ARE NOT DETECTED

If the installation program cannot find a writable storage device to install to, it returns the following error message in the **Installation Destination** window: **No disks detected. Please shut down the computer, connect at least one disk, and restart to complete installation.**

Check the following items:

- Your system has at least one storage device attached.

- If your system uses a hardware RAID controller; verify that the controller is properly configured and working as expected. See your controller's documentation for instructions.
- If you are installing into one or more iSCSI devices and there is no local storage present on the system, verify that all required LUNs are presented to the appropriate Host Bus Adapter (HBA).

If the error message is still displayed after rebooting the system and starting the installation process, the installation program failed to detect the storage. In many cases the error message is a result of attempting to install on an iSCSI device that is not recognized by the installation program.

In this scenario, you must perform a driver update before starting the installation. Check your hardware vendor's website to determine if a driver update is available. For more general information about driver updates, see the *Updating drivers during installation*.

You can also consult the Red Hat Hardware Compatibility List, available at https://access.redhat.com/ecosystem/search/#/category/Server.

B.3. CANNOT BOOT WITH A RAID CARD

If you cannot boot your system after the installation, you might need to reinstall and repartition your system's storage. Some BIOS types do not support booting from RAID cards. After you finish the installation and reboot the system for the first time, a text-based screen displays the boot loader prompt (for example, **grub>**) and a flashing cursor might be displayed. If this is the case, you must repartition your system and move your **/boot** partition and the boot loader outside of the RAID array. The **/boot** partition and the boot loader must be on the same drive. Once these changes have been made, you should be able to finish your installation and boot the system properly.

B.4. GRAPHICAL BOOT SEQUENCE IS NOT RESPONDING

When rebooting your system for the first time after installation, the system might be unresponsive during the graphical boot sequence. If this occurs, a reset is required. In this scenario, the boot loader menu is displayed successfully, but selecting any entry and attempting to boot the system results in a halt. This usually indicates that there is a problem with the graphical boot sequence. To resolve the issue, you must disable the graphical boot by temporarily altering the setting at boot time before changing it permanently.

Procedure: Disabling the graphical boot temporarily

1. Start your system and wait until the boot loader menu is displayed. If you set your boot timeout period to **0**, press the **Esc** key to access it.
2. From the boot loader menu, use your cursor keys to highlight the entry you want to boot. Press the **Tab** key on BIOS-based systems or the **e** key on UEFI-based systems to edit the selected entry options.
3. In the list of options, find the kernel line - that is, the line beginning with the keyword **linux**. On this line, locate and delete **rhgb**.
4. Press **F10** or **Ctrl**+**X** to boot your system with the edited options.

If the system started successfully, you can log in normally. However, if you do not disable graphical boot permanently, you must perform this procedure every time the system boots.

Procedure: Disabling the graphical boot permanently

1. Log in to the root account on your system.
2. Use the grubby tool to find the default GRUB2 kernel:

```
# grubby --default-kernel
/boot/vmlinuz-4.18.0-94.el8.x86_64
```

3. Use the grubby tool to remove the **rhgb** boot option from the default kernel in your GRUB2 configuration. For example:

```
# grubby --remove-args="rhgb" --update-kernel /boot/vmlinuz-4.18.0-94.el8.x86_64
```

4. Reboot the system. The graphical boot sequence is no longer used. If you want to enable the graphical boot sequence, follow the same procedure, replacing the **--remove-args="rhgb"** parameter with the **--args="rhgb"** parameter. This restores the **rhgb** boot option to the default kernel in your GRUB2 configuration.

B.5. X SERVER FAILS AFTER LOG IN

An X server is a program in the X Window System that runs on local machines, that is, the computers used directly by users. X server handles all access to the graphics cards, display screens and input devices, typically a keyboard and mouse on those computers. The X Window System, often referred to as X, is a complete, cross-platform and free client-server system for managing GUIs on single computers and on networks of computers. The client-server model is an architecture that divides the work between two separate but linked applications, referred to as clients and servers.*

If X server crashes after login, one or more of the file systems might be full. To troubleshoot the issue, execute the following command:

```
$ df -h
```

The output verifies which partition is full - in most cases, the problem is on the /**home** partition. The following is a sample output of the **df** command:

```
Filesystem                Size  Used Avail Use% Mounted on
devtmpfs                  396M     0  396M   0%  /dev
tmpfs                     411M     0  411M   0%  /dev/shm
tmpfs                     411M  6.7M  405M   2%  /run
tmpfs                     411M     0  411M   0%  /sys/fs/cgroup
/dev/mapper/rhel-root          17G    4.1G  13G   25% /
/dev/sda1                 1014M  173M 842M  17% /boot
tmpfs                     83M    20K   83M   1%  /run/user/42
tmpfs                     83M    84K  83M    1%  /run/user/1000
/dev/dm-4                   90G    90G    0  100% /home
```

In the example, you can see that the /**home** partition is full, which causes the failure. Remove any unwanted files. After you free up some disk space, start X using the **startx** command. For additional information about **df** and an explanation of the options available, such as the **-h** option used in this example, see the **df(1)** man page on your system.

*Source: http://www.linfo.org/x_server.html

B.6. RAM IS NOT RECOGNIZED

In some scenarios, the kernel does not recognize all memory (RAM), which causes the system to use less memory than is installed. If the total amount of memory that your system reports does not match your expectations, it is likely that at least one of your memory modules is faulty. On BIOS-based systems, you can use the **Memtest86+** utility to test your system's memory.

Some hardware configurations have part of the system's RAM reserved, and as a result, it is unavailable to the system. Some laptop computers with integrated graphics cards reserve a portion of memory for the GPU. For example, a laptop with 4 GiB of RAM and an integrated Intel graphics card shows roughly 3.7 GiB of available memory. Additionally, the **kdump** crash kernel dumping mechanism, which is enabled by default on most Red Hat Enterprise Linux systems, reserves some memory for the secondary kernel used in case of a primary kernel failure. This reserved memory is not displayed as available.

Use this procedure to manually set the amount of memory.

Procedure

1. Check the amount of memory that your system currently reports in MiB:

```
$ free -m
```

2. Reboot your system and wait until the boot loader menu is displayed.
   If your boot timeout period is set to **0**, press the **Esc** key to access the menu.

3. From the boot loader menu, use your cursor keys to highlight the entry you want to boot, and press the **Tab** key on BIOS-based systems or the **e** key on UEFI-based systems to edit the selected entry options.

4. In the list of options, find the kernel line: that is, the line beginning with the keyword **linux**. Append the following option to the end of this line:

```
mem=xxM
```

5. Replace ***xx*** with the amount of RAM you have in MiB.

6. Press **F10** or **Ctrl**+**X** to boot your system with the edited options.

7. Wait for the system to boot, log in, and open a command line.

8. Check the amount of memory that your system reports in MiB:

```
$ free -m
```

9. If the total amount of RAM displayed by the command now matches your expectations, make the change permanent:

```
# grubby --update-kernel=ALL --args="mem=xxM"
```

B.7. SYSTEM IS DISPLAYING SIGNAL 11 ERRORS

A signal 11 error, commonly known as a segmentation fault means that a program accessed a memory location that it was not assigned. A signal 11 error can occur due to a bug in one of the software programs that are installed, or faulty hardware. If you receive a signal 11 error during the installation process, verify that you are using the most recent installation images and prompt the installation program to verify them to ensure they are not corrupt.

For more information, see Verifying Boot media.

Faulty installation media (such as an improperly burned or scratched optical disk) are a common cause of signal 11 errors. Verify the integrity of the installation media before every installation. For information about obtaining the most recent installation media, refer to Product Downloads page.

To perform a media check before the installation starts, append the **rd.live.check** boot option at the boot menu. If you performed a media check without any errors and you still have issues with segmentation faults, it usually indicates that your system encountered a hardware error. In this scenario, the problem is most likely in the system's memory (RAM). This can be a problem even if you previously used a different operating system on the same computer without any errors.

NOTE

For AMD and Intel 64-bit and 64-bit ARM architectures: On BIOS-based systems, you can use the **Memtest86+** memory testing module included on the installation media to perform a thorough test of your system's memory. For more information, see Detecting memory faults using the Memtest86 application.

Other possible causes are beyond this document's scope. Consult your hardware manufacturer's documentation and also see the Red Hat Hardware Compatibility List, available online at https://access.redhat.com/ecosystem/search/#/category/Server.

B.8. UNABLE TO IPL FROM NETWORK STORAGE SPACE ON IBM POWER SYSTEMS

If you experience difficulties when trying to IPL from Network Storage Space (*NWSSTG), it is most likely due to a missing PReP partition. In this scenario, you must reinstall the system and create this partition during the partitioning phase or in the Kickstart file.

B.9. USING XDMCP

There are scenarios where you have installed the X Window System and want to log in to your Red Hat Enterprise Linux system using a graphical login manager. Use this procedure to enable the X Display Manager Control Protocol (XDMCP) and remotely log in to a desktop environment from any X-compatible client, such as a network-connected workstation or X11 terminal.

NOTE

XDMCP is not supported by the Wayland protocol.

Procedure

1. Open the **/etc/gdm/custom.conf** configuration file in a plain text editor such as **vi** or **nano**.
2. In the **custom.conf** file, locate the section starting with **[xdmcp]**. In this section, add the following line:

```
Enable=true
```

3. If you are using XDMCP, ensure that **WaylandEnable=false** is present in the **/etc/gdm/custom.conf** file.

4. Save the file and exit the text editor.
5. Restart the X Window System. To do this, either reboot the system, or restart the GNOME Display Manager using the following command as root:

```
# systemctl restart gdm.service
```

WARNING

Restarting the **gdm** service terminates all currently running GNOME sessions of all desktop users who are logged in. This might result in users losing unsaved data.

1. Wait for the login prompt and log in using your user name and password. The X Window System is now configured for XDMCP. You can connect to it from another workstation (client) by starting a remote X session using the X command on the client workstation. For example:

```
$ X :1 -query address
```

2. Replace **address** with the host name of the remote X11 server. The command connects to the remote X11 server using XDMCP and displays the remote graphical login screen on display :1 of the X11 server system (usually accessible by pressing **Ctrl-Alt-F8**). You can also access remote desktop sessions using a nested X11 server, which opens the remote desktop as a window in your current X11 session. You can use Xnest to open a remote desktop nested in a local X11 session. For example, run Xnest using the following command, replacing address with the host name of the remote X11 server:

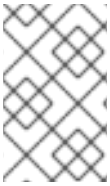
```
$ Xnest :1 -query address
```

Additional resources

- X Window System documentation

B.10. USING RESCUE MODE

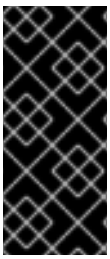
The installation program's rescue mode is a minimal Linux environment that can be booted from the Red Hat Enterprise Linux DVD or other boot media. It contains command-line utilities for repairing a wide variety of issues. Rescue mode can be accessed from the **Troubleshooting** menu of the boot menu. In this mode, you can mount file systems as read-only, blacklist or add a driver provided on a driver disc, install or upgrade system packages, or manage partitions.



NOTE

The installation program's rescue mode is different from rescue mode (an equivalent to single-user mode) and emergency mode, which are provided as parts of the **systemd** system and service manager.

To boot into rescue mode, you must be able to boot the system using one of the Red Hat Enterprise Linux boot media, such as a minimal boot disc or USB drive, or a full installation DVD.



IMPORTANT

Advanced storage, such as iSCSI or zFCP devices, must be configured either using **dracut** boot options such as **rd.zfcp=** or **root=iscsi:** *options*, or in the CMS configuration file on 64-bit IBM Z. It is not possible to configure these storage devices interactively after booting into rescue mode. For information about **dracut** boot options, see the **dracut.cmdline(7)** man page on your system.

B.10.1. Booting into rescue mode

This procedure describes how to boot into rescue mode.

Procedure

1. Boot the system from either minimal boot media, or a full installation DVD or USB drive, and wait for the boot menu to be displayed.
2. From the boot menu, either select **Troubleshooting** > **Rescue a Red Hat Enterprise Linux system** option, or append the **inst.rescue** option to the boot command line. To enter the boot command line, press the **Tab** key on BIOS-based systems or the **e** key on UEFI-based systems.
3. Optional: If your system requires a third-party driver provided on a driver disc to boot, append the **inst.dd=driver_name** to the boot command line:

```
inst.rescue inst.dd=driver_name
```

4. Optional: If a driver that is part of the Red Hat Enterprise Linux distribution prevents the system from booting, append the **modprobe.blacklist=** option to the boot command line:

```
inst.rescue modprobe.blacklist=driver_name
```

5. Press **Enter** (BIOS-based systems) or **Ctrl**+**X** (UEFI-based systems) to boot the modified option. Wait until the following message is displayed:

```
The rescue environment will now attempt to find your Linux installation and mount it under the
directory: /mnt/sysroot/. You can then make any changes required to your system. Choose 1
to proceed with this step. You can choose to mount your file systems read-only instead of
read-write by choosing 2. If for some reason this process does not work choose 3 to skip
directly to a shell.

1) Continue
2) Read-only mount
3) Skip to shell
4) Quit (Reboot)
```

If you select **1**, the installation program attempts to mount your file system under the directory **/mnt/sysroot/**. You are notified if it fails to mount a partition. If you select **2**, it attempts to mount your file system under the directory **/mnt/sysroot/**, but in read-only mode. If you select **3**, your file system is not mounted.

For the system root, the installer supports two mount points **/mnt/sysimage** and **/mnt/sysroot**.

The **/mnt/sysroot** path is used to mount / of the target system. Usually, the physical root and the system root are the same, so **/mnt/sysroot** is attached to the same file system as **/mnt/sysimage**. The only exceptions are rpm-ostree systems, where the system root changes based on the deployment. Then, **/mnt/sysroot** is attached to a subdirectory of **/mnt/sysimage**. Use **/mnt/sysroot** for chroot.

6. Select **1** to continue. Once your system is in rescue mode, a prompt appears on VC (virtual console) 1 and VC 2. Use the **Ctrl+Alt+F1** key combination to access VC 1 and **Ctrl+Alt+F2** to access VC 2:

```
sh-4.2#
```

7. Even if your file system is mounted, the default root partition while in rescue mode is a temporary root partition, not the root partition of the file system used during normal user mode (**multi-user.target** or **graphical.target**). If you selected to mount your file system and it mounted successfully, you can change the root partition of the rescue mode environment to the root partition of your file system by executing the following command:

```
sh-4.2# chroot /mnt/sysroot
```

This is useful if you need to run commands, such as **rpm**, that require your root partition to be mounted as /. To exit the chroot environment, type **exit** to return to the prompt.

8. If you selected **3**, you can still try to mount a partition or LVM2 logical volume manually inside rescue mode by creating a directory, such as **/directory/**, and typing the following command:

```
sh-4.2# mount -t xfs /dev/mapper/VolGroup00-LogVol02 /directory
```

In the above command, **/directory/** is the directory that you created and **/dev/mapper/VolGroup00-LogVol02** is the LVM2 logical volume you want to mount. If the partition is a different type than XFS, replace the xfs string with the correct type (such as ext4).

9. If you do not know the names of all physical partitions, use the following command to list them:

```
sh-4.2# fdisk -l
```

If you do not know the names of all LVM2 physical volumes, volume groups, or logical volumes, use the **pvdisplay**, **vgdisplay** or **lvdisplay** commands.

B.10.2. Using an SOS report in rescue mode

The **sosreport** command-line utility collects configuration and diagnostic information, such as the running kernel version, loaded modules, and system and service configuration files from the system. The utility output is stored in a tar archive in the **/var/tmp/** directory. The **sosreport** utility is useful for analyzing system errors and troubleshooting. Use this procedure to capture an **sosreport** output in rescue mode.

Prerequisites

- You have booted into rescue mode.
- You have mounted the installed system / **(root)** partition in read-write mode.
- You have contacted Red Hat Support about your case and received a case number.

Procedure

1. Change the root directory to the **/mnt/sysroot/** directory:

```
sh-4.2# chroot /mnt/sysroot/
```

2. Execute **sosreport** to generate an archive with system configuration and diagnostic information:

```
sh-4.2# sosreport
```

sosreport prompts you to enter your name and the case number you received from Red Hat Support. Use only letters and numbers because adding any of the following characters or spaces could render the report unusable: **# % & { } \ < > > * ? / $ ~ ' " : @ + ` | =**

3. Optional: If you want to transfer the generated archive to a new location using the network, it is necessary to have a network interface configured. In this scenario, use the dynamic IP addressing as no other steps required. However, when using static addressing, enter the following command to assign an IP address (for example 10.13.153.64/23) to a network interface, for example dev eth0:

```
bash-4.2# ip addr add 10.13.153.64/23 dev eth0
```

4. Exit the chroot environment:

```
sh-4.2# exit
```

5. Store the generated archive in a new location, from where it can be easily accessible:

```
sh-4.2# cp /mnt/sysroot/var/tmp/sosreport new_location
```

6. For transferring the archive through the network, use the **scp** utility:

```
sh-4.2# scp /mnt/sysroot/var/tmp/sosreport username@hostname:sosreport
```

Additional resources

- What is an sosreport and how to create one in Red Hat Enterprise Linux? (Red Hat Knowledgebase)
- How to generate sosreport from the rescue environment (Red Hat Knowledgebase)
- How do I make sosreport write to an alternative location? (Red Hat Knowledgebase)
- Sosreport fails. What data should I provide in its place? (Red Hat Knowledgebase)

B.10.3. Reinstalling the GRUB2 boot loader

In some scenarios, the GRUB2 boot loader is mistakenly deleted, corrupted, or replaced by other operating systems. Use this procedure to reinstall GRUB2 on the master boot record (MBR) on AMD64 and Intel 64 systems with BIOS.

Prerequisites

- You have booted into rescue mode.
- You have mounted the installed system / **(root)** partition in read-write mode.
- You have mounted the /**boot** mount point in read-write mode.

Procedure

1. Change the root partition:

```
sh-4.2# chroot /mnt/sysroot/
```

2. Reinstall the GRUB2 boot loader, where the **install_device** block device was installed:

```
sh-4.2# /sbin/grub2-install install_device
```

IMPORTANT

Running the **grub2-install** command could lead to the machine being unbootable if all the following conditions apply:

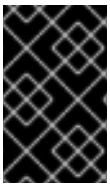
- The system is an AMD64 or Intel 64 with Extensible Firmware Interface (EFI).
- Secure Boot is enabled.

After you run the **grub2-install** command, you cannot boot the AMD64 or Intel 64 systems that have Extensible Firmware Interface (EFI) and Secure Boot enabled. This issue occurs because the **grub2-install** command installs an unsigned GRUB2 image that boots directly instead of using the shim application. When the system boots, the shim application validates the image signature, which when not found fails to boot the system.

3. Reboot the system.

B.10.4. Using dnf to add or remove a driver

Missing or malfunctioning drivers cause problems when booting the system. Rescue mode provides an environment in which you can add or remove a driver even when the system fails to boot. Wherever possible, use the dnf package manager to remove malfunctioning drivers or to add updated or missing drivers.



IMPORTANT

When you install a driver from a driver disc, the driver disc updates all **initramfs** images on the system to use this driver. If a problem with a driver prevents a system from booting, you cannot rely on booting the system from another **initramfs** image.

B.10.4.1. Adding a driver using dnf

Use this procedure to add a driver.

Prerequisites

- You have booted into rescue mode.
- You have mounted the installed system in read-write mode.

Procedure

1. Make the RPM package that contains the driver available. For example, mount a CD or USB flash drive and copy the RPM package to a location of your choice under **/mnt/sysroot/**, for example: **/mnt/sysroot/root/drivers/**.
2. Change the root directory to **/mnt/sysroot/**:

```
sh-4.2# chroot /mnt/sysroot/
```

3. Use the **dnf install** command to install the driver package. For example, run the following command to install the **xorg-x11-drv-wacom** driver package from **/root/drivers/**:

```
sh-4.2# dnf install /root/drivers/xorg-x11-drv-wacom-0.23.0-6.el7.x86_64.rpm
```

NOTE

The **/root/drivers/** directory in this chroot environment is the **/mnt/sysroot/root/drivers/** directory in the original rescue environment.

4. Exit the chroot environment:

```
sh-4.2# exit
```

B.10.4.2. Removing a driver using dnf

Use this procedure to remove a driver.

Prerequisites

- You have booted into rescue mode.
- You have mounted the installed system in read-write mode.

Procedure

1. Change the root directory to the **/mnt/sysroot/** directory:

```
sh-4.2# chroot /mnt/sysroot/
```

2. Use the **dnf remove** command to remove the driver package. For example, to remove the **xorg-x11-drv-wacom** driver package, run:

```
sh-4.2# dnf remove xorg-x11-drv-wacom
```

3. Exit the chroot environment:

```
sh-4.2# exit
```

If you cannot remove a malfunctioning driver for some reason, you can instead blocklist the driver so that it does not load at boot time.

4. When you have finished adding and removing drivers, reboot the system.

B.11. IP= BOOT OPTION RETURNS AN ERROR

Using the **ip=** boot option format **ip=[ip address]** for example, **ip=192.168.1.1** returns the error message **Fatal for argument 'ip=[insert ip here]'\n sorry, unknown value [ip address] refusing to continue**.

In previous releases of Red Hat Enterprise Linux, the boot option format was:

```
ip=192.168.1.15 netmask=255.255.255.0 gateway=192.168.1.254 nameserver=192.168.1.250
hostname=myhost1
```

However, in Red Hat Enterprise Linux 9, the boot option format is:

```
ip=192.168.1.15::192.168.1.254:255.255.255.0:myhost1::none: nameserver=192.168.1.250
```

To resolve the issue, use the format: **ip=ip::gateway:netmask:hostname:interface:none** where:

- **ip** specifies the client ip address. You can specify IPv6 addresses in square brackets, for example, **[2001:DB8::1]**.
- **gateway** is the default gateway. IPv6 addresses are also accepted.
- **netmask** is the netmask to be used. This can be either a full netmask, for example, 255.255.255.0, or a prefix, for example, **64**.
- **hostname** is the host name of the client system. This parameter is optional.

Additional resources

- Network boot options

B.12. CANNOT BOOT INTO THE GRAPHICAL INSTALLATION ON ILO OR IDRAC DEVICES

The graphical installer for a remote ISO installation on iLO or iDRAC devices may not be available due to a slow internet connection. To proceed with the installation in this case, you can choose one of the following methods:

1. Avoid the timeout. To do so:
   a. Press the **Tab** key in case of BIOS usage, or the **e** key in case of UEFI usage when booting from an installation media. That will allow you to modify the kernel command line arguments.
   b. To proceed with the installation, append the **rd.live.ram=1** and press **Enter** in case of BIOS usage, or **Ctrl+x** in case of UEFI usage.
   This might take longer time to load the installation program.

2. Another option to extend the loading time for the graphical installer is to set the **inst.xtimeout** kernel argument in seconds.

```
inst.xtimeout=N
```

3. You can install the system in text mode. For more details, see Installing RHEL8 in text mode .

4. In the remote management console, such as iLO or iDRAC, instead of a local media source, use the direct URL to the installation ISO file from the Download center on the Red Hat Customer Portal. You must be logged in to access this section.

B.13. ROOTFS IMAGE IS NOT INITRAMFS

If you get the following message on the console during booting the installer, the transfer of the installer **initrd.img** might have had errors:

```
[ ...] rootfs image is not initramfs
```

To resolve this issue, download **initrd** again or run the **sha256sum** with **initrd.img** and compare it with the checksum stored in the **.treeinfo** file on the installation medium, for example,

```
$ sha256sum dvd/images/pxeboot/initrd.img
fdb1a70321c06e25a1ed6bf3d8779371b768d5972078eb72b2c78c925067b5d8
dvd/images/pxeboot/initrd.img
```

To view the checksum in **.treeinfo**:

```
$ grep sha256 dvd/.treeinfo
images/efiboot.img =
sha256:d357d5063b96226d643c41c9025529554a422acb43a4394e4ebcaa779cc7a917
images/install.img =
sha256:8c0323572f7fc04e34dd81c97d008a2ddfc2cfc525aef8c31459e21bf3397514
images/pxeboot/initrd.img =
sha256:fdb1a70321c06e25a1ed6bf3d8779371b768d5972078eb72b2c78c925067b5d8
images/pxeboot/vmlinuz =
sha256:b9510ea4212220e85351cbb7f2ebc2b1b0804a6d40ccb93307c165e16d1095db
```

Despite having correct **initrd.img**, if you get the following kernel messages during booting the installer, often a boot parameter is missing or mis-spelled, and the installer could not load **stage2**, typically referred to by the **inst.repo=** parameter, providing the full installer initial ramdisk for its in-memory root file system:

```
[ ...] No filesystem could mount root, tried:
[ ...] Kernel panic - not syncing: VFS: Unable to mount root fs on unknown-block(1,0)
[ ...] CPU: 0 PID: 1 Comm: swapper/0 Not tainted 5.14.0-55.el9.s390x #1
[ ...] ...
[ ...] Call Trace:
[ ...] ([<...>] show_trace+0x.../0x...)
[ ...]  [<...>] show_stack+0x.../0x...
[ ...]  [<...>] panic+0x.../0x...
[ ...]  [<...>] mount_block_root+0x.../0x...
[ ...]  [<...>] prepare_namespace+0x.../0x...
[ ...]  [<...>] kernel_init_freeable+0x.../0x...
```

```
[ ...]  [<...>] kernel_init+0x.../0x...
[ ...]  [<...>] kernel_thread_starter+0x.../0x...
[ ...]  [<...>] kernel_thread_starter+0x.../0x…
```

To resolve this issue, check

- if the installation source specified is correct on the kernel command line (**inst.repo=**) or in the kickstart file
- the network configuration is specified on the kernel command line (if the installation source is specified as network)
- the network installation source is accessible from another system