NVIDIA Grace Software with Red Hat Enterprise Linux 9

Installation Guide
## Document History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>July 21, 2023</td>
<td>Initial Release</td>
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<tr>
<td>02</td>
<td>September 18, 2023</td>
<td>Updated Appendix D with the minimum kernel versions that contain the fix for those issues.</td>
</tr>
<tr>
<td>03</td>
<td>December 18, 2023</td>
<td>Added Appendix A.1 and RHEL 9.3.</td>
</tr>
<tr>
<td>04</td>
<td>March 8, 2024</td>
<td>Added the following content:</td>
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<tr>
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<td>• Clarifications to the install steps.</td>
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<td>• A boot workaround to Appendix D.1.</td>
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<td>• A note to Appendix A.1 about explicitly requiring the open-source GPU driver.</td>
</tr>
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<td>05</td>
<td>May 30, 2024</td>
<td>Added the following content:</td>
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<td></td>
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<td>• Updated Appendix A.1 with new driver level.</td>
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<td>• Added Appendix A.2.</td>
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<td></td>
<td>• Added additional clarification notes to the install steps.</td>
</tr>
</tbody>
</table>
# Table of Contents

Introduction 3  
  Related Documentation 3  
Prerequisites 3  
  Red Hat Subscription 3  
  Access to Repositories 3  
  Red Hat Repositories 3  
Installing Red Hat Enterprise Linux 4  
  Obtaining Red Hat Enterprise Linux 9 4  
  Remotely Booting the Red Hat Enterprise Linux 9 ISO 4  
  Installing Red Hat Enterprise Linux 8  
Appendix A: Installing Software 17  
  A.1 NVIDIA GPU Driver and CUDA Toolkit 17  
  A.2 NVIDIA MLNX_OFED 17  
Appendix B: Changing the BMC Login 18  
Appendix C: Automated Installation 18  
  C.1 Installing with Kickstart 18  
Appendix D: Platform-Dependent Workarounds 19  
  D.1 All Grace Platforms 19  
  D.2 Multi-Socket Grace Platforms 21
Introduction

NVIDIA® Grace systems can run Red Hat® Enterprise Linux® (RHEL) and take advantage of the advanced Grace features. This document explains how to install and configure Grace systems with RHEL 9.2 and later.

Attention: Although it might be possible to use other Linux distributions that are related to (or inspired by) RHEL, for example CentOS Stream, only RHEL has been pre-validated with the steps described by this guide for installation on Grace platforms.

Related Documentation

Refer to the Red Hat Enterprise Linux 9 Documentation Portal for more information about RHEL.

Prerequisites

This section lists the required (or recommended) prerequisites:

Red Hat Subscription

A Red Hat subscription is required to install and use RHEL 9 on the Grace platform. A subscription allows you to obtain update packages and additional packages for RHEL. To purchase a subscription or obtain a free evaluation subscription, go to the Red Hat Software & Download Center.

Access to Repositories

The repositories can be accessed from the internet. If you are using a proxy server, follow the instructions in the Red Hat Advanced Installation Guide to ensure that the system can access the necessary URIs.
Red Hat Repositories

To install software for the Grace platform over RHEL 9, you need access to the following repositories:

- Red Hat Enterprise BaseOS Repository: rhel-9-for-aarch64-baseos-rpms
- Red Hat Enterprise AppStream Repository: rhel-9-for-aarch64-appstream-rpms

Installing Red Hat Enterprise Linux

Red Hat provides several methods to install RHEL (refer to the RHEL Installation Guide for more information). Before you install, to determine whether any modifications are required for your environment, review the Appendix D. This section provides information about how to install RHEL using the Quick Install method and reclaim the disk space used by an existing installation in the process.

Note: It describes a minimal installation.

If you have a preferred method to install RHEL, you can skip this section but ensure that you reclaim the disk space that is used by an existing OS installation. The Quick Install method installs RHEL on the Grace system remotely through facilities hosted on the BMC.

Obtaining Red Hat Enterprise Linux 9

Obtain the RHEL ISO for Arm® image (aarch64) and store it on your local disk. Refer to Downloading Red Hat Enterprise Linux for the instructions.

Remotely Booting the Red Hat Enterprise Linux 9 ISO

Attention: Here is some important information to know before you begin:

- The Grace BMC comes with default login credentials, and NVIDIA recommends that you create a unique user ID and password. Contact the system vendor if you have issues logging into the BMC.
As a performance consideration, for networks that are distributed across a wide geographical area, such as a corporate VPN, we recommend that you use a browser from a host near the target server. This can be accomplished by using a remote application software solution, for example VNC, or by exporting the application X session and tunneling over SSH.

This sequence is intended for the NVIDIA reference BMC, and your results might vary when using an IBV BMC.

1. Connect to the BMC.
   a. Open a browser in your LAN, navigate to https://<BMC-IP-address>/, and log in.

   **Figure 1. BMC Login**

2. Download the ISO image to a location that can be accessed by the browser.

3. Set up the ISO image as virtual media.
   a. From the left hand menu, expand **Operations**.
   b. Select **Virtual media**.
   c. Click **Add file**, navigate to the downloaded ISO image, and select it.
   d. To begin serving the ISO image to the target server, click **Start**.
4. Boot from the virtual media.
Typically, the default boot order does not boot the CD-ROM image. You can change this in the BIOS or as a one-time option in the boot menu.
   a. Connect to the console.
      i. From the left hand menu, expand Operations, and select the SOL console.
      ii. Alternatively, SSH to the BMC from a terminal emulator, log in, and at the prompt, run the `obmc-console-client` command.
   b. To bring up the boot menu, press Escape or F11 at the beginning of the boot process.
Figure 3. Console Splash Screen

Figure 4. Boot Manager Menu
c. In the boot menu, select **UEFI OpenBMC Virtual Media Device** as the boot device and press **Enter**.
d. Follow the instructions in **Installing Red Hat Enterprise Linux**.

Figure 5. Boot Manager

---

**Installing Red Hat Enterprise Linux**

**Prerequisites:** This section assumes you have already booted the RHEL ISO image.

1. After booting the ISO image, the GRUB menu for the installer will appear.
   The menu will time out after 60 seconds.
2. If no action is taken, it will proceed with booting the **Test this media & install Red Hat Enterprise Linux 9.2** default selection.
3. To automate the installation with a Kickstart configuration file, refer to Installing with Kickstart.
4. Select one of the Install entries at the grub menu or wait for the timeout. Refer to the Red Hat Enterprise Linux Quick Installation Guide for guidance on using the installer.
5. Follow the installer prompts to configure the manual installation.
6. Select **Use text mode**.
Figure 7. Installer Menu

Note: If the installer menu fails to start, the installation mode can be specified by modifying the GRUB entry to add either the `inst.text` or `inst.vnc` boot parameter. See Boot options for RHEL Installer for more details.

7. Select the **Language** and the **Timezone**.
8. Select the Base environment and any additional software you want to install.

Note: When installing RHEL 9.2 or RHEL 9.3, you must select the Minimal Install base environment. There is a dependency with the kmod-kvdo package, and this step prevents the 4k kernel from being installed concurrently with the 64k kernel (refer to Installing kernel-64k for ARM 64 for more information).
9. On **RHEL 9.3 and later**, select the 64k kernel option.
10. Select the installation destination.

Figure 13. Destination Selection

```
/home/rh/RHEL92/RHEL92 Beta/repo/8
5) [ ] Installation Destination
   (Automatic partitioning selected)
6) [x] Kdump
   (Kdump is enabled)
7) [x] Network configuration
   (Connected: enP86)
8) [x] Root password
   (Root password is set)
9) [x] User creation
   (User nvidia will be created)
```

```
Installation Destination
1) [x] Micron_7400_MTFDKBA488T0Z: 447.13 Gb (nvme0n1)
1 disk selected; 447.13 Gb capacity; 1.8 MiB free
```

```
Please make a selection from the above ['b' to begin installation, 'q' to quit, ['r' to refresh]: 5
Probing storage...
```

```
Please make a selection from the above ['c' to continue, 'q' to quit, 'r' to refresh]: c
```
Figure 14. Partition Scheme Selection

1) [ ] Replace Existing Linux system(s)  
2) [x] Use All Space  
3) [ ] Use Free Space  
4) [ ] Manually assign mount points

Installation requires partitioning of your hard drive. Select what space to use for the install target or manually assign mount points.

Please make a selection from the above ['c' to continue, 'q' to quit, 'r' to refresh]:

Partition Scheme Options
1) [ ] Standard Partition  
2) [x] LVM  
3) [ ] LVM Thin Provisioning

Select a partition scheme configuration.

Please make a selection from the above ['c' to continue, 'q' to quit, 'r' to refresh]:

Figure 15. Partition Option Selection

Installation Destination
1) [x] Micron_7400_MTFDKBA480TD2: 447.13 GiB (nvme0n1)

1 disk selected; 447.13 GiB capacity; 1.8 MiB free

Please make a selection from the above ['c' to continue, 'q' to quit, 'r' to refresh]:

Partitioning Options
1) [ ] Replace Existing Linux system(s)  
2) [x] Use All Space  
3) [ ] Use Free Space  
4) [ ] Manually assign mount points

Installation requires partitioning of your hard drive. Select what space to use for the install target or manually assign mount points.

Please make a selection from the above ['c' to continue, 'q' to quit, 'r' to refresh]:
11. Create the users and set the root password.

**Figure 16. User and Password Selection**

12. To initiate the installation, enter b.

**Figure 17. Installation Progress**
13. After the installation is complete, the system will display a EULA prompt.

14. Press **ENTER** to quit the installer and reboot the system.

**Figure 18. Installation Complete**

```plaintext
Configuring Red Hat subscription
...........
Configuring installed system
............... Writing network configuration
Creating users
.... Configuring addons
Generating initramfs
.... Storing configuration files and kickstarts
Running post-installation scripts
Installation complete
Use of this product is subject to the license agreement found at:
/usr/share/redhat-release/EULA

Installation complete, Press ENTER to quit:
[anaconda]# main* 2:Shell 3:log 4:storage-log >Switch tab: Alt+Tab | Help: F1
```

15. If you are using **RHEL 9.3 and later**, and you selected the 64k kernel in step 8, you can skip to step 19.

16. After the system reboots, log in and install the 64k kernel as the default by running the following commands:

   ```bash
   sudo dnf install -y kernel-64k
   k=$(echo /boot/vmlinuz*64k)
   sudo grubby --set-default=$k --update-kernel=$k --args="crashkernel=auto"
   sudo grub2-editenv - unset menu_auto_hide
   sudo reboot
   ```

17. After the system reboots, confirm that the system is running the 64k kernel by evaluating the page size.

   ```bash
   $ getconf PAGESIZE
   65536
   ```

18. With the 64k kernel now booted, the 4k kernel must be removed per **Red Hat’s recommendation** by running the following command.

   ```bash
   sudo dnf erase kernel
   ```

19. The installation on Grace is complete.
Appendix A: Installing Software

RHEL uses the `dnf` package manager to install, update, and remove packages. The utility can also be used to manage repositories. For more information about using `dnf`, refer to the Red Hat Managing Software with the DNF tool article.

A.1 NVIDIA GPU Driver and CUDA Toolkit

Refer to the NVIDIA CUDA Installation Guide for Linux for the instructions to install the NVIDIA GPU driver and CUDA support for RHEL. The R535.129.03 driver is the minimum level required for the Hopper GPU.

The following commands can be used to install the minimum levels required for the Hopper GPU:

```
sudo dnf install kernel-64k-devel-$(uname -r| sed 's/+64k//g')
sudo dnf install kernel-headers-$(uname -r| sed 's/+64k//g')
sudo dnf clean expire-cache
sudo dnf install cuda-toolkit-12-4 -y
sudo dnf module install nvidia-driver:550-open -y
sudo systemctl enable nvidia-persistenced
sudo reboot now
```

**Note:** The open-source GPU driver is required for Hopper GPUs.

A.2 NVIDIA MLNX_OFED

Refer to the NVIDIA MLNX_OFED Linux Drivers for current version, release notes, and the user manual. The Grace platform requires one of the following NVIDIA MLNX_OFED versions:

- MLNX_OFED v24.01-0.3.3.1 (or later)
- MLNX_OFED LTS v23.10-0.5.5.0-LTS (or later)
To install NVIDIA MLNX OFED on RHEL 9:

1. Download the ISO image from NVIDIA MLNX OFED Linux Drivers to your host.

   The ISO image has this format MLNX_OFED_LINUX-<ver><OS label><CPU arch>.iso.

2. To mount the ISO, run the following command.

   ```
   sudo mount -o ro,loop <Downloaded ISO image> /mnt
   ```

3. To install the dependent software, run the following command.

   ```
   sudo dnf install kernel-64k-devel-$(uname -r| sed 's/+64k//g') -y
   sudo dnf install kernel-headers-$(uname -r| sed 's/+64k//g') -y
   sudo dnf install bison flex gcc make openssl-devel perl lsof rpm-build automake
   libtool patch kernel-rpm-macros autoconf gcc-gfortran tcl tk createrepo -y
   ```

4. Install NVIDIA MLNX OFED software.

   ```
   sudo /mnt/mlnxofedinstall --add-kernel-support
   ```

5. Update the boot image to include NVIDIA MLNX OFED support and reboot the system.

   ```
   sudo dracut -f
   sudo reboot now
   ```

### Appendix B: Changing the BMC Login

The NVIDIA Grace servers include a base management controller (BMC) for out-of-band management of the Grace system. NVIDIA recommends that you create a unique username and password as soon as possible.

### Appendix C: Automated Installation

This section provides information about automated installations.

#### C.1 Installing with Kickstart

Kickstart provides a way to automate the installation process by providing a configuration file with the answers to commonly asked installation questions. NVIDIA provides the following Kickstart template for Grace platforms:

https://repo.download.nvidia.com/baseos/el/el-les/9/el9-ks/grace-ks.cfg

For more information about using Kickstart files with RHEL 9, refer to RHEL on ARM platforms with the 64k kernel.
In these files, there are tags that you must replace with site-specific information including the following:

- Language
- Keyboard
- Timezone
- Hostname

Each tag is in the `<CHANGE_YOUR_xxxx>` form and must be replaced with your information.

1. After you have a kickstart file customized for your installation, place that file in a location that can be accessed by NFS, FTP, HTTP, or HTTPS.
2. After booting from the installation medium, when the grub menu appears, press `e` to edit the grub entry and append `inst.ks=<URL>` to the list of kernel boot parameters.

For example:

```
inst.ks=https://192.168.1.2/kickstart/grace-ks.cfg
```

**Appendix D: Platform-Dependent Workarounds**

Some Grace platforms require temporary (or permanent) alterations to their configurations to work around known issues, such as hardware errata. These workarounds are described in the following sections by the corresponding Grace platform.

**Note:** Unless mentioned here, later releases of RHEL 9 do not require platform-dependent workarounds.

**D.1 All Grace Platforms**

- The RHEL 9.2 installation media does not carry a patch that is required to resolve an issue with the ast driver that is used to interface with the AST2600 BMC.

  The absence of this patch can manifest a variety of issues, including kernel hangs and distorted output from the on-board VGA port. Until the system is installed and running with kernel version 5.14.0-284.30.1.el9_2 or later (available through the RHEL 9.2.z update stream), a temporary workaround is required on all Grace platforms to avoid undefined behaviors (refer to [RHSA-2023:5069 - Security Advisory](https://access.redhat.com/security advisories) for more information). As a side effect of this workaround, because the on-board VGA port is inaccessible, a serial console solution (for example, SOL) must be used for console access to the system.
To temporarily deploy this workaround for the duration of the current boot:
1. During boot, stop at the grub menu, select the boot entry, and press the e key to edit the entry.
2. Append `modprobe.blacklist=ast` to the end of the list of kernel boot parameters.
3. Boot the entry by clicking Ctrl-X or pressing F10.

To permanently deploy this workaround so that it is always active upon boot:
1. With administrative privileges, run the following command to add a boot parameter to all kernels:
   ```
   grubby --update-kernel=ALL --args="modprobe.blacklist=ast"
   ```
2. Reboot the system.

To permanently remove this workaround so that it is no longer active upon the boot:
1. With administrative privileges, run the following command to remove the boot parameter from all kernels:
   ```
   grubby --update-kernel=ALL --remove-args="modprobe.blacklist=ast"
   ```
2. Reboot the system.

To verify the presence of the workaround, complete one of the following options:
- Evaluate the kernel boot parameters that were set for the current boot by running the following command:
  ```
  cat /proc/cmdline | grep ast
  ```
  When nothing is returned, the workaround is not active.
- Alternatively, evaluate the loaded modules for the current boot by running the following command:
  ```
  lsmod | grep ast
  ```
  When nothing is returned, the workaround is active.

**Note:** When this workaround is applied using the temporary deployment method from the RHEL Installer, it is automatically included in the installed system.

Refer to [Red Hat Modifying Kernel Boot Parameters](#) for additional guidance about modifying kernel boot parameters.

- Due to a firmware bug that can cause an invalid memory access in the kernel, Grace platforms from some vendors might experience a crash during the installation or at boot time.

  This issue can impact any version of RHEL that is supported on the Grace platform. Until this issue is resolved, a workaround is required to allow a successful boot.

- To temporarily deploy this workaround for the duration of the current boot:
  1. During boot, stop at the grub menu, select the desired boot entry, and press the e key to edit the entry.
  2. Append `video=simplefb:off` to the end of the list of kernel boot parameters.
  3. Boot the entry by clicking Ctrl-X or pressing F10.
To permanently deploy this workaround, so that is always active upon boot:

1. With administrative privileges, run the following command to add a boot parameter to all kernels.

   ```bash
   grubby --update-kernel=ALL --args="video=simplefb:off"
   ```

2. Reboot the system.

To verify the presence of the workaround, evaluate the kernel boot parameters set for the current boot by running the following command:

```bash
cat /proc/cmdline | grep simplefb
```

When nothing is returned, the workaround is **not** active.

**Note:** When this workaround is applied using the temporary deployment method from the RHEL Installer, it is automatically included in the installed system.

Refer to [Red Hat Modifying Kernel Boot Parameters](#) for additional guidance about modifying kernel boot parameters.

### D.2 Multi-Socket Grace Platforms

The RHEL 9.2 installation media does **not** carry a patch required to work around [NVIDIA hardware erratum T241-FABRIC-4](#). This errata impacts Grace systems with three-and four-socket configurations, for example, Grace Hopper x4. Until the system is installed and running with kernel version 5.14.0-284.30.1.el9_2 or later (available through the RHEL 9.2.z update stream), a temporary workaround is required on impacted Grace platforms to avoid undefined behaviors (refer to [RHSA-2023:5069 - Security Advisory](#) for more information).

- The temporary workaround will restrict the system to one socket configuration, which reduces the server to a quarter of its total compute capacity.

**Caution:** Be careful when profiling a Grace Hopper x4 system with this temporary workaround.

To temporarily deploy this workaround for the duration of the current boot:

1. During boot, stop at the grub menu, select the desired boot entry, and press the **e** key to edit the entry.
2. Append `nr_cpus=72` to the end of the list of kernel boot parameters.
3. Boot the entry by clicking **Ctrl-X** or pressing **F10**.
To permanently deploy this workaround so that is always active upon boot:
1. With administrative privileges, run the following command to add a boot parameter to all kernels:
   ```bash
   grubby --update-kernel=ALL --args="nr_cpus=72"
   ```
2. Reboot the system.

To permanently remove this workaround, so that it is not active upon boot:
1. With administrative privileges, run the following command to remove the boot parameter from all kernels:
   ```bash
   grubby --update-kernel=ALL --remove-args="nr_cpus=72"
   ```
2. Reboot the system.

To verify the presence of the workaround, complete one of the following tasks
- Evaluate the kernel boot parameters set for the current boot.
  ```bash
  cat /proc/cmdline | grep nr_cpus
  ```
  When nothing is returned, the workaround is not active.
- Evaluate the CPU configuration for the current boot.
  ```bash
  lscpu | grep -E "NUMA node[0-9]+"
  ```
  Only one of the nodes should be populated [with CPUs 0-71].

Note: When this workaround is applied using the temporary deployment method from the RHEL Installer, it is automatically included in the installed system.

Refer to Red Hat Modifying Kernel Boot Parameters for additional guidance about modifying kernel boot parameters.
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