

REDHAWK Linux®
Version 8.4
Release Notes

December 2021

0898003-8.4



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1.0. Introduction

This document provides release information and installation instructions for Concurrent Real-Time, Inc.'s RedHawk™ Linux® operating system Version 8.4.

1.1 Product Description

RedHawk Linux is a real-time version of the open source Linux operating system. Modifications are made to standard Linux version 5.10 to support the functionality and the performance required by complex real-time applications. RedHawk uses a single kernel design to support a single programming environment that directly controls all system operation. This design allows deterministic program execution and response to interrupts while simultaneously providing high I/O throughput and deterministic file, networking, and graphics I/O operations. RedHawk is the ideal Linux environment for the deterministic applications found in simulation, data acquisition, industrial control and medical imaging systems.

Included with RedHawk is Rocky Linux®, version 8.4. Note, however, that RedHawk can also be installed on *any* Rocky-compatible version 8.4 distribution. In addition, RedHawk 8.4 also supports the popular Ubuntu distribution; see Appendix A, *Ubuntu Support*, for more information.

The RedHawk installation media provide additional real-time kernels and libraries for accessing RedHawk specific kernel features. Optionally, the NightStar™ RT development tool set is available for developing real-time applications, and the Frequency-Based Scheduler can be used to schedule cyclic applications driven from a real-time clock or other external interrupt source. The Performance Monitor module allows you to get detailed CPU utilization of each process on such a scheduler.

The RedHawk kernel integrates both open source patches and Concurrent Real-Time developed features derived from the real-time UNIX® implementations that Concurrent Real-Time has supported in its over 45 years of experience developing real-time operating systems.

RedHawk is included with each Concurrent Real-Time iHawk™ system. iHawks are symmetric multi-processor (SMP) systems available in a variety of architectures and configurations, though only 64-bit capable iHawks can run RedHawk 8.4 as it is only available in a 64-bit version.

Support for SMP is highly optimized. A unique concept known as *shielded CPUs* allows a subset of processors to be dedicated to tasks that require the most deterministic performance. Individual CPUs can be shielded from interrupt processing, kernel daemons, interrupt bottom halves, and other Linux tasks. Processor shielding provides a highly deterministic execution environment that guarantees processes fast and dependable response to external events.

RedHawk Linux matches the level of POSIX® conformance of other Linux distributions based on the 5.10 series of kernels. Linux on the Intel® x86 and ARMv8-A architectures has defined a defacto binary standard which allows shrink-wrapped Linux applications that are designed to run on the Intel x86 and ARMv8-A platforms to run on Concurrent Real-Time's iHawk platforms.

NightStar RT, RedHawk Architect and RedHawk KVM-RT are optional products available to run on RedHawk Linux.

NightStar RT is Concurrent Real-Time's powerful real-time tool set that provides a robust graphic interface for non-intrusive control, monitoring, analysis, and debugging of real-time multiprocessing applications. All tools can be run natively on the same system as the application or remotely.

The NightStar RT tools include the following:

- NightView™ source-level debugger – allows multi-language, multi-processor, multi-program and multi-thread monitoring and debugging from a single graphical interface.
- NightTrace™ run-time analyzer – analyzes the dynamic behavior of a running application.
- NightSim™ periodic scheduler – allows the user to easily schedule applications that require periodic execution.
- NightProbe™ data monitor – used to sample, record or modify program data in multiple running programs.
- NightTune™ performance tuner – used for analyzing system and application performance.

RedHawk Architect is a powerful tool with an easy-to-use GUI that lets a developer choose the Linux and application modules to be included in target images. Target images can be scaled from complete workstations to dedicated servers and even down to small embedded applications. RedHawk Architect provides deployment tools for installing onto hard drives, flash memories, DVD or even USB flash.

RedHawk KVM-RT is a Real-Time Hypervisor solution that utilizes QEMU/KVM and RedHawk real-time features to extend RedHawk's real-time determinism to guest RedHawk virtual machines.

1.2 Product Media

The tables below list the optical media discs that are delivered with RedHawk Linux Version 8.4 for each Concurrent Real-Time system.

WARNING

While much of the software on the RedHawk media is licensed under the GNU GPL license, some components are not. Therefore, the media cannot be freely copied.

Product Media

Processor Type:	Intel and AMD x86_64 64-bit	
Model:	iHawk Intel-based systems	[HQxxx]
	iHawk AMD-based systems	[HRxxx]
	iHawk ARM-based systems	[HAxxx]
	ImaGen Intel-based systems	[HQ0G1]
	ImaGen AMD-based systems	[HR0G1]
Operating System Discs:		
Rocky 8.4 (64-bit)	(1 BD)	[WA-ROCKY, WA-ROCKY-ARM64 Version 8.4]
Rocky 8.4 Updates (64-bit)	(1 BD)	[LXUPDATE -ROCKY Version 8.4]
RedHawk Linux OS (64-bit)	(1 DVD)	[WA-EM64T-AMD64, WA-ARM64 Version 8.4]
Software Updates for RedHawk (1 DVD or 1 CD, if present)		
Optional Discs:		
RedHawk Linux Frequency-Based Scheduler for x86_64 Systems	[WU1210-JA Version 8.4]	
NightStar RT for RedHawk	[WU1220-LDV, WU1220-LDVF Version x.x (x.x=latest version)]	
RedHawk Architect (64-bit)	[W-RHLE-E64] Version 8.4	
RedHawk KVM-RT (64-bit)	[WU1602-KVM-RT] Version 1.3	

1.3 Version Numbers

All RedHawk Linux version numbers take the following form:

$$major.minor[.update]$$

where:

major is the product's major version number
minor is the product's minor version number
update is the update's incremental version number

For example, 8.0 is the initial release of major version 8, and 8.2 is a subsequent release to version 8.0. Both 8.0 and 8.2 constitute complete product releases and do not require a previous release to be currently installed on the system; both are available on optical media from Software Distribution.

Individual kernel updates available via the RedHawk Updates website (see the “System Updates” section below) are not a complete product and can only be installed as an update to the matching *major.minor* release. For example; a 8.4.1 kernel update can only be installed on a system currently running RedHawk Linux version 8.4.

1.4 System Updates

As RedHawk Linux updates are issued, they are made available for downloading from Concurrent Real-Time's Software Portal.

Instructions for downloading updates from the website are provided in the section "Software Updates" on page 62.

1.5 Syntax Notation

The following notation is used throughout this document:

<i>italic</i>	Books, reference cards, and items that the user must specify appear in <i>italic</i> type. Special terms may also appear in <i>italic</i> .
list bold	User input appears in list bold type and must be entered exactly as shown. Names of directories, files, commands, options and man page references also appear in list bold type.
list	Operating system and program output such as prompts, messages and listings of files and programs appears in list type.
[]	Brackets enclose command options and arguments that are optional. You do not type the brackets if you choose to specify these options or arguments.
hypertext links	When viewing this document online, clicking on chapter, section, figure, table and page number references will display the corresponding text. Clicking on Internet URLs provided in <i>blue</i> type will launch your web browser and display the web site. Clicking on publication names and numbers in <i>red</i> type will display the corresponding manual PDF, if the file is available and accessible.

2.0. Documentation

2.1 RedHawk Linux Documentation

Table 2-1 lists the documentation provided with RedHawk Version 8.4 as PDF files. After installing RedHawk Linux documentation, the files are available for viewing:

- by clicking on the “Documents” icon on the desktop
- from Concurrent Real-Time’s documentation web site at <http://redhawk.concurrent-rt.com/docs>

Table 2-1 RedHawk Linux Documentation

RedHawk Linux Operating System Documentation	Document Number
<i>RedHawk Linux Version 8.4 Release Notes</i>	0898003-8.4
<i>RedHawk Linux User’s Guide</i>	0898004-780
<i>Real-Time Clock & Interrupt Module (RCIM) User’s Guide</i>	0898007-620
<i>RedHawk Linux FAQ</i>	N/A
Optional RedHawk Product Guides	
<i>RedHawk Linux Frequency-Based Scheduler (FBS) User’s Guide</i>	0898005-350
Optional RedHawk Product Documentation Sets	
<i>RedHawk Architect Release Notes</i>	0898600-8.4
<i>RedHawk Architect User’s Guide</i>	0898601-8.4
<i>KVM-RT Release Notes</i>	0898603-1.3
<i>KVM-RT User’s Guide</i>	0898604-1.3

The Optional RedHawk Product Documentation Sets include Concurrent Real-Time’s user guides as PDF files along with additional vendor documentation PDFs that facilitate using these RedHawk products.

The latest documentation for all Concurrent Real-Time software products, including updated Release Notes and User Guides, can be accessed from Concurrent Real-Time’s documentation web site at <http://redhawk.concurrent-rt.com/docs>. An updated RedHawk FAQ can be accessed at [FAQ.pdf](#)

Printed copies can be ordered by contacting the Concurrent Real-Time Software Support Center. Refer to “Direct Software Support” on page 62 for details.

2.2 Vendor Documentation

Some RedHawk optional products include vendor documentation that facilitates using these RedHawk products.

Commercial off-the-shelf (COTS) documentation applicable to your iHawk system is included with the system. Contact the vendor's sales office to purchase additional copies.

3.0. Prerequisites

3.1 Software

No previously installed software is required in order to install RedHawk Linux. The complete RedHawk Linux installation consists of the following software:

- Rocky 8.4 with updates
- RedHawk Linux operating system (with optional updates)
- NightStar RT for RedHawk tools (optional)
- RedHawk Linux Frequency-Based Scheduler (FBS) (optional)
- RedHawk Architect (optional)
- RedHawk KVM-RT (optional)

These packages operate only in a 64-bit environment. The operating environment on a system depends upon the processor type and the support included in the software for that processor. Refer to “Product Media” on page 2 for details.

NOTE

In RedHawk 8.4, real-time extensions and features are optionally available to 32-bit compatibility-mode applications running under a 64-bit operating system (i.e., x86_64).

3.2 Hardware

- Any Concurrent Real-Time iHawk or ImaGen system
- Real-Time Clock and Interrupt Module (RCIM)
- A Blu-ray optical media reader is required to install the system

4.0. Changes in this Release

This section describes enhancements and other changes introduced in RedHawk Version 8.4.

For changes in the RedHawk 8.x series, prior to this release, please see the RedHawk Linux 8.2 Release Notes in our Document Library (<http://redhawk.concurrent-rt.com/docs>).

4.1 Enhancements in RedHawk Version 8.4

4.1.1 Based on Rocky Linux Operating System

Rocky Linux is a community enterprise operating system designed to be compatible with Enterprise Linux. CentOS has reached its End Of Life and therefore CentOS upgrades to RedHawk 8.4 are not supported.

Concurrent recommends creating brand new installations of RedHawk 8.4 using Rocky Linux 8.4 (or any compatible 8.4 distributions that is still actively maintained) or Ubuntu 20.04.

4.1.2 Based on kernel.org 5.10.59-rt52

The summary of changes below is from https://kernelnewbies.org/Linux_5.10. For more details, visit the website.

“This new Linux version is a Long Term Support release, and it brings support for a fast commit mode in Ext4 which provides faster fsync(); support for safer sharing of io_uring rings between processes; a new syscall to provide madvise(2) hints for other processes, code patching to allow direct calls to be used instead of indirect calls for improved repotline performance, support for register encryption in AMD’s virtualized guests; faster and lean virtio-fs performance; support for ARM Memory Tagging Extension that prevents a number of security issues; and code patching to allow direct calls to be used instead of indirect calls. As always, there are many other new drivers and improvements.”

4.1.3 New systemd Turbo service

A new turbo service has been added to allow users to enable/disable boost on x86 systems with Turbo Boost(Intel) or CPB(AMD) enabled in the BIOS. See Appendix D, *Turbo Service*, for more information.

4.1.4 Blu-ray drive needed to install 8.4

Installations no longer fit on a dual-layer DVD, therefore a Blu-ray disc (BD) drive is now required to install Rocky 8.4.

4.1.5 Starting to address Y2038 problem

RedHawk 8.4 has added many new system calls to prepare for the year 2038. The latest time since 1 January 1970 that can be stored using a signed 32-bit integer is early morning on Tuesday, 19 January 2038. Programs that attempt to increment the time beyond this date will cause the value to be stored internally as a negative number.

4.1.6 Enhancements to RedHawk KVM-RT

These are new features implemented in RedHawk 8.4 specific for RedHawk KVM-RT. Support for these are currently available only in the RedHawk 8.4 release, but older RedHawk releases will have this support in the future.

- **KVM trace events**
The KVM_ENTER_VM and KVM_EXIT_VM trace events have been deprecated and replaced with new ones and additional events have been added.
- **KVM-RT Guest Services**
A new service that give guest userspace applications access to functions exposed by the host hypervisor.
- **Multi-merge tracing capability**
A new tracing capability that allows KVM-RT users to merge dumps taken from a host and guest virtual machines and consolidate them into a single view arranged by timestamp.

4.1.7 Updated NVIDIA driver to revision 470.74

RedHawk includes the NVIDIA Linux Display Driver version 470.74. Legacy driver support for older NVIDIA GPUs is available for download from the NVIDIA website. Refer to "NVIDIA Graphics Configuration" on page 38 for more information.

4.1.8 Updated CUDA SDK to 11.4

RedHawk 8.4 optionally installs NVIDIA CUDA 11.4. The CUDA Toolkit includes GPU-accelerated libraries, a compiler, development tools and the CUDA runtime. Developers are able to dramatically speed up computing applications by harnessing the power of GPUs. See <http://www.nvidia.com> for more information.

4.1.9 Ubuntu Supported

In addition to Rocky and Rocky-compatible distributions, RedHawk 8.4 is available for the Ubuntu 20.04 distribution. See Appendix A, *Ubuntu Support*, for more information.

4.2 Other Changes

4.2.1 Enabling SELinux in enforcing mode

RedHawk disables SELinux by default. It is now required that you boot in permissive mode before attempting to run SELinux with enforcing mode enabled. If you do not boot in permissive mode first, both the base kernels and the RedHawk kernels may freeze during the boot. Follow the instructions in section "Configuring SELinux in enforcing mode" on page 56. If you do not follow the instructions and find yourself unable to boot any kernel, a work-around is provided in the "Unable to Boot After Enabling SELinux" on page 61 in the Known Issues section of this document.

4.2.2 Onload availability

Onload (formerly OpenOnload) does not currently have support for the kernel.org 5.10 kernel and is therefore not available for the RedHawk 8.4 release at this time. Concurrent is working with Solarflare to rectify this issue, and a version of Onload that supports RedHawk 8.4 will be made available for download as soon as the issues are resolved.

Onload is a high-performance network stack that reduces latency and CPU utilization, and increases message rate and bandwidth.

4.2.3 UEFI Secure Boot Support

The current Rocky 8.4 release does not support UEFI Secure Boot but will have support in a future release. Note that RedHawk 8.4 does have support for Secure Boot and can be installed on any Rocky-compatible 8.4 distribution that has Secure Boot support.

4.2.4 Package `ccur-ntp` deprecated

The `ccur-ntp` software package has been deprecated. It is advised to switch to using GPSD with Chronyd. See the RCIM User's Guide for more information.

5.0. Installation Procedures

Use the installation procedures provided here to generate or regenerate a system.

NOTE: Upgrades from RedHawk 7.x to RedHawk 8.x and from RedHawk 8.0 or RedHawk 8.2 to RedHawk 8.4 are *not* supported.

NOTE: Resources to assist users supplying their own Red Hat software are available in the Concurrent Real-Time Software Documentation Library <http://redhawk.concurrent-rt.com/docs/>. Look under the corresponding RedHawk Linux Release for the link labeled : Installing on RHEL.

Review the following points before installing the software:

- Concurrent Real-Time recommends these procedures be followed as documented here; however, advanced users may decide to make other choices based on onsite requirements.
- The installation media in use is accessed at various times and must be kept in the drive during the installation until you are instructed to install different media.

Before you start:

- **Main Memory Size** — You need to know the system’s main memory size in order to properly set up the file system swap size. If you are not sure of the main memory size, access the system’s BIOS to ascertain this information.
- **Network Addresses** — If you do not plan to configure networking via DHCP, you will need to have the following information for your system before beginning the installation:
 - IP address - gateway address
 - netmask address - primary and secondary DNS addresses
- **Firmware Settings** — Firmware settings should be reviewed before installation and whenever problems involving non-working devices are encountered. Exercise caution before changing default settings. Concurrent Real-Time makes the following recommendations:
 - “Linux” should be specified for the “Installed OS” setting (or its equivalent) if it is an available option. If not, use the default “other.”
 - Only the default settings for memory functions and PCI timing functions are supported.
 - ACPI support should be enabled, but care should be taken before changing other ACPI options from their defaults. ACPI sleep states should *not* be enabled in the firmware or in any custom kernel build.
 - Ensure that the drive to be used for installations and updates is bootable and that the boot order is correctly set in the firmware so that you will boot to the installer from a disc.
 - Concurrent recommends using UEFI for all RedHawk 8.x systems.
 - UEFI Secure Boot should be disabled if installing Rocky 8.4.

5.1 Installing Rocky Software

The version of Rocky Linux that is appropriate to your system's architecture must be installed on the system first by *specifically completing the steps below*.

Installation of Rocky is accomplished in two parts:

- Installing Rocky
- Installing Rocky Updates

If you already have a Rocky system installed at the 8.4 version level you can skip directly to "Installing Rocky Updates" on page 28.

NOTE

The current Rocky 8.4 release does not support UEFI Secure Boot but will support it in a future release. Before installing Rocky 8.4, verify that UEFI Secure Boot is disabled in your firmware.

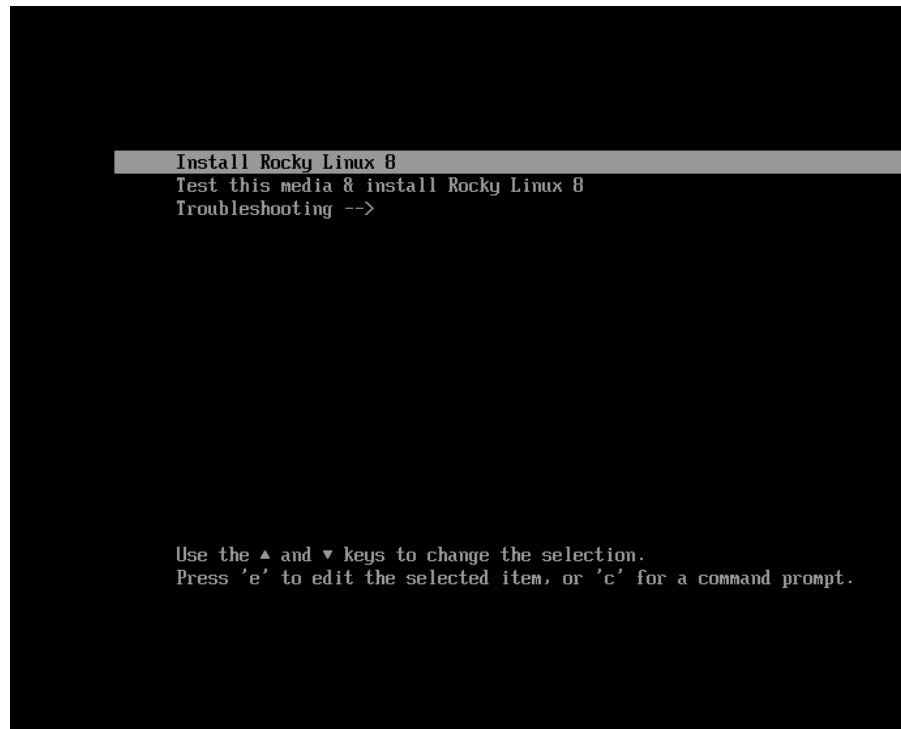
RedHawk 8.4 does have support for UEFI Secure Boot and can be installed on any Rocky-compatible 8.4 distribution that has support for Secure Boot.

5.1.1 Installing Rocky

This section typically takes between 40-70 minutes to complete.

1. Power on the system, if needed, to open the Blu-ray disc drawer.
2. Insert Rocky Installation Disc in the drive and power down the system.

- Power on the system with the installation disc installed to boot from the disc. After a short delay, the following screen should appear.



- Initially the option to test the media is highlighted; press the Up Arrow to highlight Install Rocky Linux 8 and press Enter.

NOTES

If the installation GUI does not launch:

If you wish to use GUI mode but it does not launch, refer to section **7.1.5** on page 54 for some boot options that may allow the GUI to launch. Some NVIDIA cards require specifying the display resolution before the install GUI will start. If successful, continue to follow the installation directions below.

In addition to GUI mode, Rocky can be installed in text mode or by using VNC.

In text mode, aids at the bottom of the screen describe how to navigate through the text mode screens and make selections. The instructions given in the steps below can be applied to both GUI and text mode installation; however, the number and order of the configuration screens differ slightly between the two modes.

If you wish to use VNC for the installation instead of the GUI or text modes, refer to section **7.1.4** on page 52 for full instructions.

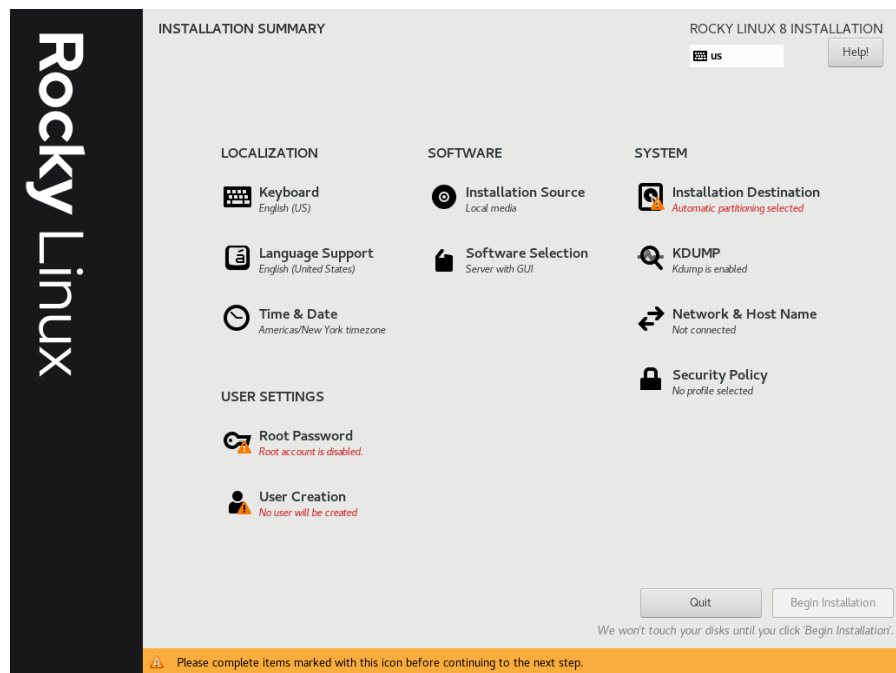
If your system contains disk drives or devices that are not supported by the Rocky installation program, you will need to obtain the necessary driver(s) in order to install Rocky Linux. A diskette containing the driver may be included

with your system or it may be available on the Rocky installation media. If not available, contact the driver manufacturer for an updated driver or call Concurrent Real-Time Support (see "Direct Software Support" on page 62).

For this type of installation, type `linux dd` at the `boot:` prompt. Insert the diskette in the drive when instructed to do so.

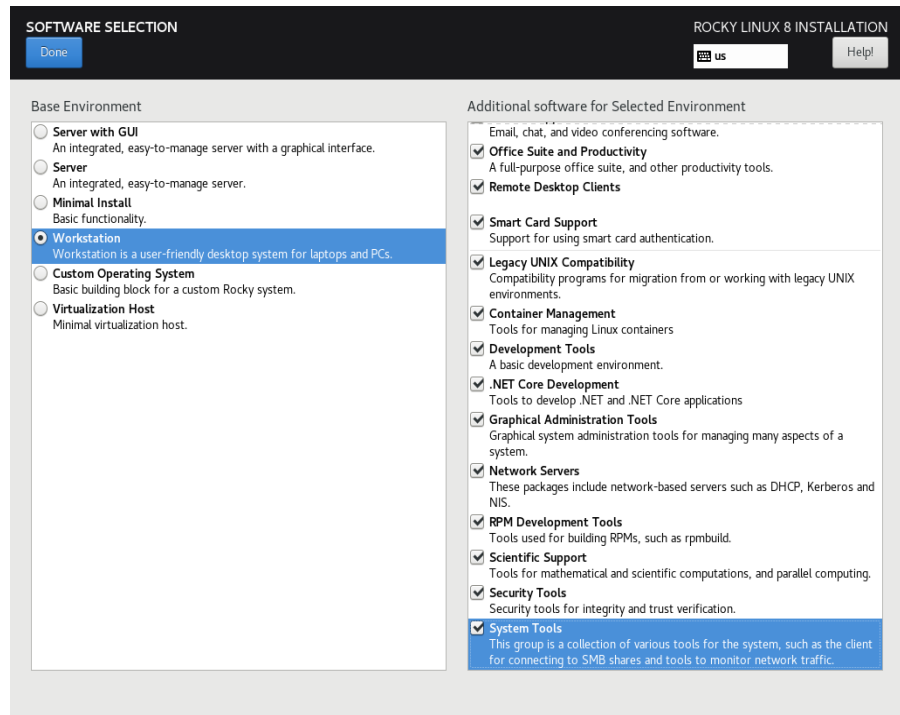
If your hard drive is not recognized and no driver diskette is supplied, a screen appears stating that no hard drives are found, would you like to select drivers. The installation disc contains a number of device drivers. Select **Yes**, then **Add Device** to display a list of drivers. Select the desired driver and proceed through the screens, completing this action by selecting **Done**.

5. Once the installation has started you will be presented with the welcome screen. Select your desired language and press **Continue** to proceed.
6. You will now be presented with the **Installation Summary** page, which is the main launching point for all installation activities.



Click on the settings under **Localization** if you wish to make any site-specific changes to the date, time, language and keyboard settings.

7. Click on **Software Selection** to select the package installation profile for the installation. The following screen will be displayed.

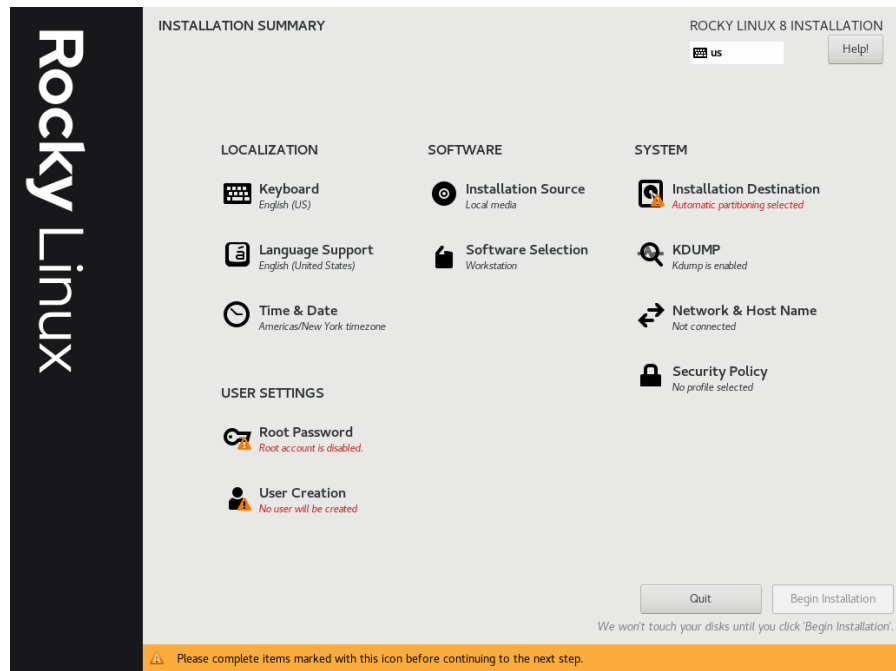


Choose **Workstation** and select all of the **Additional software for Selected Environments** categories displayed on the right side of the screen.

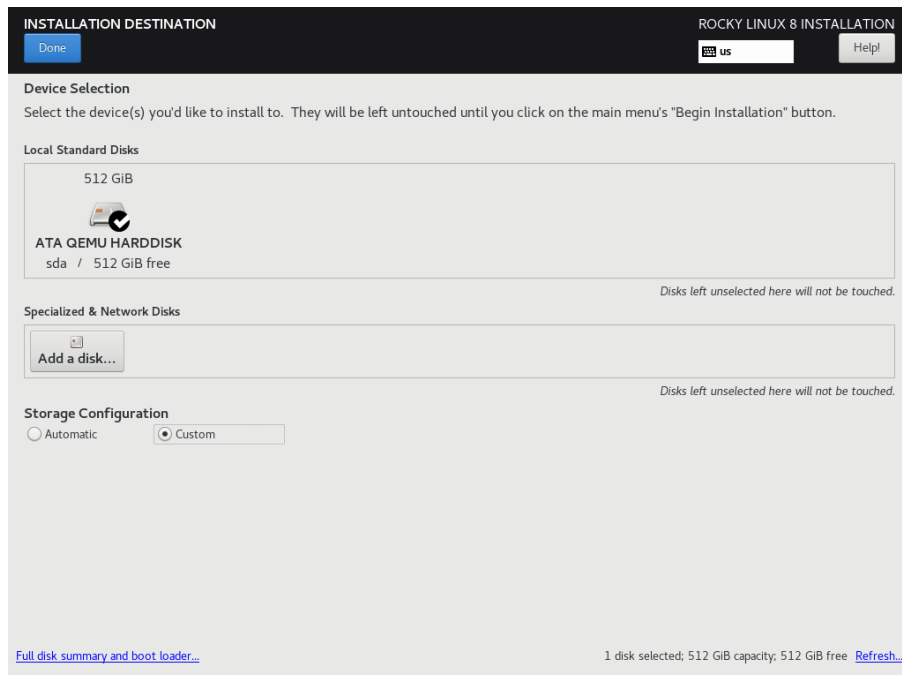
NOTE

Click on the top software and then repeat pressing the down arrow on the keyboard, followed by the space bar, until all software are selected. Note that the list will continue to scroll across multiple pages of add-ons and will stop scrolling only after reaching the last add-on.

Then press **Done** in the upper left corner to complete software selection and return to the **Installation Summary** page. The **Installation Summary** page should eventually appear as shown below.



- Next, click on **Installation Destination** to manually partition the system's hard drive for the best operation with RedHawk Linux. A page similar to the following page will be displayed.

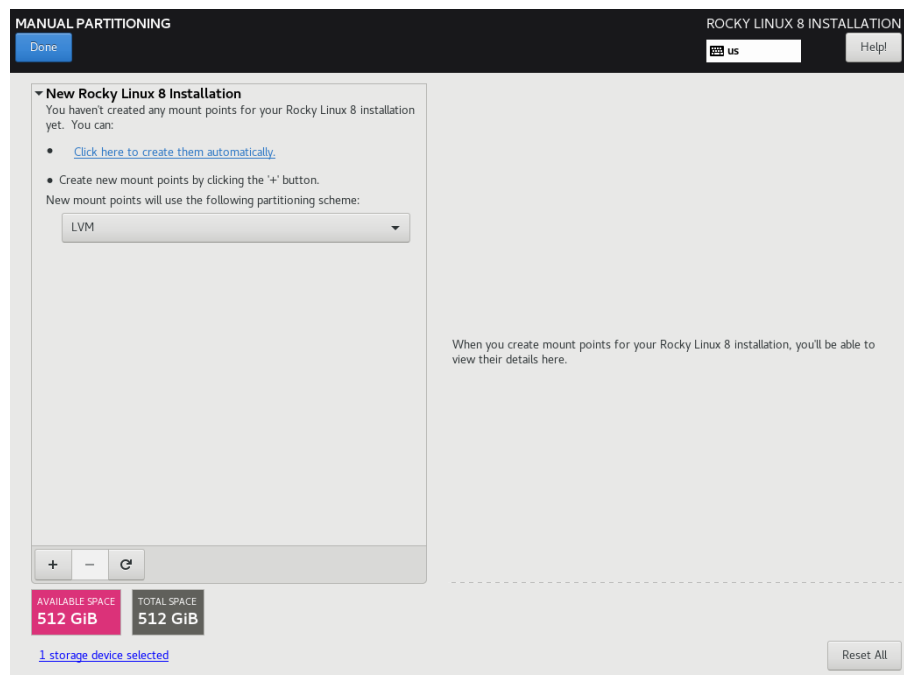


NOTE

If there is more than one hard drive attached to the system, you will see multiple hard drive icons displayed. In this case, select the hard drive where you wish to place the RedHawk installation, as well as any other drives that you wish to configure and/or format during the installation.

On this page, select **Custom** under **Storage Configuration** and then press **Done** in the upper left to continue.

9. You will now be presented with the **Manual Partitioning** page, which should appear similar to the following.

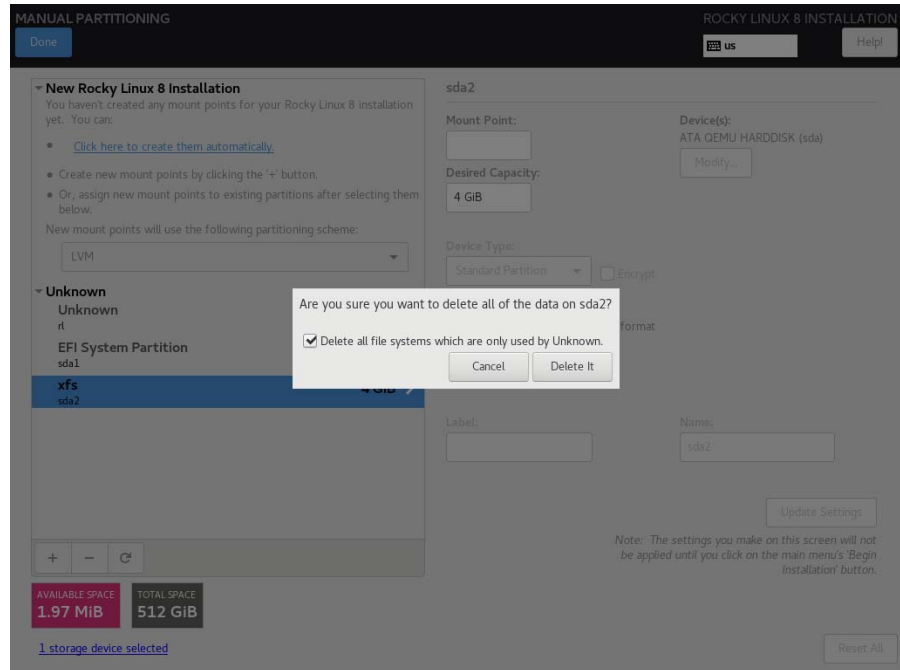


If the system's hard drive has been used previously, you should delete any existing partitions to start from a clean state.

NOTE

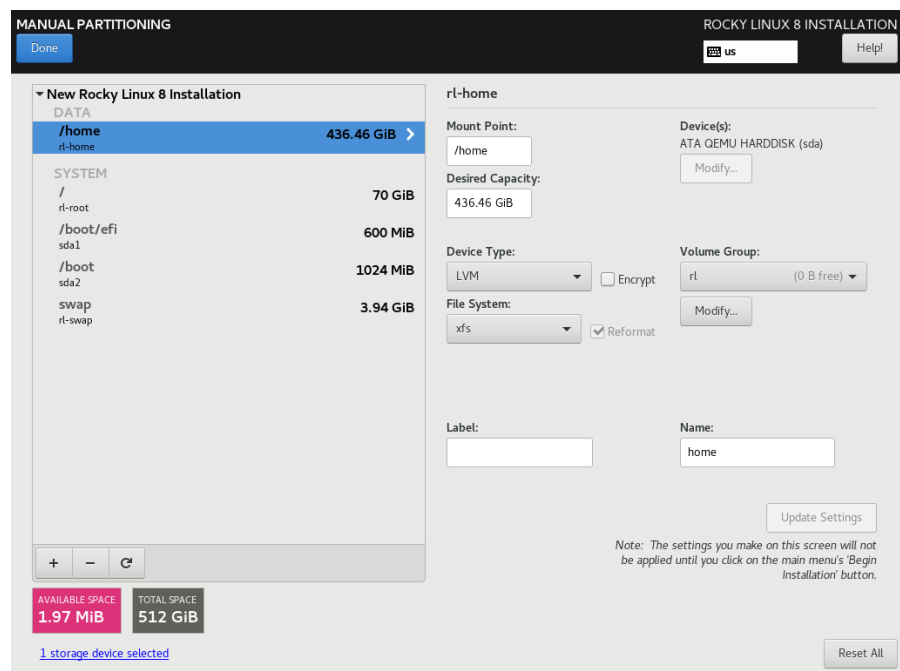
Deleting existing partitions is recommended unless you wish to create a multi-boot system. For example, one system with the ability to boot into multiple versions of RedHawk or possibly even Microsoft® Windows® operating systems. In these cases, consult with your system administrator as this document does not cover setting up a multi-boot system.

The following page illustrates selecting an existing / partition, clicking the “-” (minus) icon, checking the Delete all other filesystems checkbox, and finally pressing the Delete It button to delete an entire existing partitioning scheme, if necessary.



- On the Manual Partitioning page, press the Click here to create them automatically link to automatically create the necessary partitions required for your installation.

The following page shows an example of the automatically created partitions.



NOTE

The sizes of the automatically created partitions are inadequate; the following steps will adjust the partition sizes to be optimal for a RedHawk installation.

NOTE

Be careful not to accidentally press the **Done** or the **Reset All** buttons at this point. You must only press the **Done** button at the very end of modifying the partitions.

NOTE

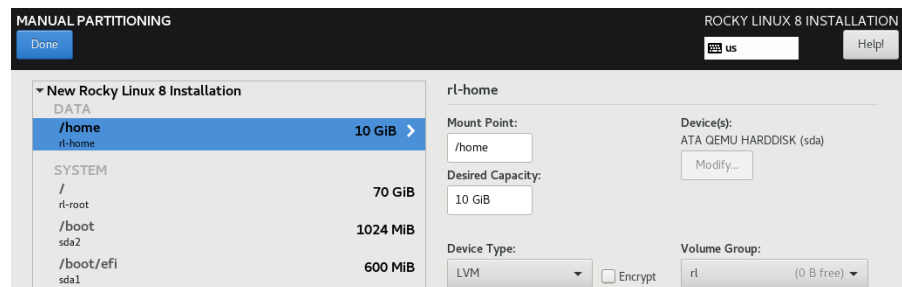
On systems configured to use UEFI, an additional `/boot/efi` partition will be automatically created as shown below. Do not modify this partition as it is already configured properly for a RedHawk installation.

11. On the **Manual Partitioning** page, select the `/home` partition, change the **Desired Capacity** to 10 GiB, and then press the **Update Settings** button.

NOTE

For smaller hard drives with 128 GB capacity or less, the separate `/home` partition should be eliminated by selecting it and pressing the `-` (minus) key at the bottom of the partition list. Then, skip to the next step and ignore `/home` in all of the examples.

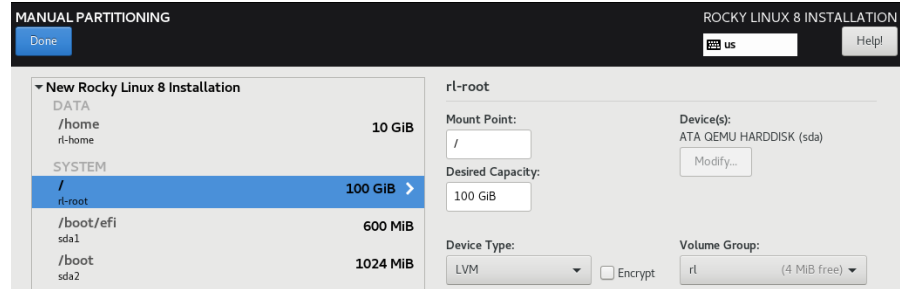
The following snippet shows an example of what should now be displayed:

**NOTE**

Setting the `/home` partition to 10 GB is only a temporary change that is required in order to allow the other partitions to be resized.

- Next, select the / partition, change the Desired Capacity to 100 GiB, and then press the Update Settings button.

The following snippet shows an example of what should now be displayed:

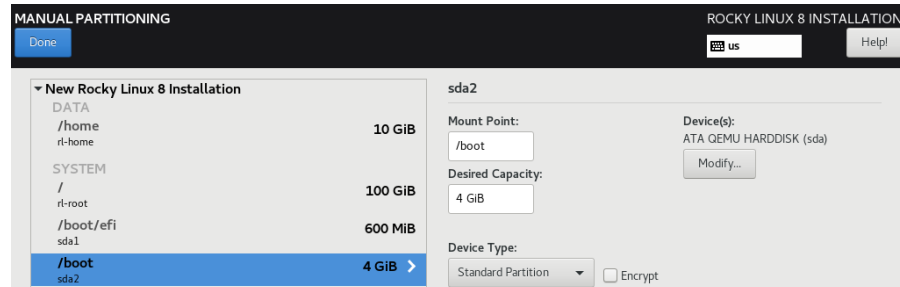


NOTE

For smaller hard drives with 128 GB capacity or less you can leave the default for the / partition and skip to the next step to create the boot partition.

- Next, select the /boot partition, change the Desired Capacity from 1024 MiB to 4096 MiB, and then press the Update Settings button.

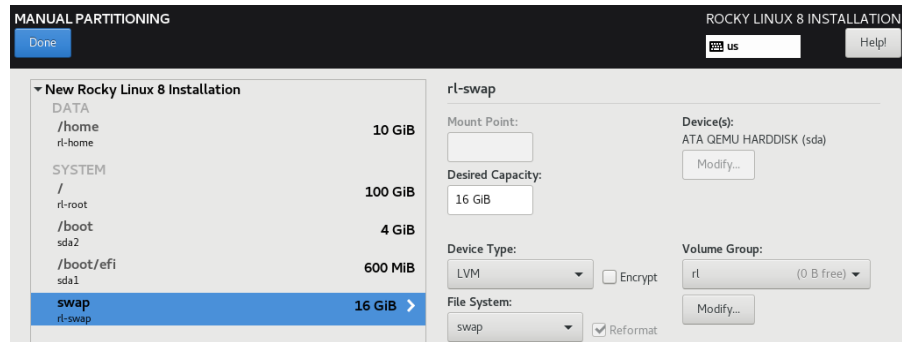
The following snippet shows an example of what should now be displayed:



- Next, select the swap partition, change the Desired Capacity to match the size recommended in the following table, and then press the Update Settings button.

Main Memory Size (GB)	Recommended Swap Partition Size
0 - 3	2048 MiB
4 - 15	4096 MiB
16 - 63	8192 MiB
64 - 255	16 GiB
256 - 511	32 GiB
512 - 1024	64 GiB

The following snippet shows an example of what should now be displayed:

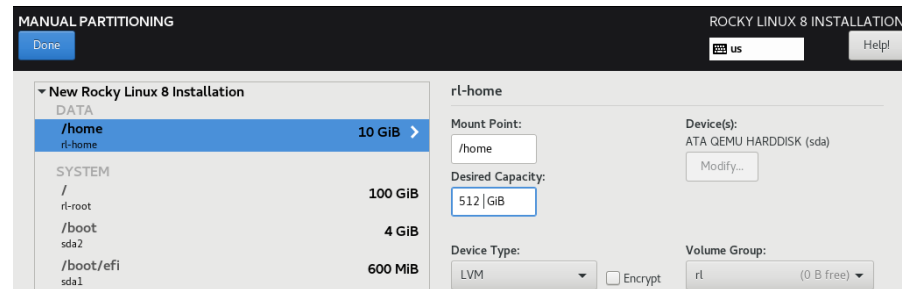


15. Lastly, select the `/home` partition again, enter the complete size of the disk (in this example the disk is 512 GiB) in the **Desired Capacity** box and then press the **Update Settings** button to set the size to the maximum size available from the disk space remaining.

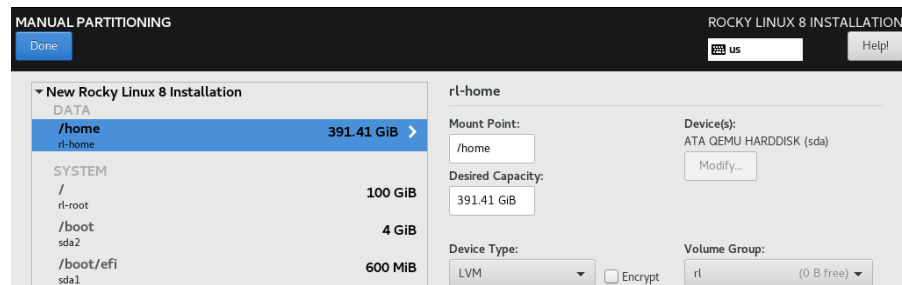
NOTE

For smaller hard drives with 128 GB capacity or less, the `/home` partition should have been deleted above, so you can perform this step with the `/` partition instead; thus, the `/` partition size will be set to the maximum size available using all remaining disk space.

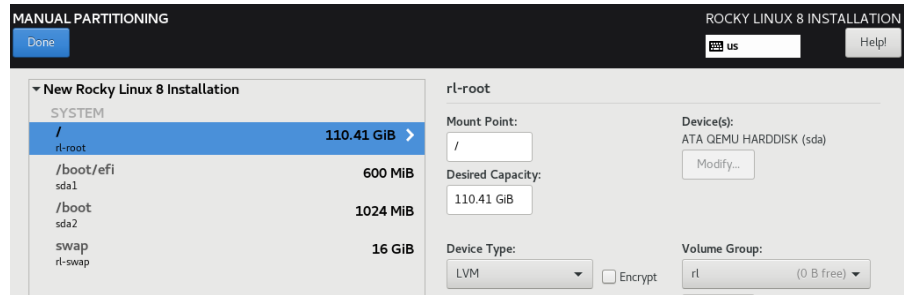
The following snippet shows `/home` size being set to the whole disk:



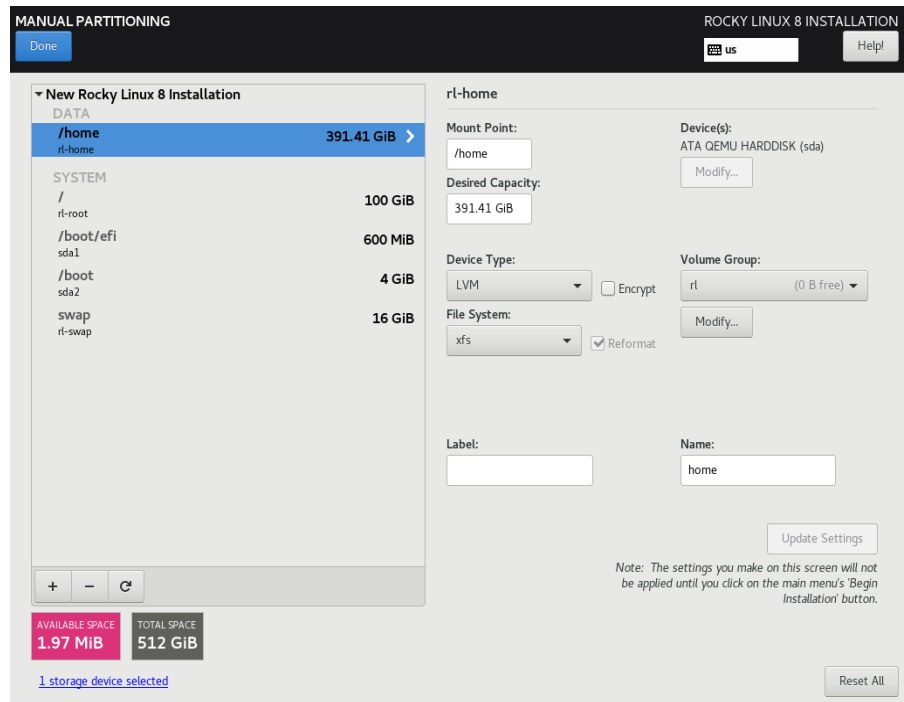
When you press **Update Settings**, it will set it to the maximum available size:



Alternatively, here is an example of what should now be displayed for systems with smaller hard drives, with 128 GB capacity or less, that should not have a /home partition:

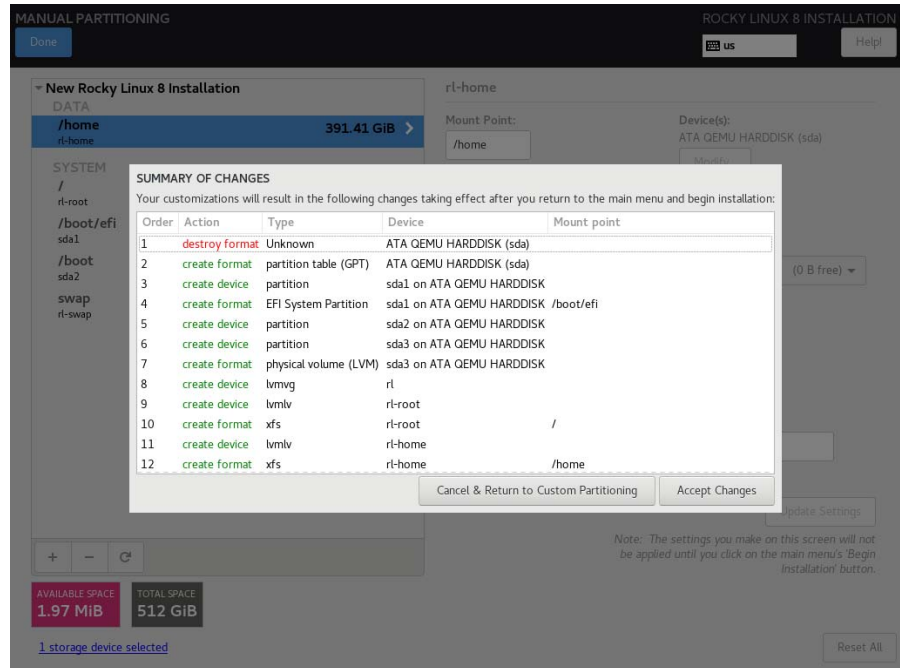


16. At this point, you should now see a Manual Partitioning page similar to the following:



Finally, press the Done button to use this layout for the system's partitioning.

17. You will now be presented with a Summary of Changes confirmation screen similar to the following:

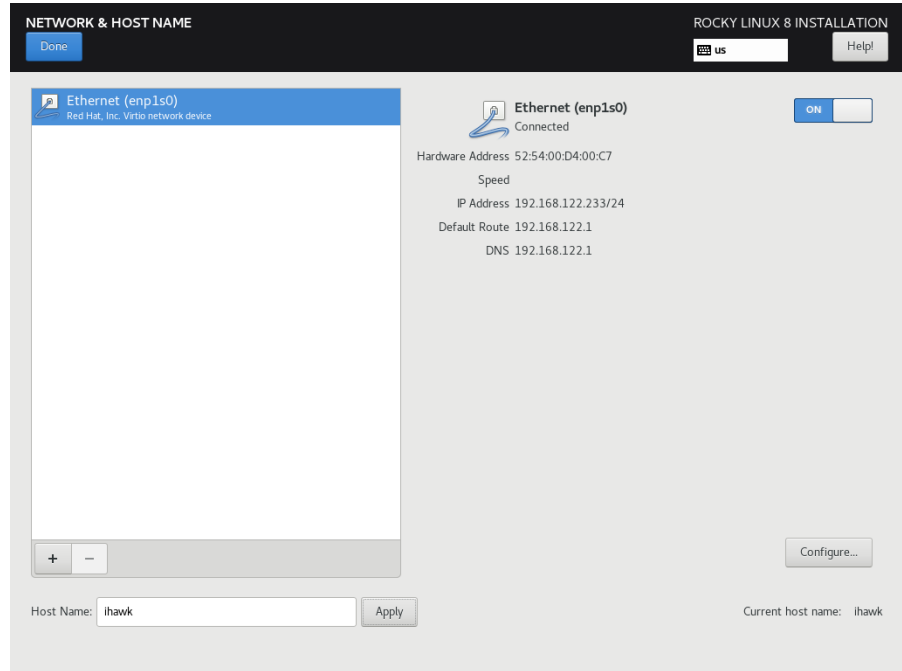


Next, press **Accept Changes** to accept the custom partitioning.

18. Back on the Installation Summary page, click on **Network & Hostname** to set the system's hostname and networking configuration. Type in the hostname on the box at the bottom of the page and click on the **Apply** button next to it.

For each network connection device shown on the left, toggle the connection button to the right to the **ON** position to connect to that network automatically.

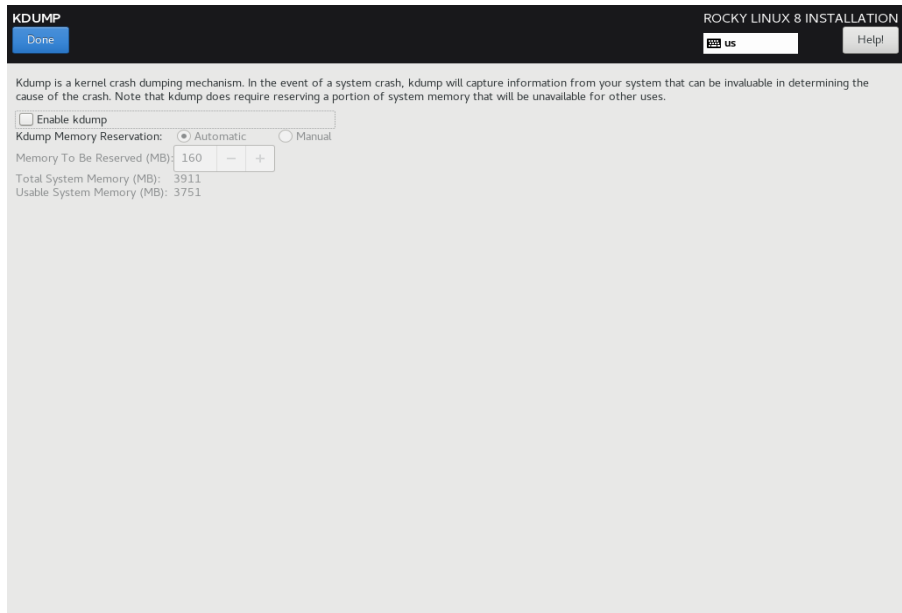
An example page follows:



Ensure the connected device is set to ON and press Done when you have finished configuring all of the networking details.

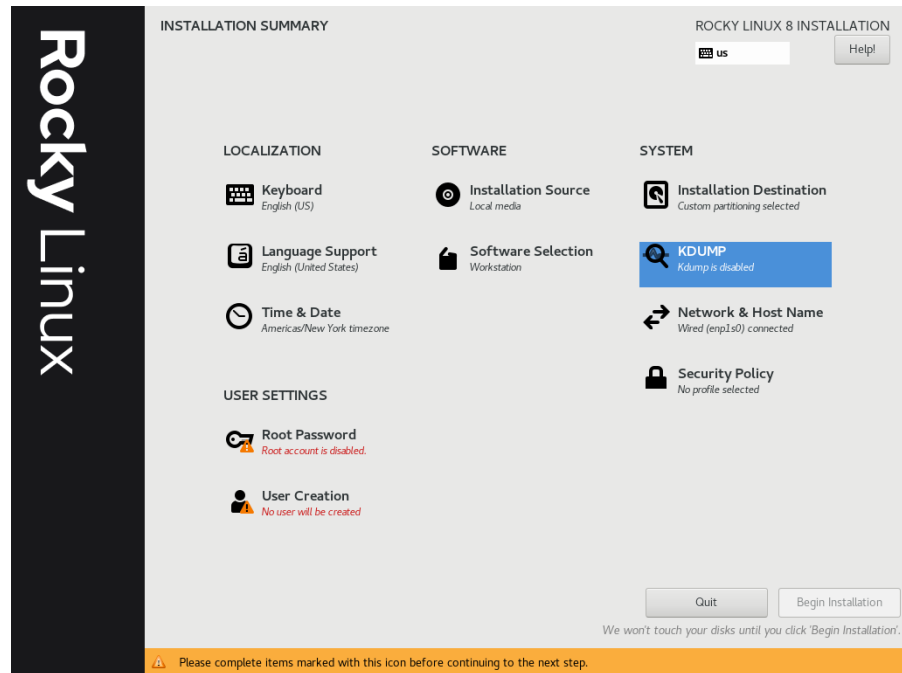
19. Back on the Installation Summary page, click on Enable kdump to deconfigure the default kernel crash dump settings.

The following screen shows the default kernel crash disabled:



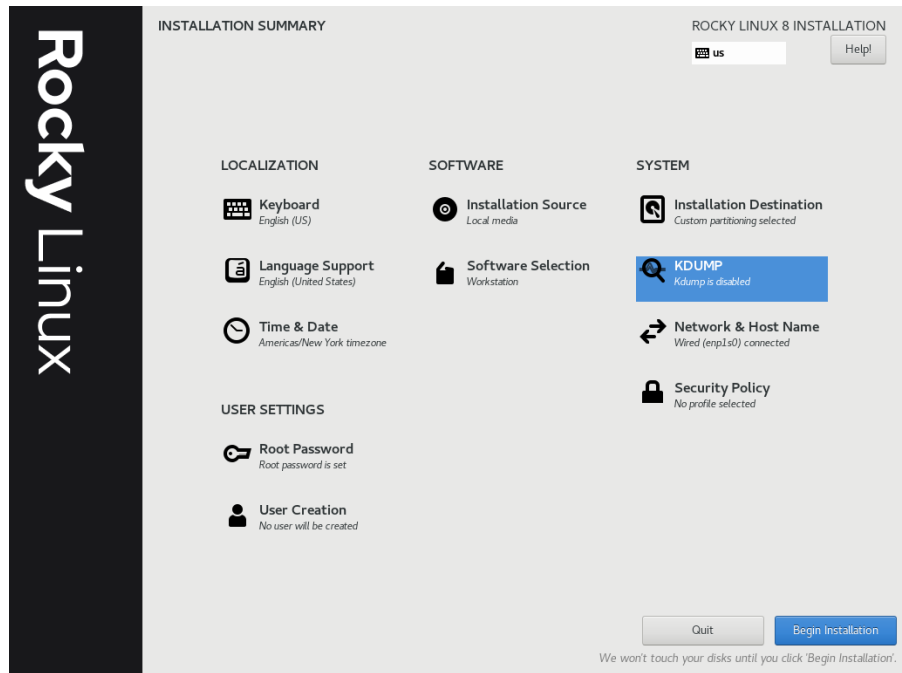
Uncheck the Enable kdump check box and then press Done.

20. The Installation Summary page should now be similar to what is shown in the following example screen:



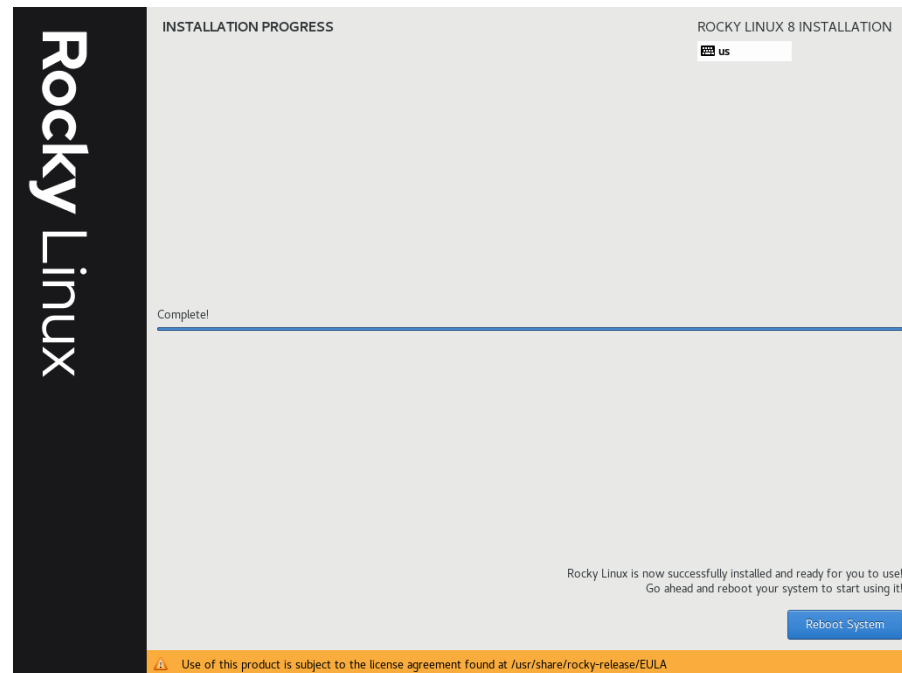
Before you can begin the installation you must set the system's root password and optionally also create a non-root user. Under the **USER SETTINGS** click on **Root Password** to set the root password. Although the **User Creation** is optional, it is highly recommended that you also create one at this time. Once the root password is created, the **Begin Installation** button will be visible.

The following page shows the root password has been created and the **Begin Installation** button is available.



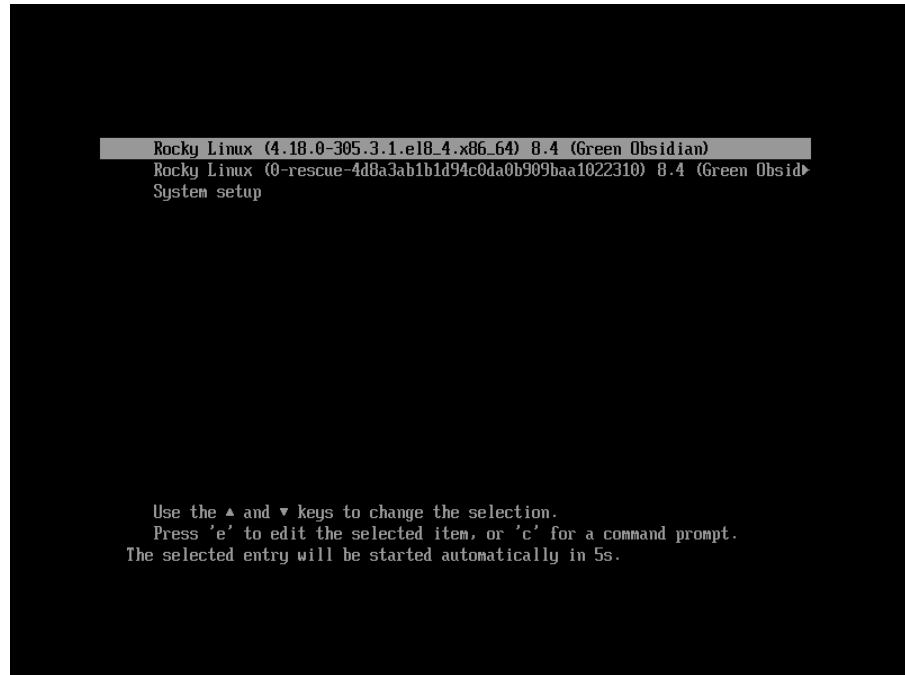
Click on the **Begin Installation** button on the lower-right of the screen to start package installation.

21. After all packages have been installed you will see the following screen.



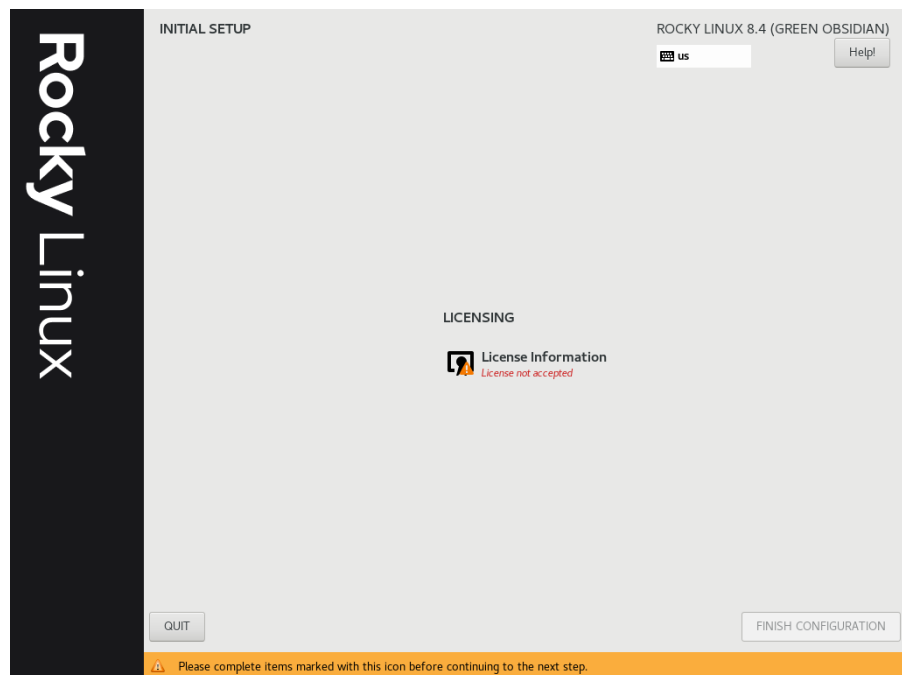
Remove the installation Blu-ray disc and press **Reboot** in the lower right to restart the system and continue.

22. You should see the following grub screen displayed after the system restarts.



Press the Enter key or allow the grub screen to timeout to boot the newly installed system.

23. Once the system has almost fully booted, the boot process will pause and require you to accept the Rocky license agreement, as shown in the following screen:



Click on the **License Information** icon. On the resulting screen check the **I accept the license agreement** checkbox at the bottom of the screen and then press the **Done** button at the top left. The following screen should now be displayed:

Finally, press the **Finish Configuration** button and the system will boot up to a graphical login. Login as root.

NOTE

During each user's first graphical log in, the user will be presented with various screens to configure localization, create users, connect to external resources, etc. before they will be able to use the system.

Next, to bring up a terminal window, click on the **Activities** menu at the top of the screen and then on the terminal icon that appears on the left side of the screen.

The preliminary installation of Rocky is complete. Proceed to the next section to complete the Rocky installation and update.

5.1.2 Installing Rocky Updates

Install the disc labeled Rocky Updates Version 8.4. This contains the latest updates released by Rocky which have been validated by Concurrent Real-Time on RedHawk Linux. These updates are important to the proper operation of RedHawk Linux.

Execute the following instructions on the console or in a terminal window running as root.

1. Log in as root and take the system down to single-user mode:
 - a. At the system prompt, type **init 1**.
 - b. Enter the root password at the rescue prompt to access the shell.
2. If the optical media did not mount automatically, execute the **mount** command appropriate for mounting your optical device.

NOTES

NOTE 1: A specific mount point may not have been created under **/run**, **/mnt** or **/media**.

If not, you can often identify the device file associated with your optical media device by looking for files matching the following patterns:

```
ls /dev/cd* /dev/dvd*
```

If these files are not present, you should examine the boot messages in **/var/log/messages** and look for your optical media device and find the associated **/dev** file.

Once located, you can mount the device with commands similar to the following:

```
[ -d /media/dvd ] || mkdir -p /media/dvd
mount device-name /media/dvd -o ro
```

where *device-name* is the `/dev/` file you located.

NOTE 2: Do *not* mount the device on the `/mnt` or `/media` directories; you must use a subdirectory of one of these directories. Failure to follow this advice may cause the installation to abort.

- Execute the following commands to install the update software, substituting the actual mount point used for your optical media disc device:

```
cd /path-to-actual-mount-point
./install-updates
```

NOTE

If you cannot execute the `install-updates` script (it fails with Permission Denied), or if you attempt to execute it by launching it from a file browser and it immediately returns, the optical media may have been mounted with the `noexec` option.

Run the `mount` command (without arguments) and check the options. If `noexec` is present, remount the optical media using:

```
mount -o remount,exec mount-point
```

where *mount-point* is the directory name in the output of the previous `mount` command for that optical media. For example:

```
> mount | fgrep noexec
/dev/scd0 on /media/Rocky8.4-Updates type iso9660 (ro,noexec)

> mount -o remount,exec /media/Rocky8.4-Updates
```

- The installation script will first ask you to confirm that you want to proceed with updating Rocky packages. Type `Y` and press `Enter` to continue.

The installation script will then ask if you wish to install additional Rocky packages required by RedHawk. Concurrent Real-Time recommends that you simply press `Enter` to install the full set of Concurrent Real-Time-recommended package updates.

The Rocky operating system will be updated from packages in the Update Blu-ray disc. No action is required of you during this step.

```

root@ihawk:/run/media/root/Rocky-8.4-Updates-x86_64
File Edit View Search Terminal Help
[root@ihawk Rocky-8.4-Updates-x86_64]# ./install-updates

This script will apply updates for the Rocky Linux packages currently
installed on this system.

You will also have the option of installing additional Rocky Linux
packages to prepare for installing RedHawk Linux and optional Concurrent
Real-Time software.

Do you want to continue? [y/n] y

In addition to installing updates, would you like to also install additional
packages to prepare for installing RedHawk Linux and optional Concurrent
Real-Time software? [y/n] (yes) y

Installing updates:

Last metadata expiration check: 0:00:03 ago on Mon 25 Oct 2021 12:51:50 PM EDT.
Dependencies resolved.
=====
Package      Arch  Version                Repository              Size
=====
Installing:
kernel       x86_64 4.18.0-305.19.1.el8_4

```

NOTE

During the update, a failure to restore the java.security file can be safely ignored.

NOTE

If the update appears to stall for several minutes shortly after pressing the **Enter** key, it is very likely that the Rocky package update checking service has locked the RPM package database to check for any available Rocky package updates. Simply issue a **killall packagekitd** at a bash shell prompt to safely allow the installation to continue.

Once the update of the Rocky operating system has completed, packages required by RedHawk will now be installed. No action is required of you during this step.

```

root@ihawk:/run/media/root/Rocky-8.4-Updates-x86_64
File Edit View Search Terminal Help

Installing additional packages:

Last metadata expiration check: 0:07:20 ago on Mon 25 Oct 2021 12:51:50 PM EDT.
Package accountsservice-0.6.55-1.el8.x86_64 is already installed.
Package alsa-lib-1.2.4-5.el8.x86_64 is already installed.
Package atkmm-2.24.2-7.el8.x86_64 is already installed.
Package atk-2.28.1-1.el8.x86_64 is already installed.
Package audit-libs-3.0-0.17.20191104git1c2f876.el8.1.x86_64 is already installed
.
Package bash-4.4.20-1.el8_4.x86_64 is already installed.
Package bc-1.07.1-5.el8.x86_64 is already installed.
Package binutils-2.30-93.el8.x86_64 is already installed.
Package bison-3.0.4-10.el8.x86_64 is already installed.
Package cairo-gobject-1.15.12-3.el8.x86_64 is already installed.
Package cairomm-1.12.0-8.el8.x86_64 is already installed.
Package cairo-1.15.12-3.el8.x86_64 is already installed.
Package chkconfig-1.13-2.el8.x86_64 is already installed.
Package coreutils-8.30-8.el8.x86_64 is already installed.
Package cpio-2.12-10.el8.x86_64 is already installed.
Package cpp-8.4.1-1.el8.x86_64 is already installed.
Package cryptsetup-2.3.3-4.el8.x86_64 is already installed.
Package dbus-glib-0.110-2.el8.x86_64 is already installed.
Package dbus-libs-1:1.12.8-12.el8_4.2.x86_64 is already installed.
Package dbus-x11-1:1.12.8-12.el8_4.2.x86_64 is already installed.

```

NOTE

While the messages displayed during package updates appear to indicate that package *downloading* is occurring, no actual network access is performed when using the Updates Blu-ray disc.

5. Upon completion of the system update as shown in the image below, the system will be ready for the RedHawk Linux installation.

```

root@ihawk:/run/media/root/Rocky-8.4-Updates-x86_64
File Edit View Search Terminal Help

qt5-qtwebchannel-5.12.5-1.el8.x86_64
qt5-qtwebsockets-5.12.5-2.el8.x86_64
qt5-qtxmlextras-5.12.5-1.el8.x86_64
recode-3.6-47.el8.x86_64
rocky-logos-httpd-84.5-8.el8.noarch
systemtap-sdt-devel-4.4-11.el8_4.0.1.x86_64
tcsh-6.20.00-13.el8.x86_64
texlive-lib-7:20180414-20.el8.x86_64
tftp-server-5.2-24.el8.x86_64
xinetd-2:2.3.15-24.el8.x86_64
xz-devel-5.2.4-3.el8.1.x86_64

Complete!

All updates have been applied.

Please contact Concurrent Real-Time technical support if you had any
problems during this installation (http://www.concurrent-rt.com/support
or 1-800-245-6453).

Note that you may rerun this script at any time. You can also mount
this DVD and use dnf(8) to access its contents. See the RedHawk Linux
Release Notes for more information.

[root@ihawk Rocky-8.4-Updates-x86_64]#

```

6. When the update completes, execute the following commands:

```
cd ..  
eject
```

NOTE: If there is more than one media device, you must specify the device to be ejected; e.g., **eject /dev/sr1**.

7. Remove the disc from the optical media drive and store.
8. Type “reboot” at the system prompt and verify that the new Rocky kernel boots.
9. Continue with the steps in the next section to install RedHawk Linux.

5.2 Installing RedHawk Linux

After completing the installation of Rocky in the previous section, perform the following steps to install RedHawk Linux:

1. Log in as root and take the system down to single-user mode:
 - a. At the system prompt, type **init 1**.
 - b. Enter the root password at the rescue prompt to access the shell.
2. Locate the disc labeled “RedHawk Linux Version 8.4” appropriate to your system’s architecture and insert it into the optical media drive.
3. If the device does not mount automatically, execute the **mount** command appropriate for your optical media device.
4. Execute the following commands to install RedHawk Linux, substituting the actual mount point used for your optical media device if necessary:

```
cd /path-to-actual-mount-point
```

```
./install-redhawk
```

```

root@ihawk:/run/media/root/RedHawk-8.4-x86_64
File Edit View Search Terminal Help
[root@ihawk RedHawk-8.4-x86_64]# ./install-redhawk
This process will install the RedHawk Linux core files
for RedHawk Linux 8.4 (Hadron) on the current system (ihawk).

Do you want to install RedHawk Linux? [y/n] y

-----
Concurrent Real-Time End-User License Agreement (the EULA).

This license should be read before acceptance of its terms. If the terms
are not acceptable then you must reject the license and terminate the
installation process.

A copy of this license may be found in /usr/share/doc/ccur/RedHawk-EULA
after installation.
-----

View, Accept, or Reject the terms of this license? [v/a/r] a

Would you like to install 32-bit compatibility packages? [y/n] (y)

This system does not appear to have an NVIDIA graphics card.
We do not recommend installing RedHawk NVIDIA graphics packages.

Install RedHawk NVIDIA graphics packages anyway? [y/n] (n) █

```

The installation script will prompt you to accept or reject the End User License Agreement. You can view the agreement by entering “v” at the prompt. Two installation options are then presented. The first option is to install 32-bit compatibility packages. The default action is to install.

The second installation option is to install the RedHawk NVIDIA graphics packages. The recommended action is dependent on whether an NVIDIA graphics card is detected on the system. If detected, the default action is yes to install; otherwise the default is no, do not install. When opting to install the RedHawk NVIDIA packages, you are also then prompted with an option to install NVIDIA CUDA packages.

NOTE

While the messages displayed during RedHawk installation appear to indicate that package *downloading* is occurring, no actual network access is performed when using the RedHawk DVD.

NOTE

It is normal for the installation script to appear to be stalled near the end of installation. It is performing several background operations that are required and the script must not be interrupted.

- The following messages will be displayed once all RedHawk package installation has completed successfully.

```

root@ihawk:/run/media/root/RedHawk-8.4-x86_64
File Edit View Search Terminal Help
Preparing      :                               1/1
Installing     : nuu-2.1.7-1.rhel8.x86_64     1/3
Running scriptlet: ccur-RedHawk-8.4-repo-3-2.noarch 2/3
Installing     : ccur-RedHawk-8.4-repo-3-2.noarch 2/3
Running scriptlet: ccur-RedHawk-8.4-repo-3-2.noarch 2/3
Running scriptlet: ccur-RedHawk-8.4.n-repo-3-2.noarch 3/3
Installing     : ccur-RedHawk-8.4.n-repo-3-2.noarch 3/3
Running scriptlet: ccur-RedHawk-8.4.n-repo-3-2.noarch 3/3
Verifying      : ccur-RedHawk-8.4.n-repo-3-2.noarch 1/3
Verifying      : ccur-RedHawk-8.4-repo-3-2.noarch 2/3
Verifying      : nuu-2.1.7-1.rhel8.x86_64      3/3
Installed products updated.

Installed:
ccur-RedHawk-8.4-repo-3-2.noarch      ccur-RedHawk-8.4.n-repo-3-2.noarch
nuu-2.1.7-1.rhel8.x86_64

Complete!

The RedHawk Linux installation is complete.

Please contact Concurrent Real-Time technical support if you had any
problems during this installation (http://www.concurrent-rt.com/support
or 1-800-245-6453).

[root@ihawk RedHawk-8.4-x86_64]#

```

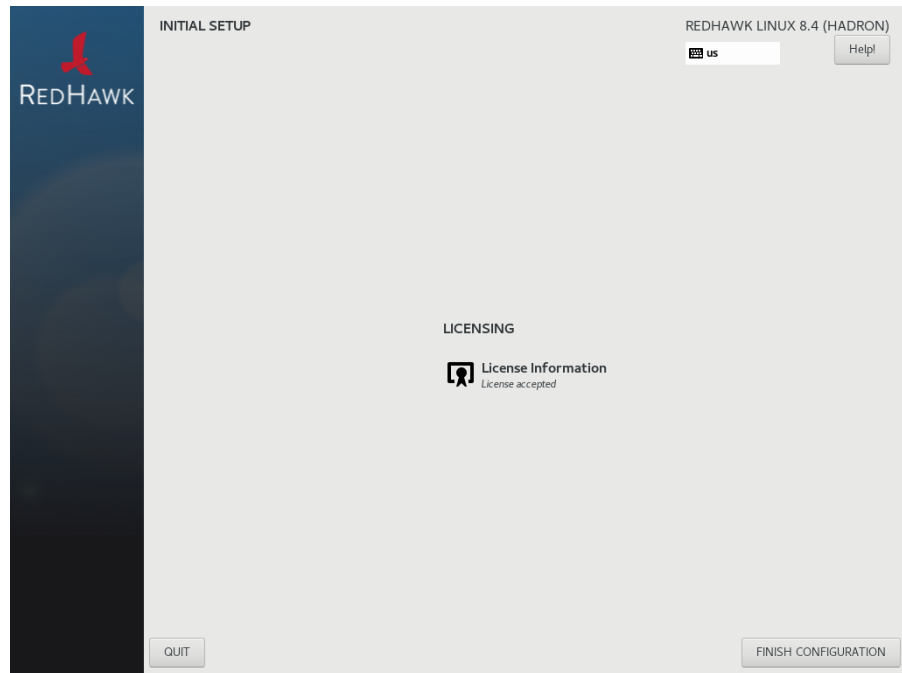
- When the installation completes, execute the following commands:


```

cd ..
eject

```
- Remove the disc from the drive and store.
- Reboot the system choosing a new RedHawk kernel and verify that the system starts booting properly.
- Once the system has almost fully booted, the boot process will again pause and allow you to accept or reject the RedHawk license agreement, as

shown in the following screen:



If you wish to accept the RedHawk license agreement simply press the **Finish Configuration** button and allow the system to continue to boot up to the graphical login screen.

NOTE

Desktops icons are not supported on the default Standard (Wayland display server) but are supported in some of the other options, such as the Classic (Wayland display server).

To switch to another display server, simply log off and, from the login screen, click on your username. At this point, click on the gear to the left of the Sign In button, and select a display server.

If you are running on a display server that supports desktop icons (see note above), you must right-click and select “Allow Launching” in order to launch the RedHawk icons.

10. If you are installing an RCIM on your system, please refer to the accompanying document ‘Real-Time Clock and Interrupt Module (RCIM) User’s Guide’. Otherwise, proceed to the following section to install Frequency-Based Scheduler (FBS).

5.3 Installing the Frequency-Based Scheduler (FBS)

FBS is an optional package to RedHawk Linux. If you will be using FBS, install it at this time by performing the following steps:

1. With RedHawk Linux Version 8.4 running, log in as root and take the system down to single-user mode.
2. Locate the disc labeled “RedHawk FBS Version 8.4” appropriate to your system’s architecture and insert it into the optical media drive.
3. If the optical media disc device does not mount automatically, execute the **mount** command; for example:

```
mount /media/dvd
```

4. To install, execute the following commands:

```
cd /path-to-actual-mount-point  
./install-fbs
```

Follow the on-screen instructions until the installation script completes.

5. When the installation completes, execute the following commands:

```
cd ..  
eject
```

6. Remove the disc from the optical media drive and store.
7. Exit single-user mode (Ctrl-D).

5.4 Installing Additional RedHawk Products

If you will be installing any additional RedHawk products, do so now. Refer to the products’ documentation for installation instructions.

5.5 Installing RedHawk Updates from Disc

Discs labeled “RedHawk Update Disc” include updates to RedHawk and its products. If a RedHawk Updates disc is provided, install it now.

1. Ensure that the system is in multi-user mode.
2. Locate the disc labeled “RedHawk Update Disc” appropriate to your system’s architecture, insert it into the drive.
3. If the disc device does not mount automatically, execute the **mount** command; for example:

```
mount /media/dvd
```

4. Execute the following commands to install the RedHawk updates included on the disc:

```
cd /path-to-actual-mount-point  
./install-updates
```

When the installation is complete, the Main window for Concurrent Real-Time’s Network Update Utility (NUU) displays, listing product updates that complete your installation of RedHawk. Depending on the installation state of your Concurrent Real-Time products, the NUU Main window may show software modules which are out of date.

Before installing any modules, check for NUU updates separately. Apply any NUU updates and then restart NUU before applying any other updates.

NOTE

You should disable the external Rocky repositories (Base, Updates and Contrib) before continuing. Select **Edit Configuration** in the **Repositories** menu to disable these repositories.

With NUU up-to-date, from the NUU Main window, click on the **Select Update of All Out-of-Date** button, then click on the **Apply Actions** button to install all listed product updates.

5. When the installation completes, execute the following commands:

```
cd ..
eject
```

6. Remove the disc from the optical media drive and store.
7. If there are more update discs, repeat these steps to install all updates.
8. Reboot the system choosing the updated RedHawk kernel and verify that the system boots properly.
9. Check for additional RedHawk updates available through the RedHawk Updates web site as outlined in the following section.

5.6 Installing RedHawk Updates from Web Site

1. Additional updates may have been issued (that are not included on any “RedHawk Update Disc” you may have received). They should be downloaded and installed now. Refer to “Software Updates” on page 62 for details.
2. When complete, or if no updates are available, reboot the system choosing the new RedHawk kernel and verify that the system boots properly.

6.0. NVIDIA Graphics Configuration

The Unified NVIDIA Linux Display Driver (version 470.74) is included in the RedHawk Linux installation and built automatically for all pre-built and custom RedHawk Linux kernels. The RedHawk installer probes for the type and model of video adapters present in the system, and recommends installing the unified `ccur-nvidia-glx` rpm when it detects one or more NVIDIA video cards present.

See sections 6.1, "Supported NVIDIA GPUs" and 6.2, "Multiple NVIDIA Video Card Considerations" below for more information on NVIDIA driver compatibility.

6.1 Supported NVIDIA GPUs

If the `ccur-nvidia-glx` rpm has been installed on your system, you can view the list of all NVIDIA GPUs supported by the 470.74 driver in "Appendix A" in the following file:

```
/usr/share/doc/ccur-nvidia-glx-470-74/README.txt
```

Alternatively, you can examine the list of supported GPUs for driver 470.74 at the NVIDIA web site which is located at:

<http://www.nvidia.com>

Note that if your NVIDIA GPU is not supported by the 470.74 driver, you will have to do one of the following:

- replace the existing older NVIDIA card in your system with a newer NVIDIA card that is supported by the 470.74 driver
- go to the NVIDIA web site mentioned above and download a legacy NVIDIA driver that supports your NVIDIA card, and follow the installation instructions described on that driver's web page

NOTE

The NVIDIA driver that is provided with RedHawk installations has been modified to reduce jitter on shielded CPUs in a real-time environment. Therefore, if you choose to download and use a legacy NVIDIA driver directly from the NVIDIA web site, you may observe interference on shielded CPUs during graphics activity.

6.2 Multiple NVIDIA Video Card Considerations

Note that you may not use the unified 470.74 Driver and a legacy NVIDIA Linux Display Driver together at the same time.

If you have a system with a mix of legacy-only and unified-only NVIDIA video cards, you will only be able to use one set of cards (legacy or unified) at any single point in time.

It is highly recommended that you physically remove the legacy or unified video cards that you are not using so that they do not interfere with the card(s) that you are planning to use. Failure to do so may lock up your system or X11 session.

If you have a mixed video card system as described here, it is recommended that you upgrade your legacy NVIDIA video cards to unified video cards and use the unified 470.74 driver as your display driver.

6.3 Display Configurations

RedHawk comes with the GNOME windowing system which only supports multiple displays as a single continuous desktop spanning multiple displays with one controlling mouse and keyboard. Screens can be configured left, right, above, or below each other in any fashion.

NOTE

Earlier RedHawk releases that included GNOME 2 supported configuring each individual monitor of a multiple monitor setup as a separate desktop, however, this capability was dropped in GNOME 3. Advanced users who still wish to utilize separate desktops will need to install a different windowing system than GNOME 3, but that is beyond the scope of this documentation.

You can use the `nvidia-xconfig(1)` tool to recreate the X configuration file, `xorg.conf` and `nvidia-settings(1)` to customize the configuration. Both are briefly described below.

6.3.1 Single

Single mode is a single X Screen displayed as a single Desktop on a single monitor.

6.3.2 Multiple X Screens

The Multiple X Screens configuration consists of a single Desktop spanning multiple monitors. This mode has the following characteristics:

- A separate X Screen for each display is used.
- The mouse moves freely between displays.
- If you maximize a window, it fills a single display.
- You can drag objects from one display to another.
- This mode causes a little extra overhead for X.

6.4 Using nvidia-xconfig

When the NVIDIA driver is first installed, it will create the `/etc/X11/xorg.conf` file based on the system's NVIDIA configuration.

The `nvidia-xconfig` utility can also be used to recreate the file. It is suggested that the following precautions be taken:

1. Read sections 6.1 - 6.3 above and complete any actions required.

2. Run init 3 from the command line:
`init 3`
3. Save the `xorg.conf` file:
`mv -i /etc/X11/xorg.conf /etc/X11/xorg.conf.orig`
4. Run the `nvidia-xconfig` utility:
`nvidia-xconfig`
5. Run init 5 from the command line:
`init 5`

See the `nvidia-xconfig(1)` man page for details about using `nvidia-xconfig`.

You can customize the configuration further via the `nvidia-settings(1)` command. See “Using `nvidia-settings`” section below for more information on this command.

6.5 Using `nvidia-settings`

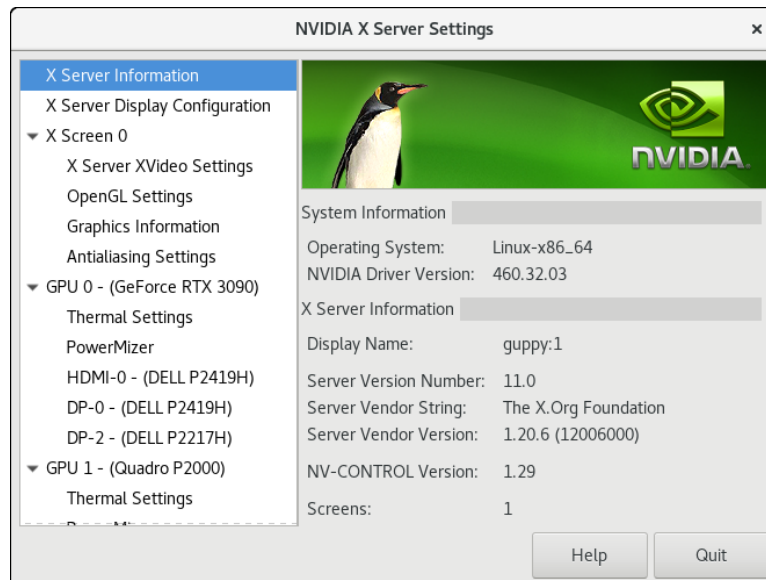
The `nvidia-settings` utility can be used to tune single display settings and also to configure a multidisplay configuration. See the `nvidia-settings(1)` man page for more details.

In the example that follows, a multidisplay configuration is modified using `nvidia-settings`.

To start the `nvidia-settings` utility, issue following the command:

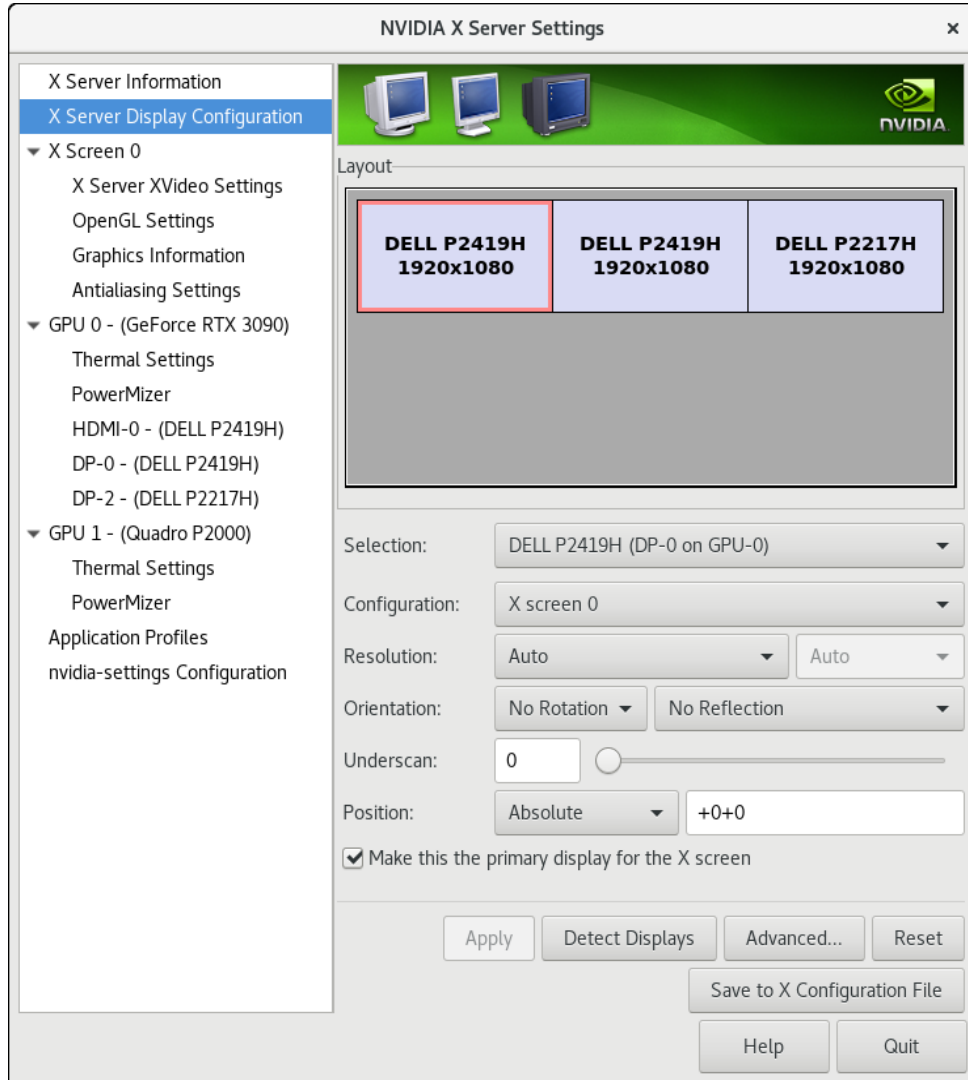
`nvidia-settings`

The GUI will start and you will see the “X Server Information” as indicated by the highlighted option on the left side:



On the left side of the screen, you can see that there are two NVIDIA cards on the system: GPU0, and GPU1. All three monitors are connected to the GPU0 card. On the right side, you have system information including the NVIDIA driver version.

To view the “X Server Display Configuration” select that option from the list on the left as shown highlighted below:



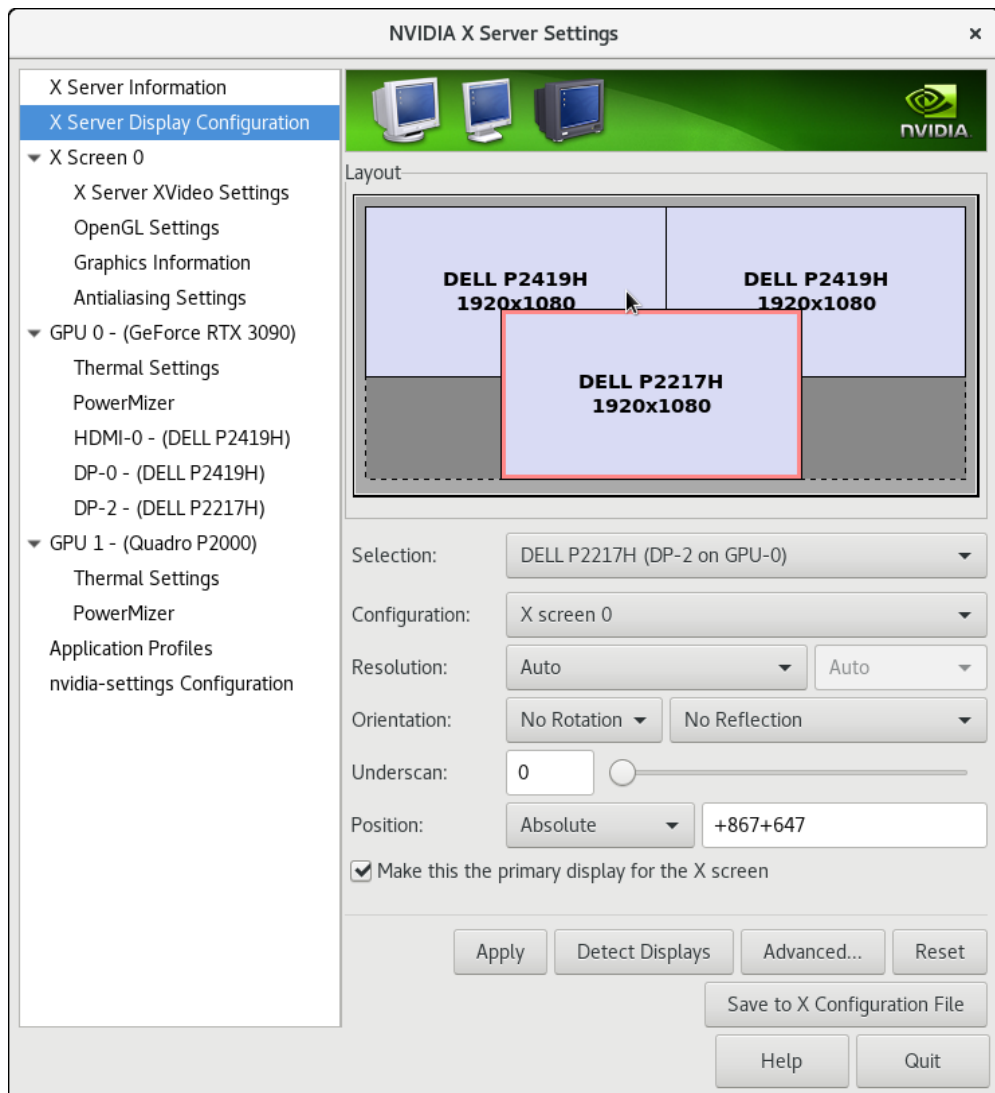
In the Layout window, we see a graphical depiction of the three displays detected. Notice that all the monitors were already configured by **nvidia-xconfig** on the first boot.

Click on the **Detect Displays** button if there are other monitors connected that are not shown in the Layout window.

While the displays were detected and configured, it is not the desired layout for this example. Currently the 2217H display is on the right and one of the 2419H displays is the primary. We want the P227H display to be in the middle position and to be the primary.

The image below shows we have selected the DELL 2217H display (as seen by the red outline around the box) and its configuration page is now displayed.

We have declared it to be the primary monitor (the screen where the desktop will be displayed) by checking the box labeled **Make this the Primary** for the X Screen. And currently we are dragging its box to the middle position for the desired layout.

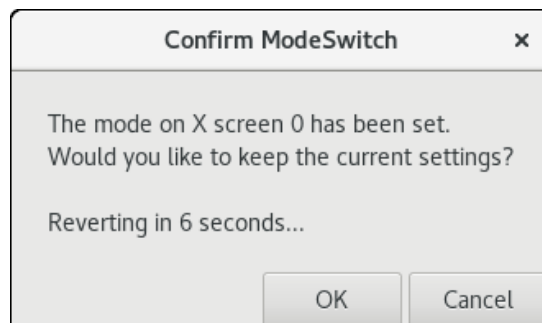


The result will look like the following image, with the displays side by side:

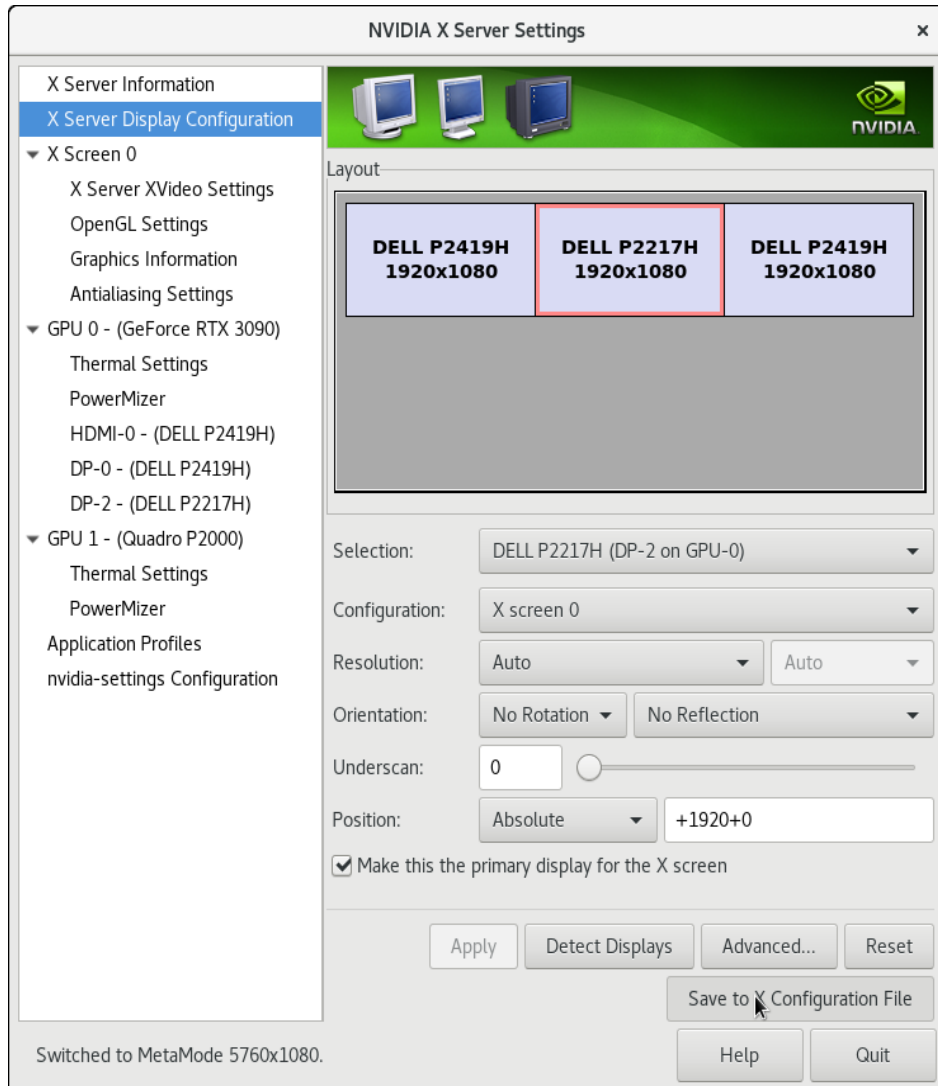


When you click on **Apply**, the changes will take effect immediately. The desktop will now appear on the display selected as primary, the DELL 2217H in this example.

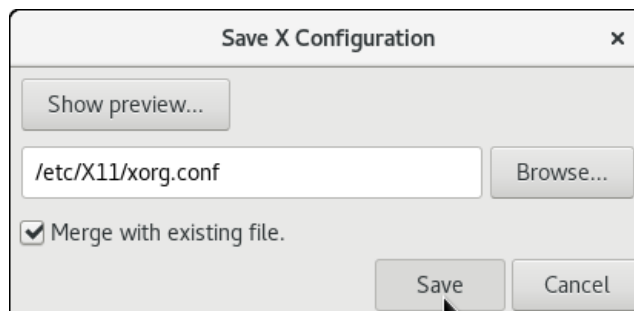
For some operations, such as changing the layout of the displays, a confirmation box will display and you will be given about 12 seconds to confirm the change or it will revert back to the previous setting. Press **OK** to accept the changes. If you were late in confirming and the changes were reverted, just click on the **Apply** button again.



Next step is to save the configuration changes to the **xorg.conf** file on the system. Click on **Save to X Configuration File** button as shown below to save the file:



A box labeled **Save X Configuration** will then appear. Choose **Save** to save the changes to the **/etc/x11/xorg.conf** file.



Use the **Quit** button at the right hand corner of the display to exit the tool.

6.6 Troubleshooting Problems

The X server looks for a configuration in `/etc/X11/xorg.conf` each time it starts up (normally in runlevel 5). You will find that newer versions of X are getting away from depending on configuration files and require only minimum information to create even the largest multidisplay configurations. In fact, X will work in default mode with NO configuration file at all.

It is not uncommon for obsolete options or incorrect settings specified in `xorg.conf` to cause the system to fail to start X correctly. Sometimes X will get so confused it won't be able to do anything but lock up, cause the system to panic or reboot, or just come up in some invalid video state.

Simply stopping and restarting X does not always restore correct functionality. It is best to issue the command(s):

```
init 1
init 5
```

or

```
reboot
```

See the X server actions logged in `/var/log/Xorg.<number>.log` and `Xorg.<number>.log.old`. Look for the most recently updated.

Normally, X will respond to errors at start up time by telling you there is a problem and offer to show you the log, then create a fresh configuration.

A fresh configuration looks very much like the configuration created by the installer.

If you are unable to create a working `xorg.conf` using the `nvidia-xconfig` utility, it may be because the directions were not followed precisely, or problems may have been created by hand edits after the fact. Take logical steps and verify functionality at the various steps.

Try removing `/etc/X11/xorg.conf` entirely, reboot to runlevel 3, and run `nvidia-xconfig`.

NOTE

Do not run `nvidia-xconfig` in run level 1 or single user mode. This will create an invalid `xorg.conf` file.

If you have the original `xorg.conf` created by the installer, but it's not working, you probably have the wrong driver defined for the primary video display defined by the BIOS. Try the following config:

```
Section "ServerLayout"
    Identifier      "Default Layout"
    Screen          0  "Screen0" 0 0
    InputDevice     "Keyboard0" "CoreKeyboard"
EndSection

Section "InputDevice"
    Identifier      "Keyboard0"
    Driver          "kbd"
EndSection
```

```

Section "Device"
    Identifier      "Videocard0"
    Driver          "vesa"
EndSection

Section "Screen"
    Identifier      "Screen0"
    Device          "Videocard0"
    DefaultDepth    24
    SubSection "Display"
        Viewport    0 0
        Depth       24
    EndSubSection
EndSection

```

In some cases, the PCI Bus ID is not stated in the **xorg.conf** file and the X server will not start without it. If this might be the case, append the PCI Bus ID to the last line of the Device Section.

To find the PCI Bus ID on your system, use the query option of the **nvidia-xconfig** tool as follows:

```

nvidia-xconfig -query-gpu-info | head -n 24
Number of GPUs: 2

GPU #0:
Name      : Quadro P2000
UUID      : GPU-424d5960-4d24-25bc-8081-3e64829b9e63
PCI BusID : PCI:129:0:0

Number of Display Devices: 0

GPU #1:
Name      : GeForce RTX 3090
UUID      : GPU-dblbf7e8-cf92-5127-f0e1-463eb8b39744
PCI BusID : PCI:1:0:0

Number of Display Devices: 3

```

From this output we can see that GPU #1 is the one with devices attached. If a PCI Bus ID line does not exist in the Section Device entry in the **xorg.conf** file, append one with the appropriate value for your system. For example:

```

Section "Device"
    Identifier      "Device 0"
    Driver          "nvidia"
    VendorName      "NVIDIA Corporation"
    BoardName       "GeForce RTX 3090"
    BusID           "PCI:1:0:0"
EndSection

```

Typical drivers in iHawk systems include:

- radeon – Common in many servers with embedded graphics chips
- nouveau – The generic Linux NVIDIA driver
- nvidia – Provided by NVIDIA or Concurrent Real-Time. NVIDIA drivers are modified by Concurrent Real-Time for real-time performance. Use the correct driver from Concurrent Real-Time to ensure the best performance for your system.

- vesa – The generic fall back low performance driver which should work for all VGA adapters.

NVIDIA has a number of generations of graphics cards which cannot all use the same “nvidia” driver version. Not even the generic “nouveau” driver in the Linux kernel works on all NVIDIA cards. The “nvidia” driver will actually disable an nvidia controller or fail to load if it is the wrong version for that card. You cannot mix cards of different generations if the driver does not support all of them.

There is no need to specify resolutions, refresh rates, and color depths for modern VGA adapters and Displays. It is best to allow the hardware and software to negotiate these settings.

WARNING

Using old configuration files is risky. It is not uncommon for obsolete options and entries to cause your system to hang, reboot, or prevent normal usage. You should start with these basic configs and gradually modify them with the options you think you need in order to create customized configurations.

7.0. Additional Information

This section contains helpful information about issues that may be applicable at your site.

7.1 Installation/Configuration Issues

7.1.1 File System Backup Recommendations

All file systems should be archived or preserved prior to commencing a re-installation. This can be accomplished using normal backup methods. Concurrent Real-Time recommends obtaining a new disk while keeping the original disk to ensure minimal data loss.

Table 7-1 contains a list of configuration files that may be useful in configuring a newly installed RedHawk system to match an existing configuration.

Table 7-1 Files Recommended for Backup

NOTE: This is not an all inclusive list and not all files are meant to be copied intact to a new system.

Path	Comments
/etc/hosts	To preserve hostnames on file.
/etc/fstab	To maintain existing mounts. Will not preserve mount points.
/etc/sysconfig/network	Network information.
/etc/sysconfig/network-scripts/ifcfg-*	Network device configuration.
/etc/resolv.conf	DNS configuration info.
/etc/nsswitch.conf	NIS/DNS configuration info.
/etc/ntp.conf /etc/ntp/step-tickers	NTP configuration. See ntpd(1).
/etc/rc.local /etc/rhosts	Startup info.
/etc/X11/xorg.conf	X11 server/device/screen configuration data.
/etc/modules.conf	For reference and comparison.
/etc/security/capability.conf	PAM configuration.
/etc/ssh/*	To preserve host keys.
/etc/inittab	For reference and comparison.
/etc/xinetd.d/	For reference and comparison. Capture any file customizations.
/var/spool/cron/	To preserve user crontab entries.
/sbin/systemctl -t service -a > <i>save_file</i>	For reference to configure new system.
/etc/*.conf	Customized configuration files.
/etc/sysconfig/*	Customized configuration files.
/etc/pam.d/*	Customized PAM files.
rpm files	Those installed after previous system installation that need to be moved forward to the new system. Use <code>/bin/rpm -qal --last more</code> to view.

7.1.2 File System Swap Size Guidelines

Table 7-2 supplies the recommended swap partition sizes for various sizes of main memory. The swap space allocations listed below should be adequate for all real-time systems.

Table 7-2 Swap Partition Size Guidelines

Main Memory Size (GB)	Recommended Swap Partition Size
0 - 3	2048 MiB
4 - 15	4096 MiB
16 - 63	8192 MiB
64 - 255	16 GiB
256 - 511	32 GiB
512 - 1024	64 GiB

7.1.3 How to Use Linux Rescue

An installation or upgrade may not boot if the following conditions exist:

- the disk LABEL scheme is not correct
- there are mismatching LABEL or partition entries in `/etc/fstab` and/or `/etc/grub2.cfg` -> `/boot/grub2/grub.cfg`
`/etc/grub2-efi.cfg` -> `/boot/efi/EFI/rocky/grub.cfg`

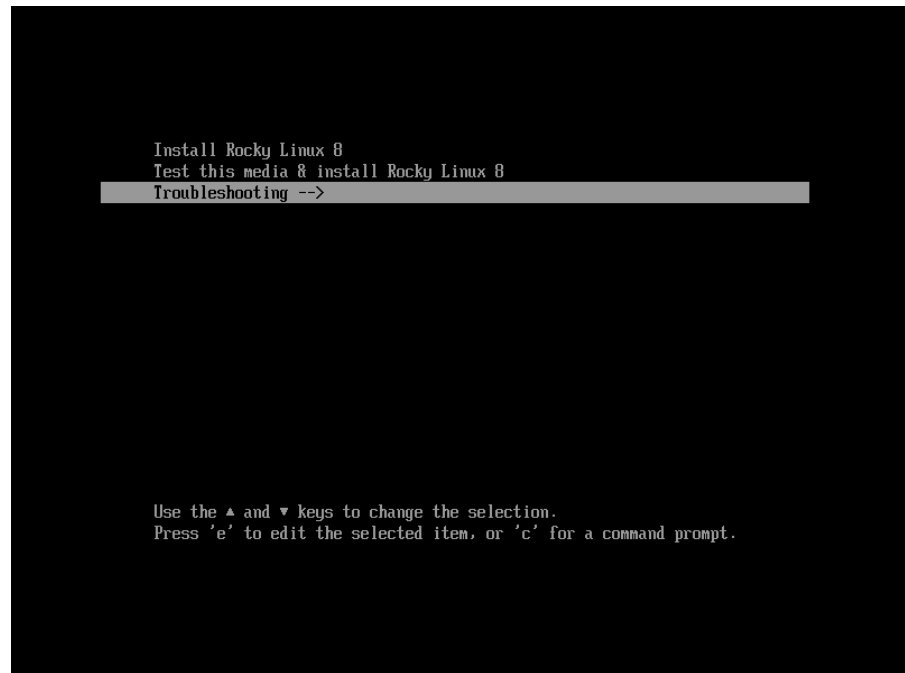
This can happen when dealing with multiple disks and can be extremely confusing.

It is possible to recover from these situations by booting into a Linux rescue image via the *Rescue a Rocky Linux system* boot option on the Rocky 8.4 installation media.

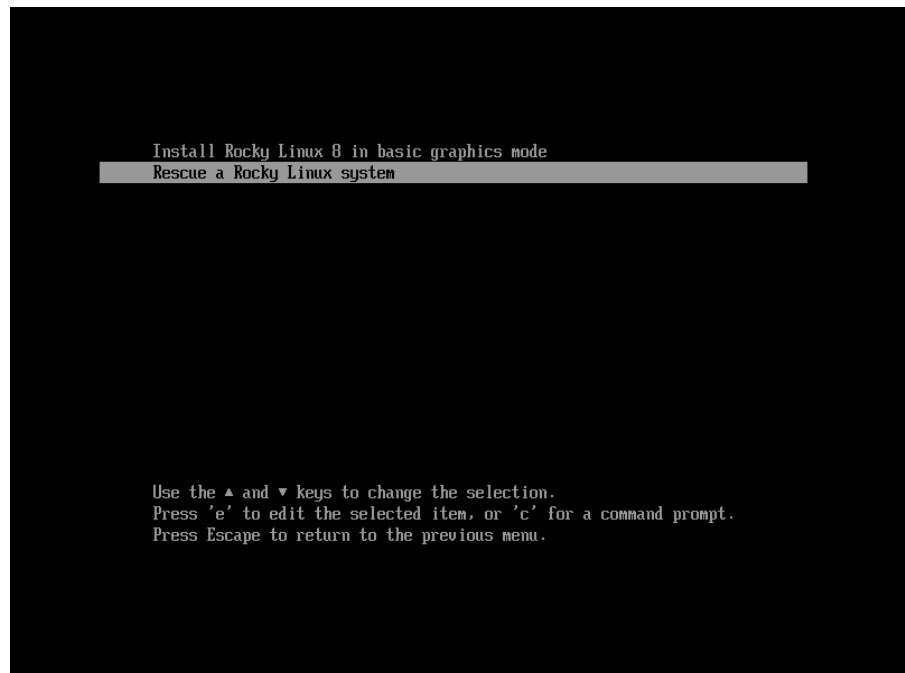
If you cannot boot after the installation or upgrade, perform the following steps.

1. Boot a Rocky 8.4 installation disc.

2. Once the grub menu is displayed use the arrow keys to select Troubleshooting as shown in the following screen.



3. Press **Enter** and then select Rescue a Rocky Linux system as shown in the following screen.



- Press Enter and the system will boot into rescue mode from the live Blu-ray Disc. Once fully booted the following screen will be displayed.

```
Starting installer, one moment...
21:21:43 Deprecated boot argument 'rescue' must be used with the 'inst.' prefix. Please use 'inst.rescue' instead.
21:21:43 anaconda boot arguments without 'inst.' prefix have been deprecated and will be removed in a future major release.
anaconda 23.16.4.15-1.el9-rocky for Rocky Linux 9 started.
* installation log files are stored in /tmp during the installation
* shell is available on TTY2
* when reporting a bug add logs from /tmp as separate text/plain attachments
=====
Rescue

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)

Please make a selection from the above: 1

anaconda11:main* 2:shell 3:log 4:storage-log 5:program-log          Switch Tab: alt+Tab | Help: F1
```

- Press 1 to continue and the following text should be displayed.

```
=====
Rescue Shell

Your system has been mounted under /mnt/sysroot.

If you would like to make the root of your system the root of the active system,
run the command:

    chroot /mnt/sysroot

When finished, please exit from the shell and your system will reboot.
Please press ENTER to get a shell: sh-4.4# _
```

- Press Enter to get to the root shell.
- You can now examine the files under /mnt/sysimage to correct issues identified in error messages before the system failed to boot properly.
- If you wish to transfer files or packages to the system over the network you can start networking via DHCP with the following command. Invoke the **ifconfig** command to find out the network device name if it is not eth0 as used in this example.

```
ifup eth0
```

- After networking is enabled, you can also issue the following command to better simulate running commands on the actual system:

```
chroot /mnt/sysimage
```

At this point the system files on the hard drive appear in the usual locations in the file system, and you can run additional commands like **blscfg** in Rocky-based operating systems and **ccur-grub2** in Ubuntu, to change the default kernel to boot or modify kernel boot options. See the **blscfg(1)** and **ccur-grub2(1)** man page for more information.

7.1.4 How to Install Rocky Remotely Over VNC

Virtual Network Computing (VNC) is a graphical desktop sharing system which uses the RFB protocol to remotely control another computer. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen updates in reverse direction, over a network.

VNC by default uses TCP ports 5900 through 5906, each port corresponding to a separate screen (:0 to :6).

If you are having difficulties installing in graphical mode and do not want to use text mode, VNC is an option. You need to be able to establish a network connection between the system you are installing (the VNC server) and the system that will remotely display the installation GUI (the VNC client).

Any system with a VNC viewer application can be used as a VNC client. If you are currently running a previously installed RedHawk system, the VNC client application is accessed under the gnome desktop cascading menu selection: **Applications -> Internet -> Remote Viewer**. Alternatively, you can install the *tigervnc* package and then run the **vncviewer** application.

Perform the following steps to install using VNC.

On the system you wish to install:

1. Follow the procedure outlined in section **5.0. Installation Procedures** on page 11 until you reach **5.1.1** step 4.

Select “Install Rocky Linux 8” from the grub menu.

2. Hit the **Tab** key. Add “vnc” (and other options) to the end of the line that appears:

```
> vmlinuz initrd=initrd.img vnc [options]
```

Hit the **Enter** key.

NOTE

If the VNC service fails to start, it may be necessary to specify the `ip=xxx.xxx.xxx.xxx` and `netmask=xxx.xxx.xxx.xxx` grub options to ensure proper NIC address configuration.

3. Continue with step 5 in section **5.1.1**.
4. After step 5, the VNC installer *may* prompt you with a text based GUI for extra setup. Use the **Tab** key to jump between fields, the up/down arrows within the fields, and the space bar to select your settings.
5. At this point you should see output similar to the following:

Starting VNC ...

WARNING!!! VNC server running with NO PASSWORD
You can use the `vncpassword=<password>` boot option
if you would like to secure the server.

Please manually connect your vnc client to
129.134.30.100:1 to begin the install.

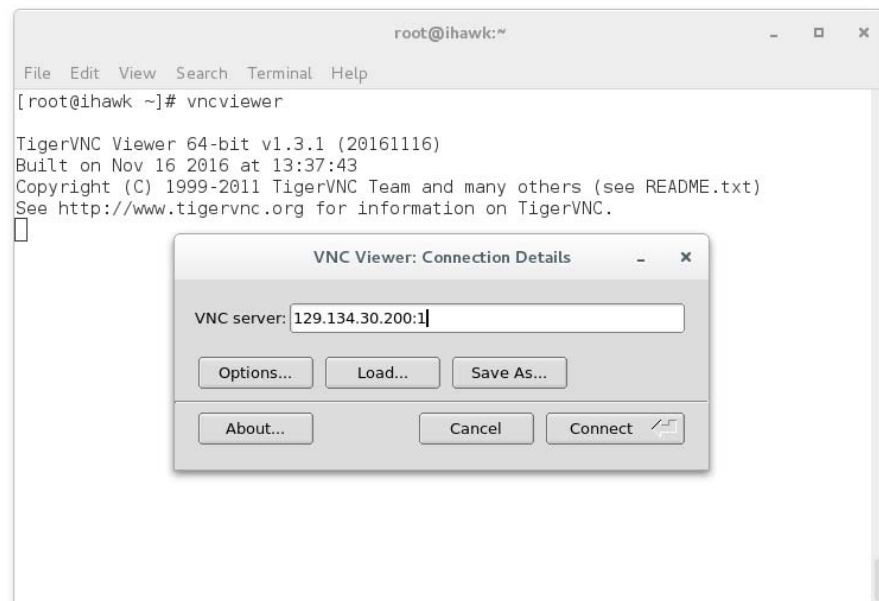
Starting graphical installation.

6. If you wish to verify your network connection to the VNC client, press **Enter** and use **ifconfig** and **ping**. If you cannot ping your intended VNC client, you will have to troubleshoot your network configuration.
7. On the system that you will remotely display the installation (VNC client), start the VNC Viewer.

On the gnome menu: Applications -> Internet -> Remote Viewer

Or from the command line using **vncviewer** if you previously installed the *tigervnc* package.

8. Establish the VNC connection to your VNC server by entering the *IPaddress:screen* in the VNC Viewer: Connection Details dialog box.



9. Select OK and press **Enter** to continue. At this point, you are able to perform a graphical installation remotely.
10. Continue with the graphical installation process as described in section **5.1.1** steps 6 - 21, beginning on page 14. After completing step 23 on page 27, perform the steps below back on the actual system's graphical console.
11. The reboot puts the system in runlevel 3 and a text-based Initial setup prompt is displayed.

12. Type **1** and press **Enter** to proceed to the License information prompt.
13. Type **2** and press **Enter** to select **I accept the license agreement**.
14. Type **c** and press **Enter** to complete license acceptance and return to the **Initial setup** prompt.
15. Type **c** and press **Enter** again to complete the **Initial setup**; the system will now proceed to the customary login prompt.
16. Log in as the root user and issue the following commands to enable graphical startup and reboot the system:

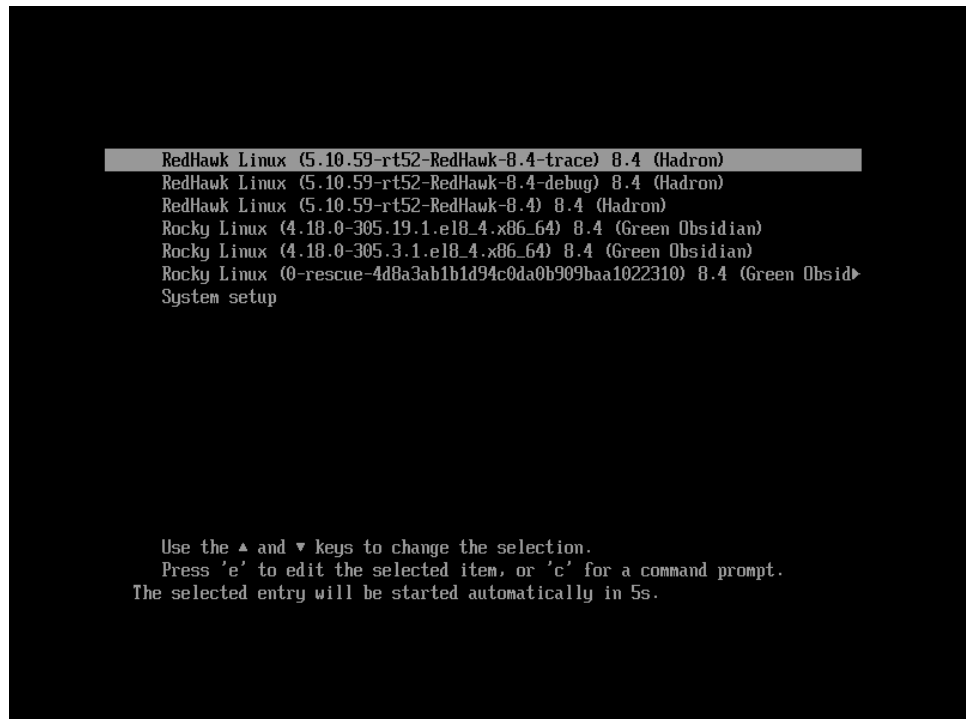
```
# systemctl set-default graphical.target  
# reboot
```

17. After the system reboots, continue with the installation as documented.

7.1.5 If the Installation GUI Fails to Start

If during installation the GUI fails to start, it may be caused by graphics driver compatibility problems or with certain graphics cards and/or monitors not being probed properly. Adding the **nomodeset** boot parameter to the kernel may solve this problem.

To modify boot parameters first stop the grub automatic boot countdown by pressing the arrow keys on the keyboard. You should now see a screen similar to the following.



Next press the **e** key to edit the grub boot entry for the highlighted kernel (this example is using the trace kernel) and a screen similar to the following will appear.

```

load_video
set gfx_payload=keep
insmod gzio
linux ($root)/vmlinuz-5.10.59-rt52-RedHawk-8.4-trace root=/dev/mapper/r1-root \
ro resume=/dev/mapper/r1-swap rd.lvm.lv=r1/root rd.lvm.lv=r1/swap rhgb quiet \
initrd ($root)/initramfs-5.10.59-rt52-RedHawk-8.4-trace.img $tuned_initrd

Press Ctrl-x to start, Ctrl-c for a command prompt or Escape to
discard edits and return to the menu. Pressing Tab lists possible
completions.
```

Press the down arrow to scroll down until the line beginning with **linux (\$root)** appears. Use the arrow keys to append the **nomodeset** boot option to the end of this line, as shown in the following screen.

```

load_video
set gfx_payload=keep
insmod gzio
linux ($root)/vmlinuz-5.10.59-rt52-RedHawk-8.4-trace root=/dev/mapper/r1-root \
ro resume=/dev/mapper/r1-swap rd.lvm.lv=r1/root rd.lvm.lv=r1/swap rhgb quiet \
nomodeset
initrd ($root)/initramfs-5.10.59-rt52-RedHawk-8.4-trace.img $tuned_initrd

Press Ctrl-x to start, Ctrl-c for a command prompt or Escape to
discard edits and return to the menu. Pressing Tab lists possible
completions.
```

Once the option has been added press **Ctrl-x** to boot the kernel and hopefully the new option will improve the graphics startup situation.

7.1.6 Configuring SELinux in enforcing mode

By default RedHawk is installed with SELinux disabled. To avoid problems when enabling SELinux, such as systems unable to boot, first boot in permissive mode to relabel the filesystems and then boot to enforcing mode, as follows:

1. Edit the `/etc/selinux/config` file and set:
`SELINUX=permissive`
2. Reboot
3. Edit the `/etc/selinux/config` file and set:
`SELINUX=enforcing`
4. Reboot
5. Verify that SELinux is enabled in enforcing mode by running:
sestatus

If you do not follow the instructions and find yourself unable to boot any kernel, a work-around is provided in the "Unable to Boot After Enabling SELinux" on page 61 in the Known Issues section of this document.

7.2 Considerations

7.2.1 Compiler Requirements

If you plan to build a kernel from source residing on your iHawk system on a different system, that system must be using **gcc-4.4.4** or later.

7.2.2 Hyper-thread Activation

Hyper-threading is configured by default in each of the standard RedHawk Linux kernels. It can be disabled on a per-CPU basis using the **cpu (1)** command. However, hyper-threading is also defined in the system BIOS. The setting in the BIOS will supersede any configuration of this feature in the kernel. Therefore, if hyper-threading is turned off in the BIOS, it will not be available on your system even if it is configured in the kernel.

If your system is not behaving as expected in regards to hyper-threading based on the kernel configuration, check the BIOS setting and modify it as needed. Refer to your hardware documentation to determine which BIOS setting is involved.

8.0. Known Issues

Special consideration should be given to the following areas:

Invalid Signature Detected

The current Rocky 8.4 release does not support UEFI Secure Boot but will support it in a future release. If you have installed Rocky 8.4, verify that UEFI Secure Boot is disabled in your firmware.

Note that RedHawk 8.4 does support UEFI Secure Boot and can be installed on any Rocky-compatible 8.4 distribution that has support for Secure Boot.

Extra step to enable FIPS

Before enabling FIPS (Federal Information Processing Standards) in the RedHawk kernel, you must execute the following script:

```
/usr/bin/fips-mode-setup --enable
```

Afterwards, you may boot a RedHawk kernel with the `fips=1` kernel boot option.

Package required to make a RedHawk custom kernel

Rocky 8.4 and similar distributions require the package `qt5-qtbase-devel` package in order to make a RedHawk custom kernel. This package is not included in the RedHawk installation and must be installed prior to running `ccur-config(1)`. Ubuntu has different package requirements which are listed in the section “Building and Installing Custom Kernels” in Appendix A.

Various warnings during crash dump creation

During the creation of crash dump files on RedHawk 8.4+ systems, various warnings may be produced that do not impact the validity of the crash dump file. The warnings vary depending on the base distribution of the RedHawk installation. For example, the following warnings may be observed:

With RedHawk on Rocky systems:

```
Missing the log_buf symbol
saving vmcore-dmesg.txt failed
```

With RedHawk on Ubuntu systems:

```
dump_dmesg: Can't find some symbols for log_buf.
The kernel version is not supported.
kdump-tools: The makedumpfile operation may be
incomplete.
kdump-tools: makedumpfile Failed.
```

While these warnings do indicate that the `vmcore-dmesg.txt` file has not been successfully created, the `vmcore` file is still saved correctly and users can view the `dmesg` messages within crash dumps by using the crash utility.

AMD Core Performance Boost feature not working

AMD processors do not provide a mechanism to determine if Core Performance Boost is enabled in the system’s firmware settings while RedHawk is running. Due to this limitation, the `turbo` service will always appear to start successfully with AMD

processors, even if the processors do not support the Core Performance Boost feature or the feature is disabled in the system’s firmware settings. Verify in the firmware that the processor supports the Core Performance Boost feature and that it is enabled. See the section “Configuration” in Appendix D for more information.

EFI Runtime Services Disabled By Default

The EFI runtime services have been observed to interfere with real-time performance therefore, starting with RedHawk release 8.2.1, the services will be disabled by default. With the services disabled, the `mokutil` command cannot be used to query the secure boot state, import certificates or update the UEFI firmware.

To see that Secure Boot has been enabled, you can run `dmesg | grep -i secure`. If real-time performance is not a concern, set the kernel parameter `efi=runtime` to enable the services. Note that the EFI runtime services remain enabled in the base distribution kernels (for example, the Rocky kernel).

Problems executing programs that use RedHawk system calls

The RedHawk system call IDs have been changed to start at 1900. Verify that you are using the new system call IDs as shown in the table below.

System call	New ID	Old ID
fbsched	1900	420
sched_setscheduler_head	1901	435
resched_cntl	1902	421
postwait	1903	422
cpustat	1904	424
cpucntl	1905	444
procstat	1906	452
local_irq	1907	434
mlockall_pid	1908	437
munlockall_pid	1909	454
watchpoint_ctl	1910	510

BIOS “Console Redirection”

The “Console Redirection” BIOS feature, when enabled, has been observed to interfere with the proper operation of the integrated VGA video and the Xorg X server with some iHawk platforms, such as the Dell PowerEdge™ 6650 (iHawk Model HQ665).

NMI Button

Using the NMI button on the processor enters `kdb` on the console when configured. It cannot be used, however, to step repeatedly through an error condition.

PAM Capabilities

Using Kerberos telnet services with PAM is not recommended. If `krb5-telnet` is on and Kerberos is not properly configured, the following error will occur upon logging in via telnet:

```
login: Cannot resolve network address for KDC in requested realm
while getting initial credentials
```

The `krb5-telnet xinetd` service should be disabled:

```
systemctl disable krb5-telnet
```


sadc(8) Issue

When a system configuration change is made that affects the number of CPUs (for example when booting with a uniprocessor kernel or changing hyper-threading configuration), the **sadc(8)** (sar data collector) program cannot successfully write data in the daily data file `/var/log/sa/sa??` (?? is the day of the month). This results in **crond** sending an email every ten minutes to `root@localhost` with the following message:

```
Cannot append data to that file
```

To eliminate the email, remove or move the `/var/log/sa/sa??` file for the current date.

irqbalance

The **irqbalance** feature is disabled on RedHawk Linux. This Rocky feature is meant to distribute interrupts equally across CPUs. It does not honor the IRQ affinity masks set up in `/proc/irq/irq#/smp_affinity` and therefore will cause interrupts to be routed to shielded CPUs.

This feature can be enabled/disabled at boot time with:

```
systemctl {enable|disable} irqbalance
```

as well as started/stopped while the system is running with:

```
systemctl {start|stop} irqbalance
```

Boot Problems with Monitor-embedded USB Hub and Flash Memory Reader

An iHawk system with a USB hub embedded within its attached monitor that includes a flash memory reader will fail to boot if the flash media is not installed. Once the flash media is installed, the system will boot.

Compatibility Issues for Ada programs

RedHawk 8.4 is based on Rocky Enterprise Linux 8.4. Binary and source compatibility issues exist for MAXAda programs between Rocky 3.0 and Rocky 8.4.

Please see the Compatibility section in the *MAXAda for RedHawk Linux Version 3.5.1 Release Notes*, publication number 0898357-3.5.1, for details.

Inactive Virtual Terminal State After Changing Run Levels

Note that on some systems, changing from run-level 5 to run-level 3 may place the VGA console onto an inactive virtual terminal (e.g. `/dev/tty8`). If this happens, switching to an active virtual terminal will allow normal system operation to continue; press `Ctrl-Alt-F1` to switch to virtual terminal 1.

Excessive ksoftirqd Runs Affecting Determinism

In more recent kernel.org kernels the IP route cache table size was changed from a fixed size of 4K entries to a dynamic size based on the amount of available memory. With 4 GB of memory, this table is sized at 128K entries. Every 10 minutes, a flush of that table is initiated. The approximate time to flush 4K entries is 1.5ms every 10 minutes. If the table is sized at 128K entries, this time can be in the area of 10ms to 15ms every 10 minutes. This can be problematic if network determinism is an issue, especially in a single CPU system.

If this is an issue, the IP route cache table can be set to a fixed size using the grub command `rhash_entries=n`, where *n* is the number of table entries; e.g., `rhash_entries=4096` for 4K entries.

Pings to Multicast Addresses Disabled by Default

In more recent kernel.org kernels the default setting for the `sysctl` flag that allows ping to a multicast address has changed. Previously it was set to enable broadcast and multicast ICMP echo (pings) and timestamp requests. Now this functionality is disabled.

There are two methods in which to change this flag if you need to ping multicast addresses:

- The `sysctl(8)` utility changes the value in a running kernel and takes effect immediately; no rebuild or reboot is needed:

```
# sysctl -w net.ipv4.icmp_echo_ignore_broadcasts=0
```

- To initialize the parameter to the desired value on every reboot, add the following command and `sysctl` parameter to `/etc/sysctl.conf`:

```
# Controls broadcast and multicast ICMP echo and timestamp requests
net.ipv4.icmp_echo_ignore_broadcasts = 0
```

Grub Option Holdovers from Previous Kernel Installations

Be aware that when kernel packages are installed, they add a grub entry with options associated with that kernel (e.g., trace and debug kernels add “`crashkernel=128M@64M,`” other kernels add “`quiet,`” etc.). In addition, all kernel packages also copy the default grub options into their grub entries. These default grub options are taken from the kernel entry that is currently marked as the default kernel to boot in `grub.conf`.

Depending upon which kernel is designated the default booting kernel and which kernels are installed subsequently, you may find that grub entries that are inherited from the default kernel and previously installed kernels are not suitable for the currently running kernel.

USB Ports Non-functional on Supermicro Boards

Some Supermicro boards (Model X6DA8-G2, CCUR part number 820-2010483-913) may have non-functional USB ports accompanied by the following message:

```
USB 1-1: new high speed USB device using ehci_hsd and address 2
USB 1-1: device descriptor read/64, error -110
```

This can be corrected by changing the BIOS setting for both SATA [0/1] IDE Interface and SCSI interface controllers to “ENABLED”.

Configure Quad Port Ethernet

If your system has a quad port Ethernet, you may need to edit `/etc/modprobe.conf` and configure the ports to the appropriate driver. The example below assigns the quad port to `eth0` through `eth3` and uses the Intel e1000 module (Gigabit Network driver). For readability, convention has these lines inserted at the top of `/etc/modprobe.conf`.

```
alias eth0 e1000
alias eth1 e1000
alias eth2 e1000
alias eth3 e1000
```

NFS v4 Intermittent Connectivity

On rare occasions, attempts to use NFS version 4 protocol to connect to an older NFS server may be denied intermittently, with the connection also subsequently failing to negotiate an NFS version 3 protocol connection. If your system experiences this behavior with any NFS servers, adding a `vers=3` mount option to the corresponding entry in `/etc/fstab` will allow the NFS filesystem to be mounted properly.

Unable to Boot After Enabling SELinux

If you experience problems logging in or booting a RedHawk system after enabling SELinux, it is most likely because some filesystem needs to be relabeled to be compatible with SELinux. To achieve this you must first boot in permissive mode before attempting to boot in enforcing mode.

If you have made the change to run in enforcing mode before running in permissive mode and none of your kernels now boot, you must stop the boot at the grub screen, choose the kernel with SELinux enabled and edit the kernel boot command, appending the following to that line:

```
enforcing=0
```

Then continue to boot the system. The system will boot in permissive mode, file systems will be relabeled as required and the system will then reboot. After the system successfully boots, you can verify that you are running in enforcing mode by executing the `sestatus` command. Instructions on how to enable SELinux in enforcing mode are in the section "Configuring SELinux in enforcing mode" on page 56.

9.0. Software Updates and Support

9.1 Direct Software Support

Software support is available from a central source. If you need assistance or information about your system, please contact the Concurrent Real-Time Software Support Center at our toll free number 1-800-245-6453. For calls outside the continental United States, the number is 1-954-283-1822. The Software Support Center operates Monday through Friday from 8 a.m. to 5 p.m., Eastern Standard Time.

Calling the Software Support Center gives you immediate access to a broad range of skilled personnel and guarantees you a prompt response from the person most qualified to assist you. If you have a question requiring on-site assistance or consultation, the Software Support Center staff will arrange for a field analyst to return your call and schedule a visit.

You may also submit a request for assistance at any time by using the Concurrent Real-Time, Inc. web site at <http://concurrent-rt.com/support>

9.2 Software Updates

Updates to Concurrent Real-Time RedHawk software can be obtained via Concurrent Real-Time's Software Portal. There are three ways of installing product updates:

- Using the Network Update Utility (NUU) installed on your RedHawk system
- Manual installation after browsing and downloading individual RPMs from Concurrent Real-Time's software repositories
- Building a customized Update disc using Concurrent Real-Time's web site for immediate download

9.2.1 Updating via NUU

NUU supports installation and updating of software products from Concurrent Real-Time software repositories over a network. NUU utilizes DNF and the RPM subsystems to install and update software.

NUU is installed automatically with RedHawk, however, you should configure it to include all of the Concurrent Real-Time software products installed on your system.

Clicking on the "Updates (NUU)" icon on your desktop launches NUU to check to see if Concurrent Real-Time updates are available for your system.

NOTE

It is recommended that all Rocky repositories should be disabled when checking for Concurrent Real-Time updates. In NUU, select the **Repositories -> Edit Configuration** menu item and ensure that the *base*, *updates* and *extras* repositories are disabled.

Instructions for configuring NUU can be found in the QuickStart.pdf document available when you click on the NUU link on the redhawk.concurrent-rt.com website or directly via this link <http://redhawk.concurrent-rt.com/network/QuickStart.pdf>

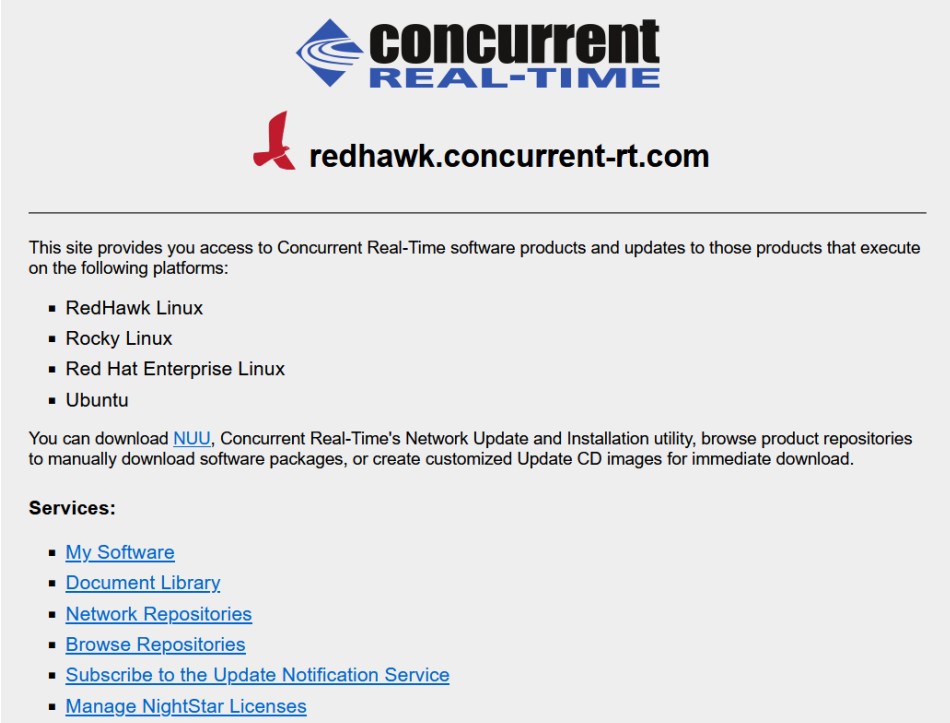
The first time you invoke NUU you will need to specify your redhawk.concurrent-rt.com Login ID and Password that were provided in the shipping documents accompanying your system. If you require assistance, refer to “Direct Software Support” on page 62.

Before using NUU to install any updated software modules, check for NUU updates separately. Apply any NUU updates and then restart NUU before applying any other updates.

9.2.2 Installing Manually Downloaded RPMs

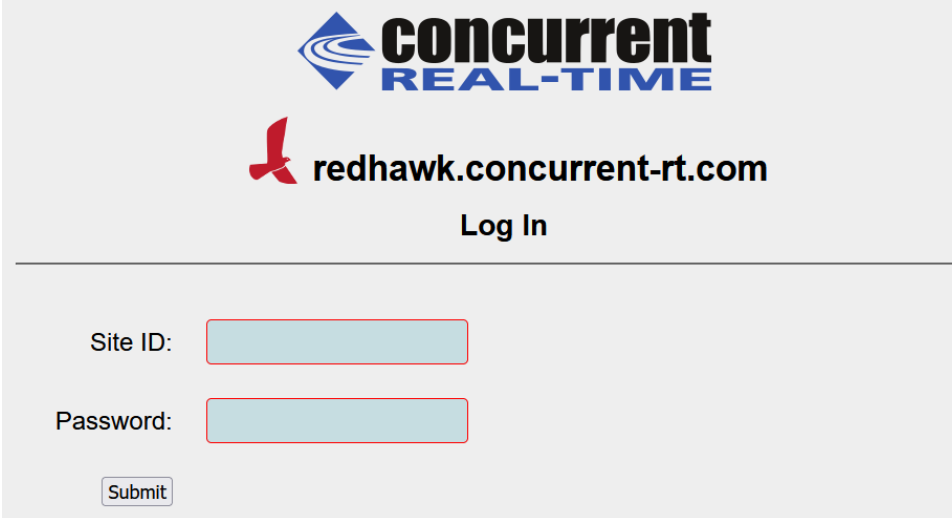
You can browse Concurrent Real-Time’s software repositories to locate updated RPMs and download them for manual installation.

Access the RedHawk Updates web site (<http://redhawk.concurrent-rt.com/>) by clicking on the “Concurrent Real-Time Software Portal” icon on the desktop. Below is the top half of the screen displayed when you access this web site.



The screenshot shows the top half of the Concurrent Real-Time website. At the top center is the logo for "concurrent REAL-TIME" with a blue and white stylized 'C' icon. Below the logo is a red hawk icon and the URL "redhawk.concurrent-rt.com". A horizontal line separates the header from the main content. The main content starts with the text: "This site provides you access to Concurrent Real-Time software products and updates to those products that execute on the following platforms:". This is followed by a bulleted list of supported platforms: RedHawk Linux, Rocky Linux, Red Hat Enterprise Linux, and Ubuntu. Below the list is a paragraph: "You can download [NUU](#), Concurrent Real-Time's Network Update and Installation utility, browse product repositories to manually download software packages, or create customized Update CD images for immediate download." At the bottom of the screenshot, under the heading "Services:", there is another bulleted list of links: [My Software](#), [Document Library](#), [Network Repositories](#), [Browse Repositories](#), [Subscribe to the Update Notification Service](#), and [Manage NightStar Licenses](#).

Clicking on the Browse Repositories link takes you to an authentication page.



Enter your redhawk.concurrent-rt.com Login ID and Password and click the **Browse** button.

Select the products of interest and architecture from the following pages to see the list of RPMs in the product software repository.

Index of /portal/repos/RedHawk/8.4

Name	Last modified	Size	Description
Parent Directory/		-	
aarch64/	03-Nov-2021 15:19	-	
i386/	03-Nov-2021 15:19	-	
i586/	03-Nov-2021 11:22	-	
x86_64/	03-Nov-2021 15:19	-	

To locate the latest RPMs in the repository, click on the **Last modified** column header to sort by date. You may need to click twice to set the sort order to newest-to-oldest.

After locating the RPMs of interest and downloading them to your system, you can manually install them.

To install newly downloaded packages, follow these steps:

1. Log in as root and take the system down to single-user mode:
 - a. Right click on the desktop and select **Open Terminal**.
 - b. At the system prompt, type **init 1**.
2. Change directory to the location of the updates and issue the following command:

```
rpm -Uvh *.rpm
```

The time it takes to install will vary depending on the number of updates being installed.

3. When complete, exit single-user mode (Ctrl-D).

NOTE

If you have installed an update containing new RedHawk kernels on a system that has post-installation loadable modules present, those modules must be recompiled for the new kernel; for example, an NVIDIA driver that is a later version than the one included with RedHawk or any third party package that uses loadable modules.

9.2.3 Customized Update Discs

You can use Concurrent Real-Time's Software Portal to create a customized Update Disc for your system which you can then download and burn onto physical media, or simply mount as an ISO9660 image.

Update discs have customized copies of product software repositories and a simple graphical interface for selecting packages for update and installation. These discs use NUU (described above) to talk to the disc to obtain packages -- no network access is required during installation via Update Discs.

Access the RedHawk Updates web site (<http://redhawk.concurrent-rt.com>) by clicking on the "Concurrent Real-Time Software Portal" icon on the desktop, then click on **Create Update Images**.

You will need to enter your redhawk.concurrent-rt.com Login ID and Password and then you can select the products to update. A disc image is built as part of the web session. At the end of the session, you can immediately download it for subsequent installation.

9.3 Documentation Updates

For the latest documents, including updated Release Notes and User Guides, go to Concurrent Real-Time's documentation web site at <http://redhawk.concurrent-rt.com/docs>.

You can also view the latest RedHawk FAQ at [FAQ.pdf](#)

A

Ubuntu Support

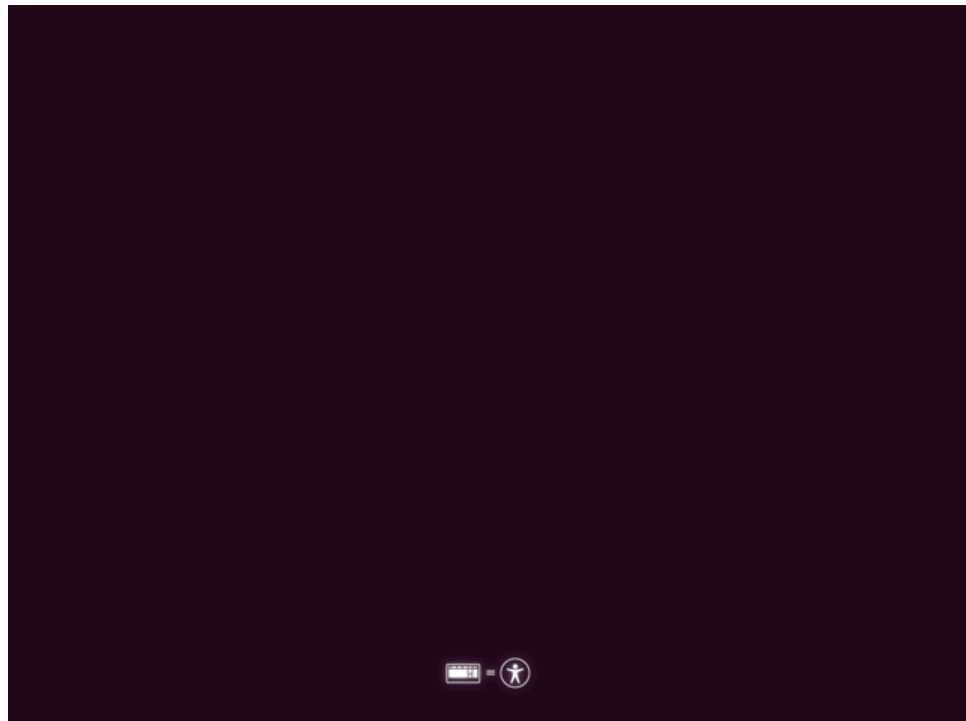
This appendix contains additional information on using RedHawk 5.10.59-rt52 with the open source Ubuntu Linux distribution.

Overview

RedHawk 8.4 is compatible with the Ubuntu 20.04 LTS (Long Term Support) distribution. This appendix provides instructions for installing RedHawk 8.4 onto a brand new Ubuntu 20.04 installation. Installing RedHawk 8.4 onto an existing Ubuntu 20.04 system should also work correctly, however that is beyond the scope of this document.

Installing Ubuntu

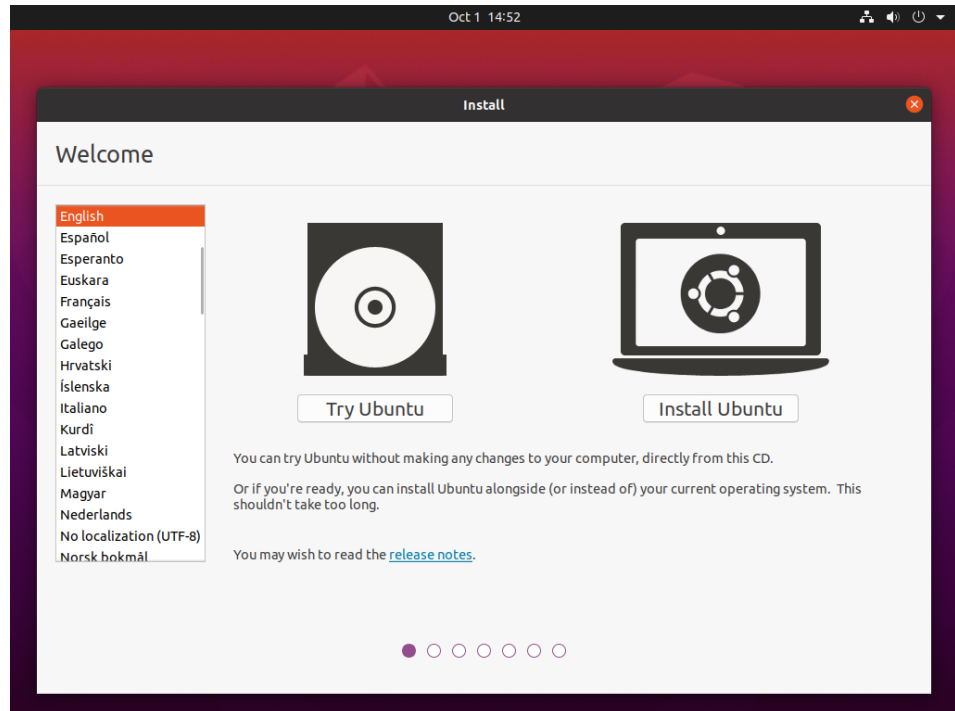
First, download the latest Ubuntu 20.04 LTS Desktop ISO from the [Ubuntu.com](https://ubuntu.com) website and burn it onto a DVD. Boot the DVD in your target system. The following page will appear.



NOTE

If your system is using UEFI firmware, you will come up on a page with a boot menu. Double click on **Ubuntu** at the top and on the next page click on the **Install Ubuntu** icon. Starting with the **Keyboard Layout** page, the pages should be the same as shown below.

Shortly after, the **Welcome** page will be displayed as below:

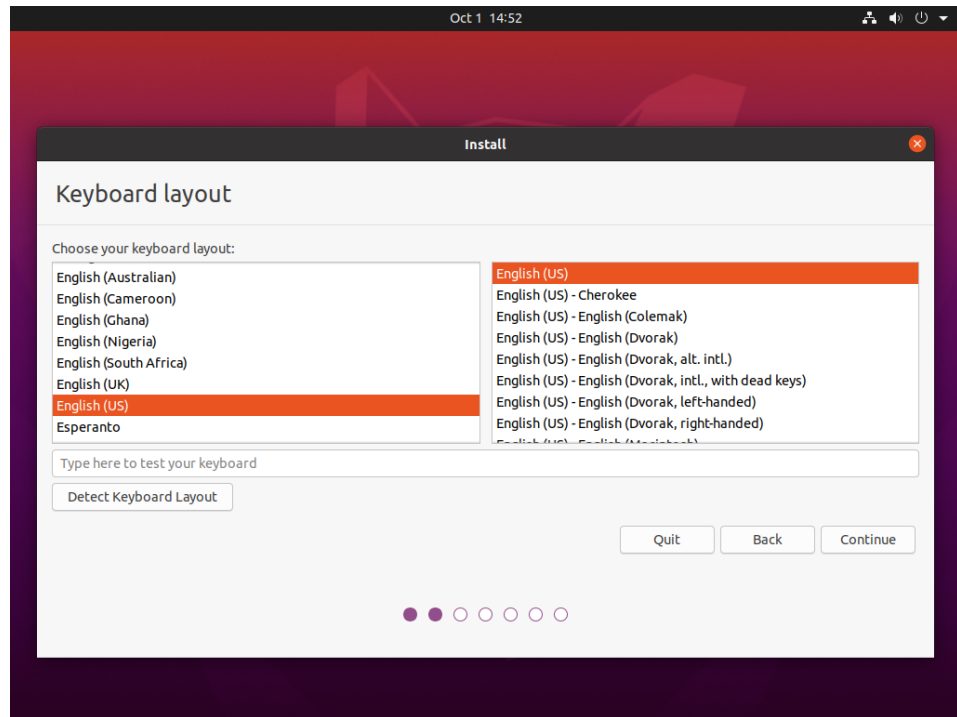


Press the **Install Ubuntu** button to begin the installation.

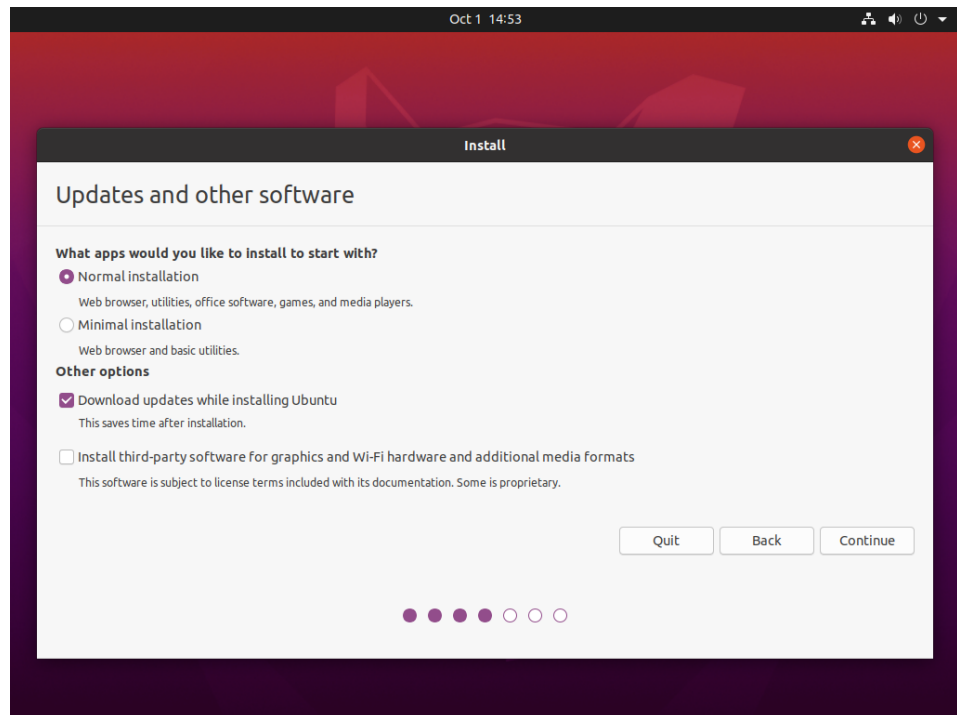
NOTE

If instead of the **Welcome** page you see a persisting dark screen, it may be that the installer system is incompatible with the graphics card on the target system. In that case, you may still be able to install in a safe graphics mode. See “Installing Ubuntu in Safe graphics mode” on page A-15.

Next, select the desired layout in the Keyboard layout page shown below.

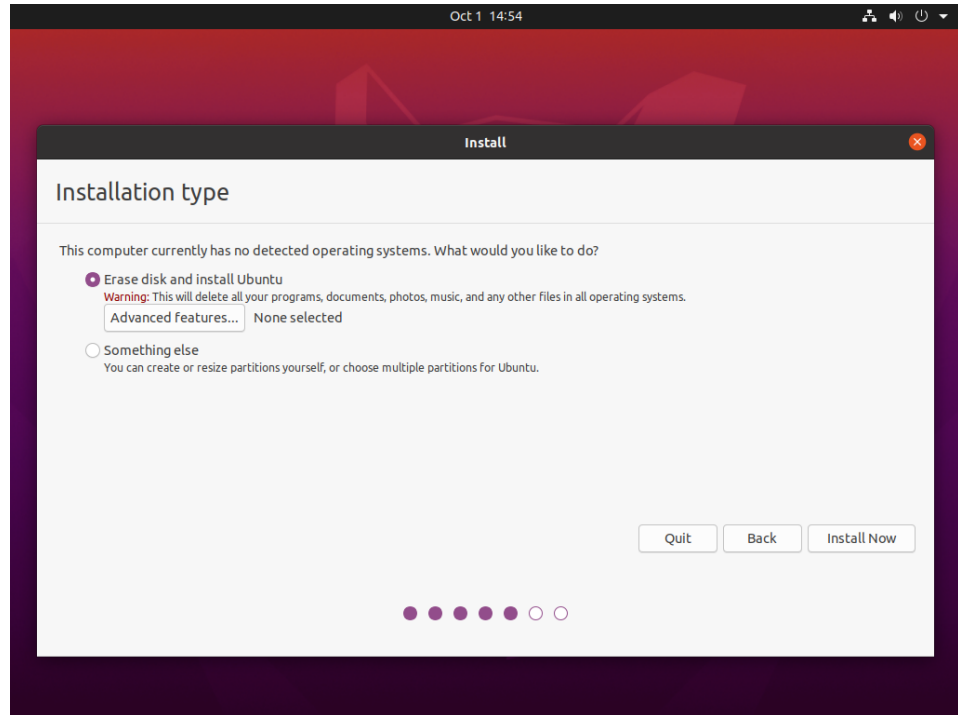


Press Continue and the Updates and other software page should be displayed as follows:



Check the boxes for **Normal installation** and **Download updates while installing Ubuntu**. The download option will download, but not install, updates.

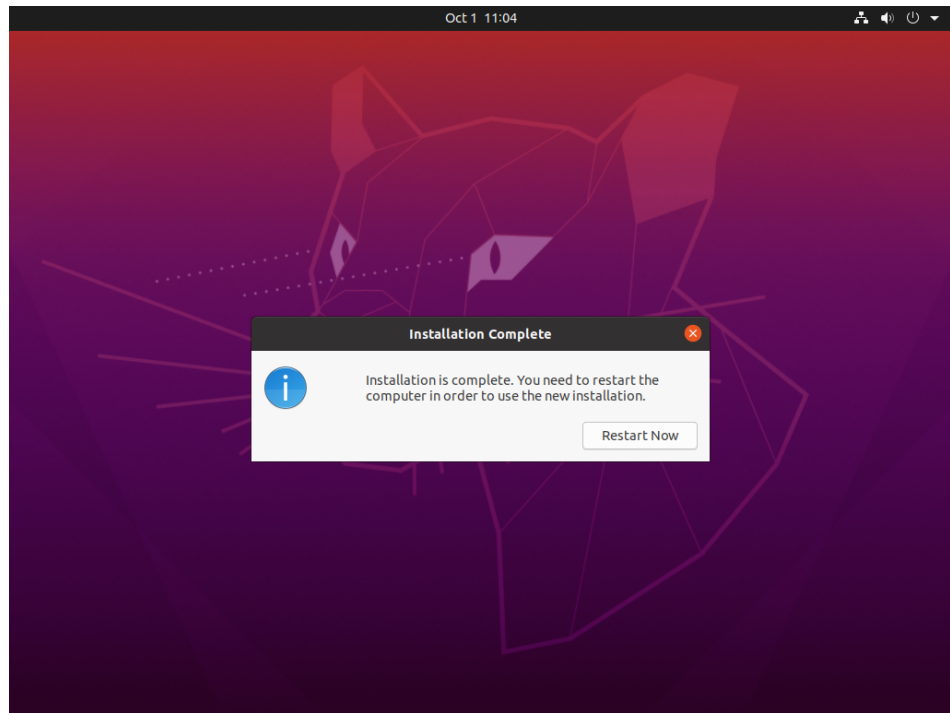
Press **Continue** and the **Installation type** screen should be displayed as follows:



Choose **Erase disk and install Ubuntu** and then press **Install Now** to continue. You will then be prompted to confirm the action. Press **Continue** to confirm and continue.

In the next few pages you will be prompted to configure various settings including **Timezone**, **Username**, **System Name** and **Password**. After configuring these settings, press **Continue** to continue with the installation.

Depending on system and network speed, the installation can take up to 60 minutes to complete; once the installation has finished, the following message will be displayed.



Press **Restart Now** to reboot the newly installed system.

Updating Ubuntu Software

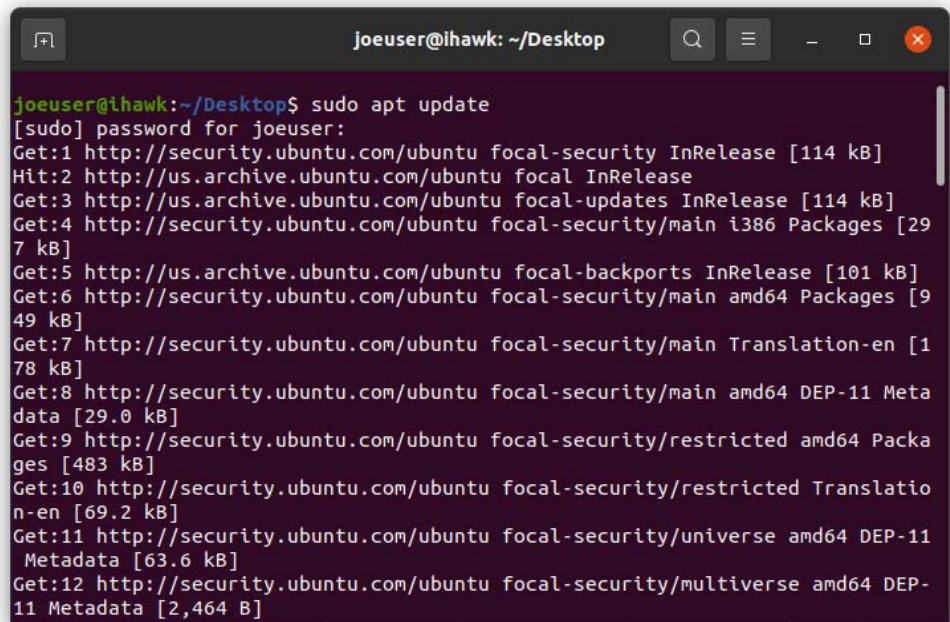
While updates were downloaded on the system during the install, the updates were not applied. Follow the instructions below to update the system now.

Once the system has booted to a graphical login screen, log into the system and bring up a terminal window.

Execute the following command to update the cached list of available packages and their versions.

```
sudo apt update
```

The screen image below shows an example output from the command.



```

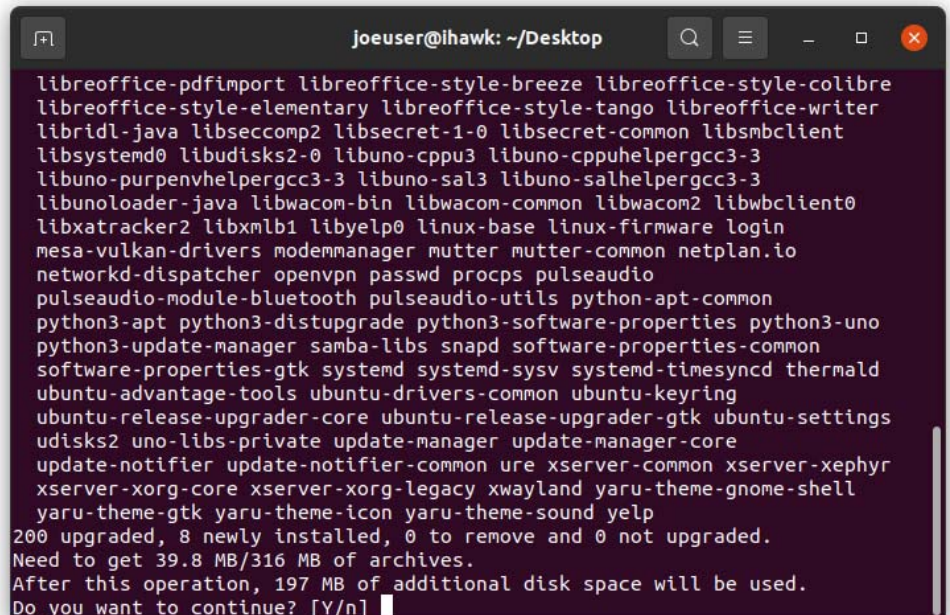
joeuser@ihawk: ~/Desktop
joeuser@ihawk:~/Desktop$ sudo apt update
[sudo] password for joeuser:
Get:1 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Hit:2 http://us.archive.ubuntu.com/ubuntu focal InRelease
Get:3 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:4 http://security.ubuntu.com/ubuntu focal-security/main i386 Packages [297 kB]
Get:5 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:6 http://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [949 kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/main Translation-en [178 kB]
Get:8 http://security.ubuntu.com/ubuntu focal-security/main amd64 DEP-11 Meta data [29.0 kB]
Get:9 http://security.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [483 kB]
Get:10 http://security.ubuntu.com/ubuntu focal-security/restricted Translation-en [69.2 kB]
Get:11 http://security.ubuntu.com/ubuntu focal-security/universe amd64 DEP-11 Metadata [63.6 kB]
Get:12 http://security.ubuntu.com/ubuntu focal-security/multiverse amd64 DEP-11 Metadata [2,464 B]

```

To install new packages and newer versions of packages, issue the following command:

```
sudo apt upgrade
```

You will be presented with information about the pending upgrade and then be prompted to continue:



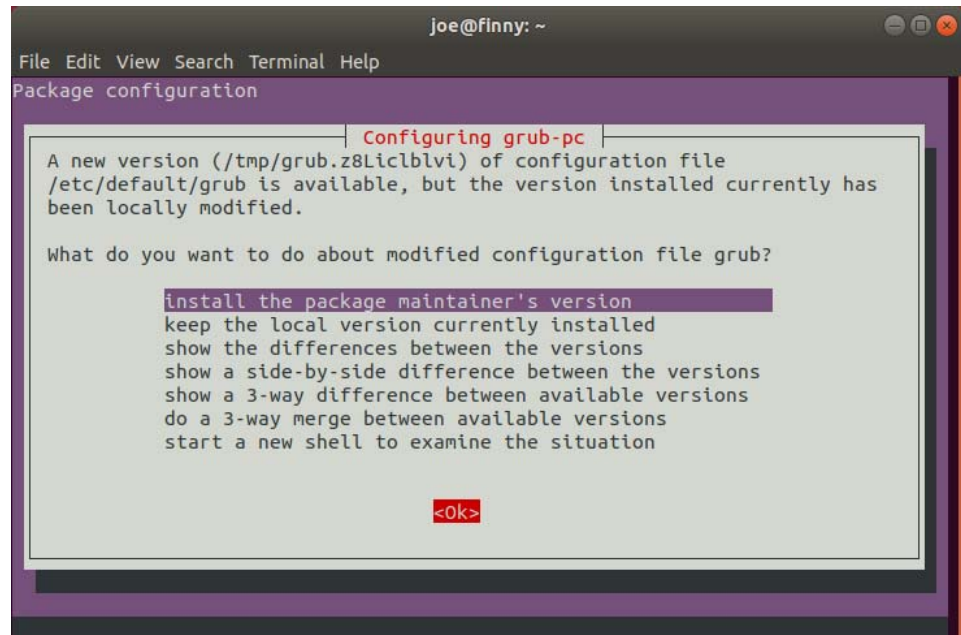
```

joeuser@ihawk: ~/Desktop
libreoffice-pdfimport libreoffice-style-breeze libreoffice-style-colibre
libreoffice-style-elementary libreoffice-style-tango libreoffice-writer
libridl-java libseccomp2 libsecret-1-0 libsecret-common libsmbclient
libsystemd0 libudisks2-0 libuno-cppu3 libuno-cppuhelpergcc3-3
libuno-purpenvhelpergcc3-3 libuno-sal3 libuno-salhelpergcc3-3
libunoloader-java libwacom-bin libwacom-common libwacom2 libwbclient0
libxatracker2 libxmlb1 libyelp0 linux-base linux-firmware login
mesa-vulkan-drivers modemmanager mutter mutter-common netplan.io
networkd-dispatcher openvpn passwd procs pulseaudio
pulseaudio-module-bluetooth pulseaudio-utils python3-apt-common
python3-apt python3-distupgrade python3-software-properties python3-uno
python3-update-manager samba-libs snapd software-properties-common
software-properties-gtk systemd systemd-sysv systemd-timesyncd thermald
ubuntu-advantage-tools ubuntu-drivers-common ubuntu-keyring
ubuntu-release-upgrader-core ubuntu-release-upgrader-gtk ubuntu-settings
udisks2 uno-libs-private update-manager update-manager-core
update-notifier update-notifier-common ure xserver-common xserver-xephyr
xserver-xorg-core xserver-xorg-legacy xwayland yaru-theme-gnome-shell
yaru-theme-gtk yaru-theme-icon yaru-theme-sound yelp
200 upgraded, 8 newly installed, 0 to remove and 0 not upgraded.
Need to get 39.8 MB/316 MB of archives.
After this operation, 197 MB of additional disk space will be used.
Do you want to continue? [Y/n]

```

During the upgrade, dialogs also may be displayed asking you to confirm other actions. The example dialog below asks permission to update the grub configuration file. Use the

Up Arrow key to select to install the package maintainer's version, use the Tab key to select Ok, then press Enter.



When the upgrade completes, issue the reboot command to reboot the system:

```
sudo reboot
```

Installing RedHawk Linux

Once the system has booted to a graphical login screen, log into the system. Insert the RedHawk OS Installation DVD into the system's optical media drive and close any file-browser window that opens when the DVD is inserted. Then open a terminal window, and cd to the mounted directory of the DVD.

NOTE

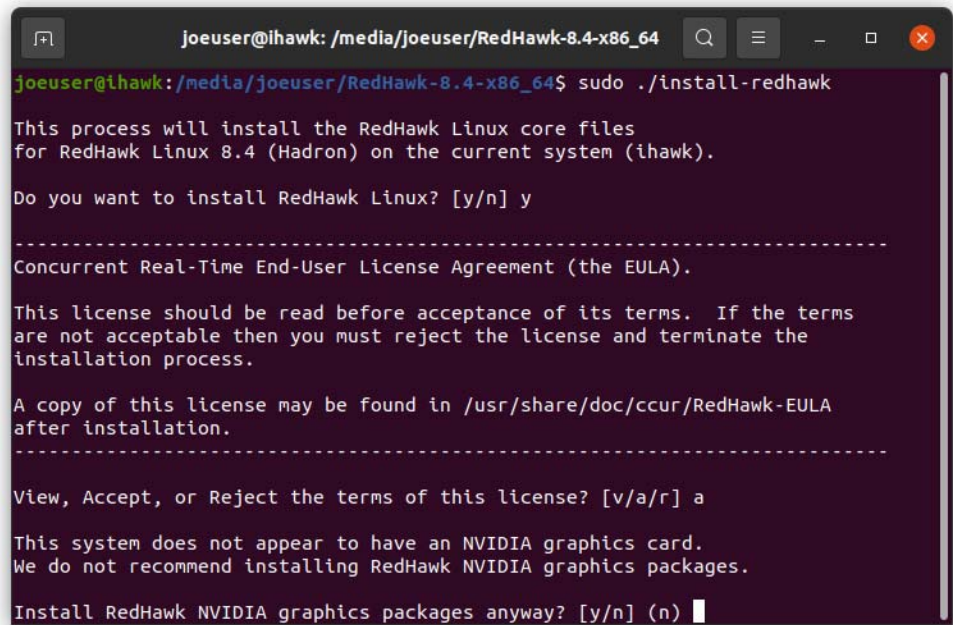
If an issue is encountered when installing from DVD, execute the following command after inserting the DVD.

```
sudo setfacl -m g::5,o::5 /media/*
```

Execute the following commands to install RedHawk Linux, substituting the actual mount point used for your optical media device.

```
cd /path-to-actual-mount-point
sudo ./install-redhawk
```

The installation script will prompt you to accept or reject the End User License Agreement. You can view the agreement by entering “v” at the prompt.



```
joeuser@ihawk: /media/joeuser/RedHawk-8.4-x86_64
joeuser@ihawk:/media/joeuser/RedHawk-8.4-x86_64$ sudo ./install-redhawk
This process will install the RedHawk Linux core files
for RedHawk Linux 8.4 (Hadron) on the current system (ihawk).

Do you want to install RedHawk Linux? [y/n] y

-----
Concurrent Real-Time End-User License Agreement (the EULA).

This license should be read before acceptance of its terms. If the terms
are not acceptable then you must reject the license and terminate the
installation process.

A copy of this license may be found in /usr/share/doc/ccur/RedHawk-EULA
after installation.

-----

View, Accept, or Reject the terms of this license? [v/a/r] a

This system does not appear to have an NVIDIA graphics card.
We do not recommend installing RedHawk NVIDIA graphics packages.

Install RedHawk NVIDIA graphics packages anyway? [y/n] (n)
```

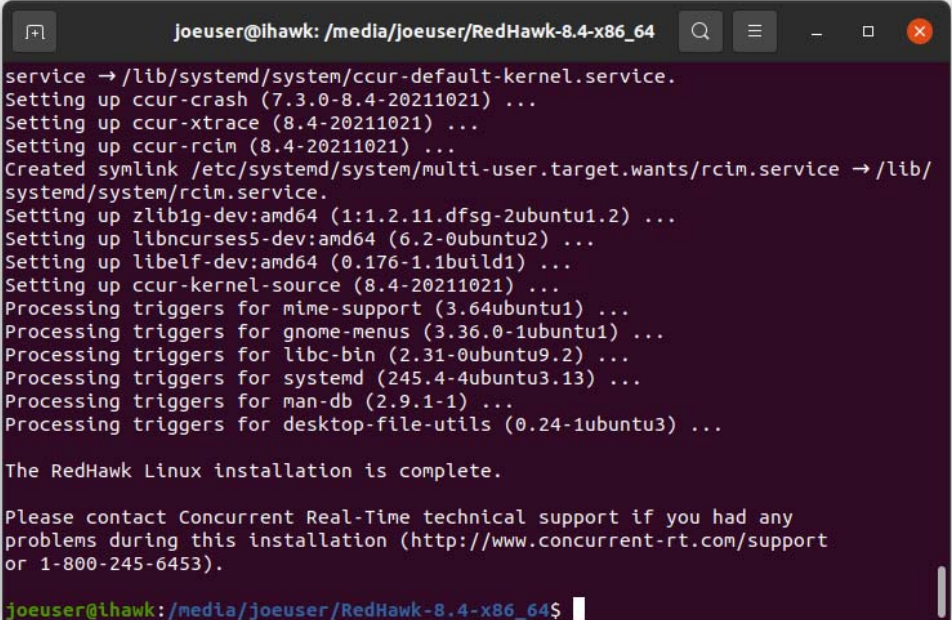
Special instructions are displayed during the installation that may require appropriate action, such as video card installation and configuration. Follow the on-screen instructions until the installation script completes.

While the messages displayed during RedHawk installation appear to indicate that package *downloading* is occurring, no actual network access is performed when using the RedHawk DVD.

NOTE

It is normal for the installation script to appear to be stalled near the end of installation. It is performing several background operations that are required and the script must not be interrupted.

Messages similar to the ones below will be displayed once all RedHawk package installation has completed successfully.



```

joeuser@ihawk: /media/joeuser/RedHawk-8.4-x86_64
service → /lib/systemd/system/ccur-default-kernel.service.
Setting up ccur-crash (7.3.0-8.4-20211021) ...
Setting up ccur-xtrace (8.4-20211021) ...
Setting up ccur-rcim (8.4-20211021) ...
Created symlink /etc/systemd/system/multi-user.target.wants/rcim.service → /lib/
systemd/system/rcim.service.
Setting up zlib1g-dev:amd64 (1:1.2.11.dfsg-2ubuntu1.2) ...
Setting up libncurses5-dev:amd64 (6.2-0ubuntu2) ...
Setting up libelf-dev:amd64 (0.176-1.1build1) ...
Setting up ccur-kernel-source (8.4-20211021) ...
Processing triggers for mime-support (3.64ubuntu1) ...
Processing triggers for gnome-menus (3.36.0-1ubuntu1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.2) ...
Processing triggers for systemd (245.4-4ubuntu3.13) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for desktop-file-utils (0.24-1ubuntu3) ...

The RedHawk Linux installation is complete.

Please contact Concurrent Real-Time technical support if you had any
problems during this installation (http://www.concurrent-rt.com/support
or 1-800-245-6453).

joeuser@ihawk: /media/joeuser/RedHawk-8.4-x86_64$

```

Eject and remove the disc from the drive and reboot the system choosing a newly installed RedHawk kernel and verify that the system boots up to the graphical login.

At this point you have completed the basic RedHawk Linux installation. If you wish to install additional RedHawk software, refer to the following sections in the main chapter of the Release Notes:

- “Installing the Frequency-Based Scheduler (FBS)” on page 35
- “Installing Additional RedHawk Products” on page 36

Updating RedHawk Software

NOTE

The latest and most up-to-date instructions for installing software via Concurrent’s network package repositories can always be found on the <http://redhawk.concurrent-rt.com/network> web page.

Perform the following steps to allow the Ubuntu package management software to access Concurrent Real-Time's Debian repositories.

1. Obtain Concurrent Real-Time's public key by issuing the following command:

```

sudo wget http://redhawk.concurrent-rt.com/
network/ccur-public-key

```

2. Add this key to the package management database by issuing the following command:

```
sudo apt-key add ccur-public-key
```

3. Create a new file named `redhawk.list` in the `/etc/apt/sources.list.d` directory with the line below, replacing *Login* and *Pass* with the appropriate values.

```
deb http://redhawk.concurrent-rt.com/ubuntu/Login/  
Pass/redhawk/generic 8.4.n core
```

Note that the Login ID (also referred to as your Site ID) and password are assigned to you from Concurrent Real-Time and are included in a cover letter that is delivered with your system or with your software.

Also note that in addition to the core channel shown in the example above you can add `fbs` and/or `rcimgps` to the end of the line if you have purchased those optional products.

4. Issue the following command to update the currently cached package repository information:

```
sudo apt-get update
```

This command will *not* change any software on your system; it merely updates all of the package repository definitions from the `/etc/apt/sources.list` and the files under `/etc/apt/sources.list.d`.

5. Use the following command to bring your system up-to-date with the latest software packages from Concurrent Real-Time:

```
sudo apt-get install 'ccur-*
```

It is important that you use single quotes around the `ccur-*` text so that the command will correctly match all available packages.

Alternatively, you can install or update individual specific Concurrent Real-Time packages using a command similar to the following example:

```
sudo apt-get install ccur-kernel-trace \  
ccur-vmlinux-trace
```

Ubuntu-Specific Notes

This section captures various Ubuntu-specific procedures that differ from Rocky procedures that existing RedHawk customers may be familiar with.

Building and Installing Custom Kernels

To install a newly built RedHawk custom kernel you should follow the usual steps that are described in the `ccur-config(1)` man page. However, you will also need to issue some additional commands to complete the kernel installation. See example below.

Note

The following additional packages are not in the default installation and must be installed on the system in order to build a RedHawk custom kernel: **make, gcc, flex, bison, qt5-default, g++.**

The following example shows the commands to configure, build and fully install a custom kernel based on the RedHawk trace configuration. Note that warnings can be safely ignored if the subsequent commands successfully complete.

```
cd /usr/src/
cd linux-5.10.59RedHawk8.4
sudo ./ccur-config trace
sudo make -j 10 bzImage modules
sudo make -j 10 modules_install
sudo make -j 10 install
sudo update-initramfs -c -k \
    5.10.59-rt52-RedHawk-8.4-custom
sudo update-grub
```

To boot from the custom kernel run `ccur-grub2(1)` without arguments to obtain the grub index number of the custom kernel. Then execute the command a second time to make the custom kernel the default kernel as follows:

```
sudo ccur-grub2 -d <index number>
```

Kernel Crash Dumps

Kdump is a kernel crash dumping mechanism that allows you to save the contents of the system's memory to be analyzed later. Kexec is used to boot a Linux kernel from the context of another kernel and save the contents of the first kernel's memory.

The following instructions provides the basics of installing the software, reserving memory, configuring kdump, forcing a crash dump, and using the crash tool to analyze the dump.

1. Install the crash dump package.

The **linux-crashdump** package installs all the tools required to get crash dumps working.

```
sudo apt install linux-crashdump
```

During the installation, the following questions may be asked. If so reply as

shown below.

```
Should kexec-tools handle reboots (sysvinit only)? NO  
Should kdump-tools be enabled by default? YES
```

2. Reserve Kernel Memory for the capture kernel.

A part of the system memory has to be reserved for the capture kernel. This part of the system memory will no longer be available to the main kernel.

A default memory reservation should be automatically configured for you when you install the tools. If it is not there or you need to alter the memory reservation, edit the configuration file.

```
sudo vi /etc/default/grub.d/kdump-tools.cfg
```

You should see a line defining the crash kernel memory reservation as:

```
crashkernel=512-:192M
```

Next, update the grub files by issuing the command:

```
sudo update-grub
```

3. Configure your kdump kernel as the default kernel and reboot the system.

Note that any of the RedHawk kernels (standard, trace, debug) can be used as the kdump kernel. Invoke **ccur-grub2** without any options to get the kernel index number of the desired kernel.

```
sudo ccur-grub2 -d <dump kernel index no.>  
sudo reboot
```

Once the system is up, verify the crashkernel memory has been reserved:

```
dmesg | grep crashkernel | grep -i reserving
```

The output will look similar to this:

```
[0.000000] kexec: Reserving the low 1M of memory for crashkernel  
[0.000000] Reserving 192MB of memory at 2912MB for crashkernel
```

4. Next modify the kdump configuration.

First remove some links in the **/boot** directory that are problematic for kdump:

```
rm /boot/vmlinuz-*RedHawk*
```

Next, if not already there, generate links for kdump in the **/var/lib/kdump** directory:

```
KRELEASE=`uname -r`  
cd /var/lib/kdump  
ln -s /boot/vmlinuz-{$KRELEASE} ./vmlinuz
```

```
ln -s /boot/initrd.img-{$KRELEASE} ./initrd.img
```

Verify that the following parameter is set to 1 in the file
/etc/default/kdump-tools:

```
USE_KDUMP=1
```

Reload the new kdump configuration with the modifications just made.

```
sudo kdump-config reload
```

5. Verify the configuration, making sure the current state in the output says 'ready to kdump'.

```
sudo kdump-config show
```

The output will look similar to this:

```
DUMP_MODE:          kdump
USE_KDUMP:          1
KDUMP_SYSCTL:       kernel.panic_on_oops=1
KDUMP_COREDIR:      /var/crash
crashkernel addr:  0xb6000000
                   /var/lib/kdump/vmlinuz: symbolic link to /boot/vmlinuz-
5.10.59-rt52-RedHawk-8.4-trace
kdump initrd:
                   /var/lib/kdump/initrd.img: symbolic link to /var/lib/kdump/
initrd.img-5.10.59-rt52-RedHawk-8.4-trace
current state:      ready to kdump

kexec command:
                   /sbin/kexec -p --command-line="BOOT_IMAGE=/boot/vmlinuz-5.10.59-
rt52-RedHawk-8.4-trace root=UUID=eab38b4f-5643-4071-baff-
5f25990e2c7d ro quiet splash vt.handoff=7 console=ttyS0,115200
reset_devices systemd.unit=kdump-tools-dump.service nr_cpus=1
irqpoll nousb ata_piix.prefer_ms_hyperv=0" --initrd=/var/lib/kdump/
initrd.img /var/lib/kdump/vmlinuz
```

6. To test the kdump configuration, a crash can be forced.

Note that the following command has to be run as the root user; **sudo** will not work in this case. Be aware that the command will crash the system and reboot it, so take necessary precautions.

```
echo c > /proc/sysrq-trigger
```

Many of the errors during the crash recovery can be ignored, including the following errors from **kdump-tools**. See "Various warnings during crash dump creation" in the Known Issues section on page-57 for more information.

```
Starting Kernel crash dump capture service...
[ 39.694990] kdump-tools[7832]: Starting kdump-tools:
[ 39.695247] kdump-tools[7850]: * running makedumpfile -c -d 31 /
proc/vmcore/var/crash/202110271350/dump-incomplete
Copying data: [100.0%] | eta: 0
s
[ 60.243791] kdump-tools[7874]: The kernel version is not
supported.
[ 60.243837] kdump-tools[7874]: The makedumpfile operation may be
incomplete.
[ 60.243872] kdump-tools[7874]: The dumpfile is saved to /var/
crash/202110271350/dump-incomplete.
[ 60.245277] kdump-tools[7874]: makedumpfile Completed.
[ 60.424189] kdump-tools[7850]: * kdump-tools: saved vmcore in /
var/crash/202110271350
[ 60.696787] kdump-tools[7850]: * running makedumpfile --dump-
```

```
dmesg /proc/vmcore /var/crash/202110271350/dmesg.202110271350
[ 60.770728] kdump-tools[7883]: dump_dmesg: Can't find some
symbols for log_bu f.
[ 60.771109] kdump-tools[7883]: The kernel version is not
supported.
[ 60.771155] kdump-tools[7883]: The makedumpfile operation may be
incomplete.
[ 60.771186] kdump-tools[7883]: makedumpfile Failed.
[ 60.771398] kdump-tools[7850]: * kdump-tools: makedumpfile --
dump-dmesg fail
ed. dmesg content will be unavailable
[ 60.773691] kdump-tools[7850]: * kdump-tools: failed to save
dmesg content in /var/crash/202110271350
[ 60.796721] kdump-tools[7886]: Wed, 27 Oct 2021 13:50:37 -0400
[ 61.076207] kdump-tools[7887]: Rebooting.
```

7. Examine the crash after the system reboots.

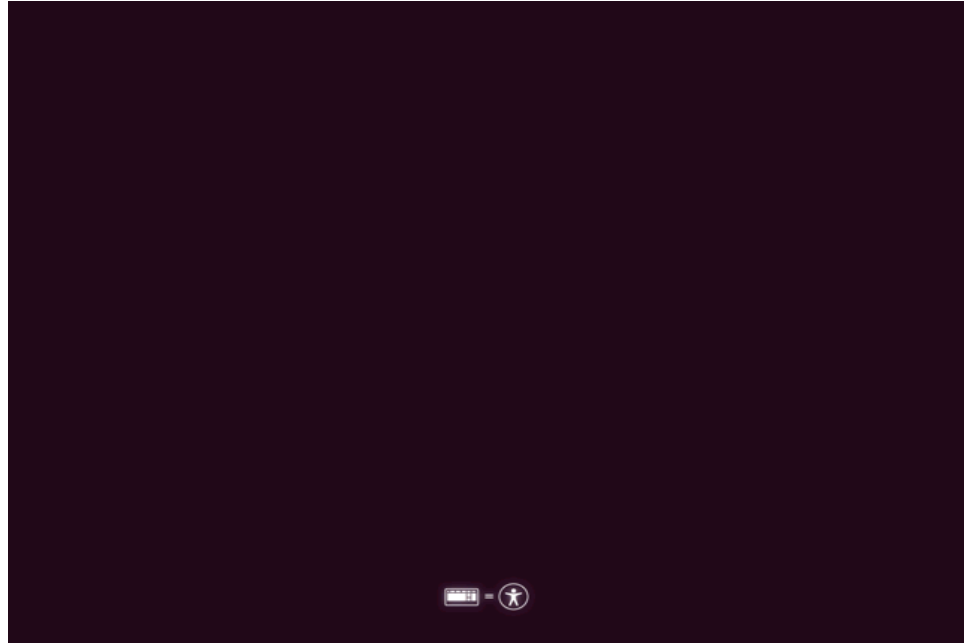
The `KRELEASE` variable, as set below, assumes you are currently booted off the same kernel version you were running when the system crashed. If not, replace `KRELEASE` with the kernel release name of the kernel used in the crash.

If you get an error from the `crash` command, verify you are using `/usr/ccur/bin/crash`:

```
which crash
KRELEASE=`uname -r`
cd /var/crash
ls -ltr
cd <crash-dir>
crash /usr/lib/debug/boot/vmlinux-{$KRELEASE} \
./dump.*
```

Installing Ubuntu in Safe graphics mode

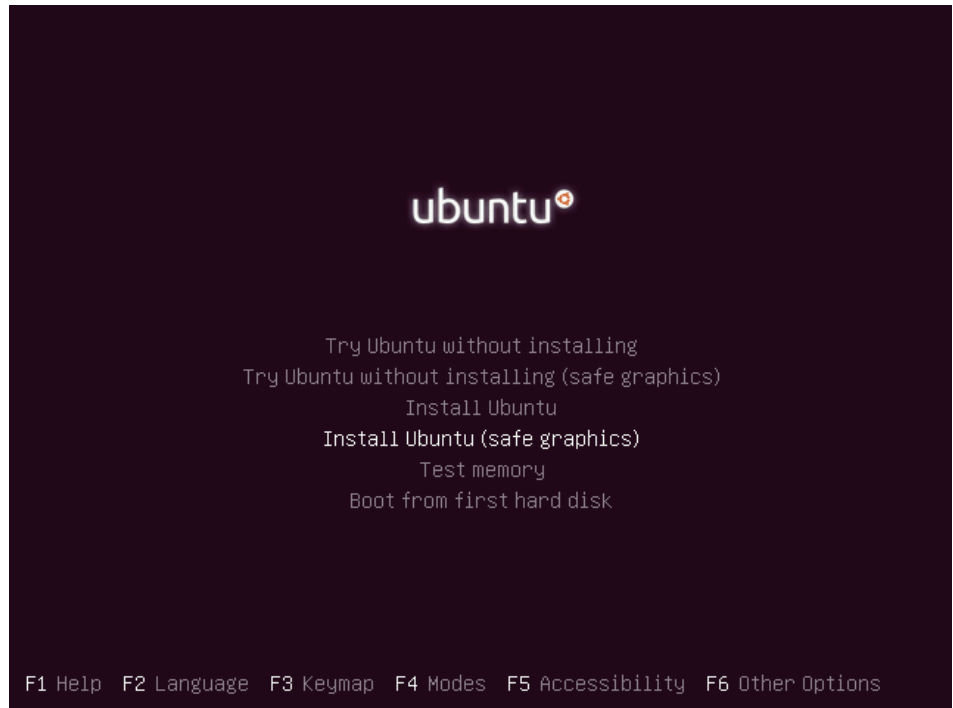
Boot from DVD and press the **Down Arrow** key when you see the following page. Pay close attention as the page is up only for a short time.



Select the appropriate language, then press **Enter**.



Use the Down Arrow key to select Install Ubuntu (safe graphics).



Once selected press **Enter** to continue. Follow the installation instructions at the beginning of this chapter to complete the installation.

B

ARM64 Support

This appendix contains additional information on using RedHawk 8.4 with hardware that utilizes the 64-bit ARMv8-A processor architecture (a.k.a. *ARM64*, a.k.a. *Aarch64*).

Overview

RedHawk 8.4 has been ported to the ARM64 architecture and has currently been qualified on the following development systems:

- Applied Micro X-C1 Server Development Platform (a.k.a. Mustang)
- ARM Juno R1 64-bit Development Platform

Support for additional ARM64 systems is planned. Customers interested in other systems should contact their regional Concurrent Real-Time sales representative for more information.

Installation

Installation of RedHawk 8.4 for ARM64 is supported utilizing both the Rocky 8.4 and Ubuntu 20.04 LTS base distributions. Unfortunately, the installation of these base distributions on all currently available ARM64 hardware varies considerably and is beyond the scope of this document.

Concurrent Real-Time recommends that you purchase pre-installed ARM64 systems from Concurrent Real-Time instead of trying to install them yourself. However, for those up for the challenge, the following guidelines may help guide you during the initial base distribution installation:

- For RedHawk to work the board must be configured with UEFI firmware. Boards that come pre-installed with other firmware (e.g. the *Das U-Boot* boot loader) cannot be used with RedHawk until they are converted to UEFI. See the many resources on the Internet for conversion instructions.
- Few ARM64 systems feature a graphical console, however both Rocky and Ubuntu support installation using a simple text interface over the serial console. In addition, Rocky can still be installed graphically by utilizing a remote VNC connection. Refer to Internet resources for more information.
- Often the easiest method for performing a Rocky or Ubuntu installation is to connect a USB DVD reader to the ARM64 system with the distribution's optical media disc inserted. While it is unlikely that the system will be able

to automatically boot the disc's installer, once the system is booted to a UEFI shell manual commands can be issued to boot the disc's installer.

- Once the base distribution installation has started successfully, refer to “Installing Rocky” on page 12 or “Installing Ubuntu” on page A-1 to complete the base distribution installation.

After performing any necessary initial low-level configuration of the ARM64 system and successfully installing the base distribution, continue with “Installing RedHawk Linux” on page 32 for Rocky systems or “Installing RedHawk Linux” on page A-7 for Ubuntu systems.

C

UEFI Secure Boot

This appendix contains instructions to configure a RedHawk Linux system to boot in UEFI Secure Boot mode.

NOTE

UEFI Secure Boot is not supported in the Rocky 8.4 release but it will be supported in a future release. Note, however, that RedHawk 8.4 does support UEFI Secure Boot and can be installed on any Rocky-compatible 8.4 distribution that has support for Secure Boot.

NOTE

The EFI runtime services are disabled by default starting with the 8.2.1 RedHawk release, therefore, you cannot use the `mokutil` command once running on a RedHawk kernel. Running the `mokutil` command to query the state will return "EFI variables are not supported on this system". The EFI runtime services remain enabled by default in the base kernels (Rocky or RedHat). See "EFI Runtime Services Now Disabled By Default" in the Known Issues section on page-57 for more information.

Overview

UEFI Secure boot is a verification mechanism ensuring that code launched by firmware is trusted. UEFI Secure Boot requires that each binary loaded at boot is validated against known keys, located in firmware. A chain of trust is then established from the firmware to the signed drivers and kernel modules.

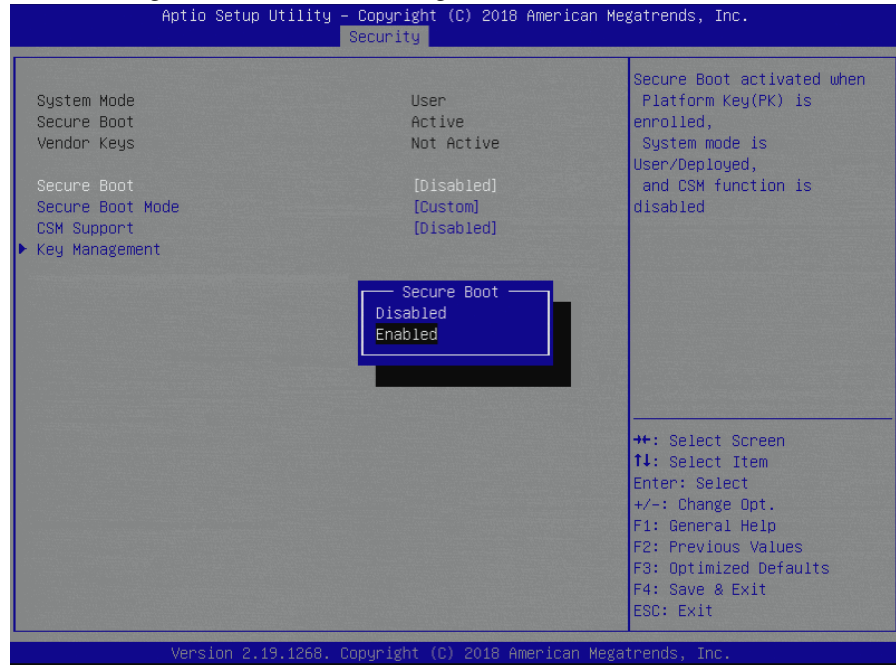
Configuration

Booting a RedHawk Linux system in UEFI Secure Boot mode requires that the BIOS is modified to enable Secure Boot and that the RedHawk machine owner key (MOK) is added to the system's MOK list.

The following instructions will configure a RedHawk Linux system to boot in UEFI Secure Boot mode.

1. If you have not yet installed the RedHawk Linux system, install it now. Note that the system must be installed UEFI-enabled and running a RedHawk Linux version 8.0.1 or later. See “Installation Procedures” on page 11 of this document for help.
2. Reboot the system and enter the BIOS Setup. Verify that the system is in UEFI Boot mode and then enable Secure Boot. Save the BIOS change and reset the system. When the kernel boot menu appears, use the up and down arrow keys to choose a base (Rocky or Red Hat) kernel from the kernel boot menu.

The following screen shows the enabling of Secure Boot in the BIOS.



3. Once booted, open a terminal window and execute the following **mokutil(1)** command to verify that the system is booted with Secure Boot enabled.

```
# mokutil --sb-state
SecureBoot enable
```

4. Next, issue the following **mokutil(1)** command to request for the enrollment of the RedHawk machine owner key (MOK). The command will prompt to create and confirm a password for this request.

```
# cd /boot/efi
# mokutil --import ./redhawk-ca.cer
input password:
input password again:
```

5. Now configure the RedHawk trace kernel as the default boot kernel. Use **blscfg** to find the index of the RedHawk trace kernel. If it is not set as the default boot kernel, then use the **-d** option to set it as the default.

6. Reboot the system. Just before loading GRUB, on the system console, the MOK Management menus will prompt you to complete the enrollment request. The screens that follow show an example MokManager key enrollment.

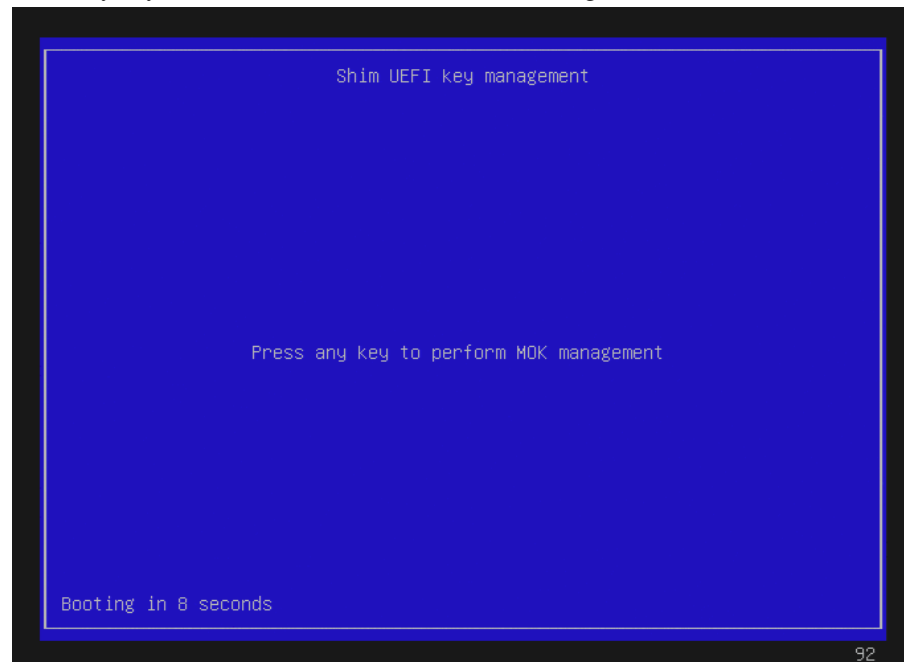
NOTE

The MokManager window displayed on the console must be accessed within 10 seconds or it will time out and resume booting without enrolling the MOK.

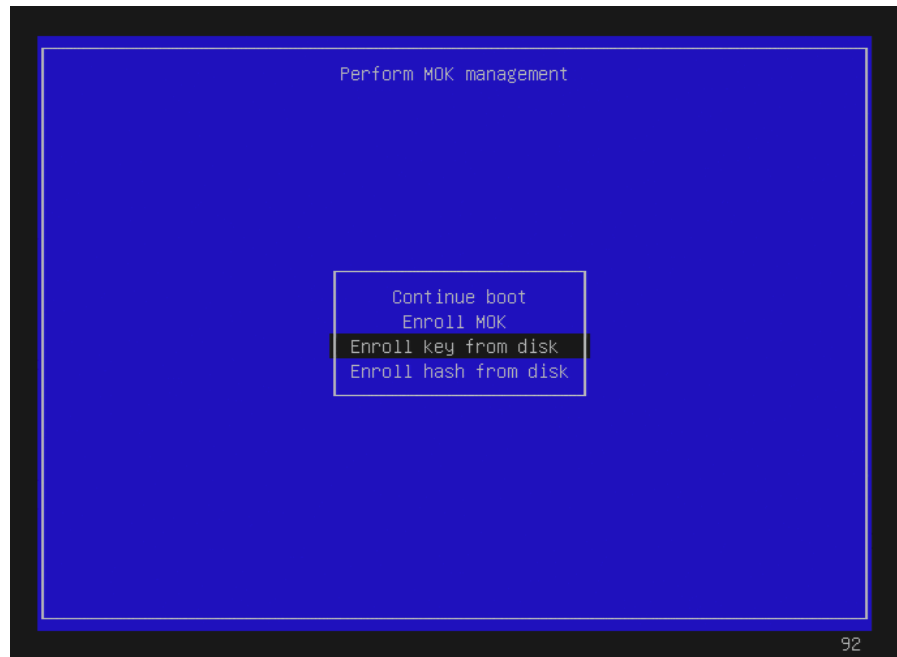
NOTE

The enrollment request is remembered only on the boot following when the request is issued. If the MokManager window times out or there is an issue during the enrollment, you must reboot a base system kernel (Rocky or Red Hat) and reissue the request, starting again with step 4 above.

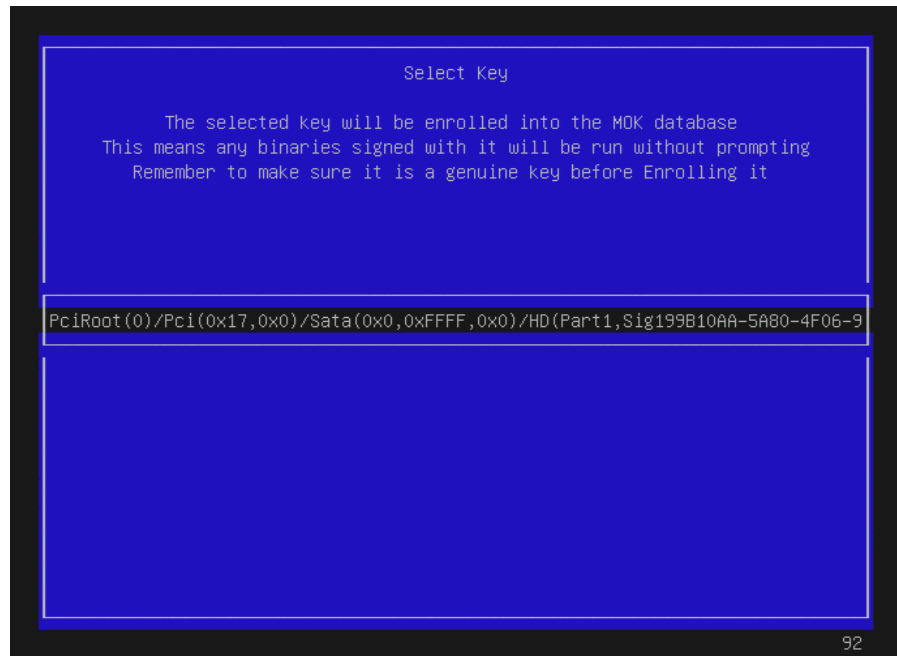
Press any key, within 10 seconds, to start MOK management.



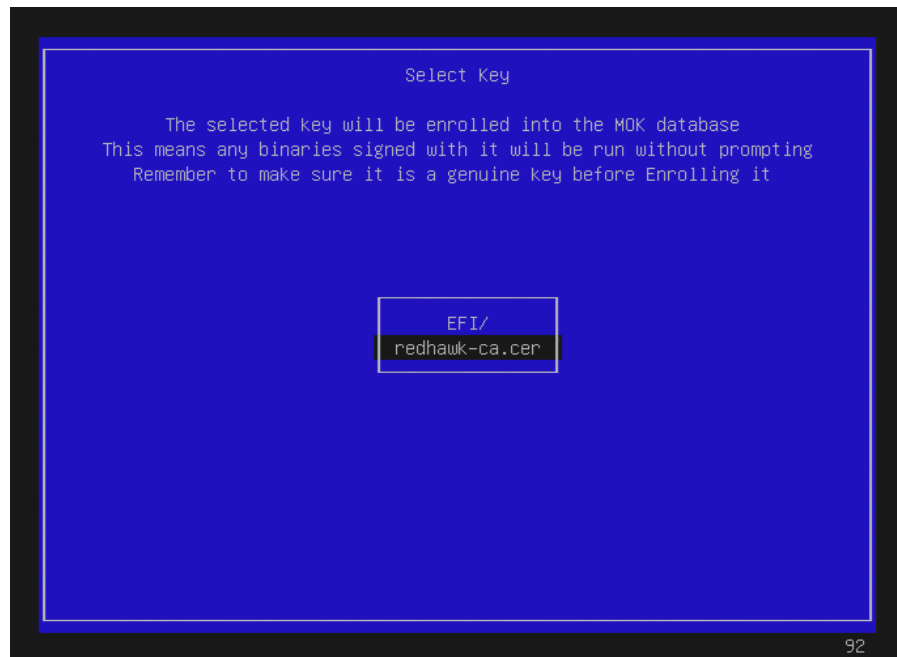
Select 'Enroll Key from disk' and press ENTER.



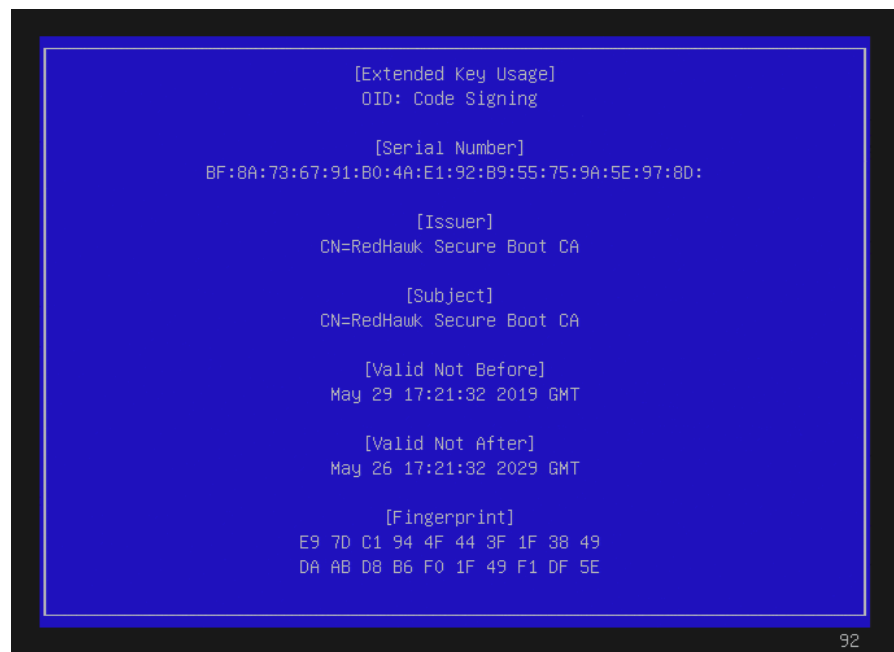
Press ENTER on the selected key to continue:.



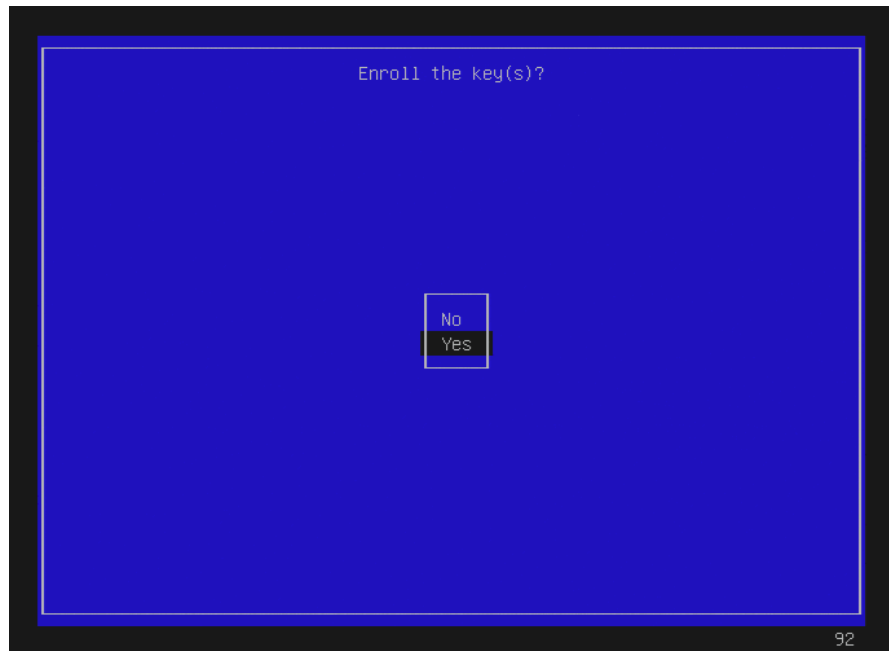
Select the key file, `redhawk-ca.cer`, and press ENTER:



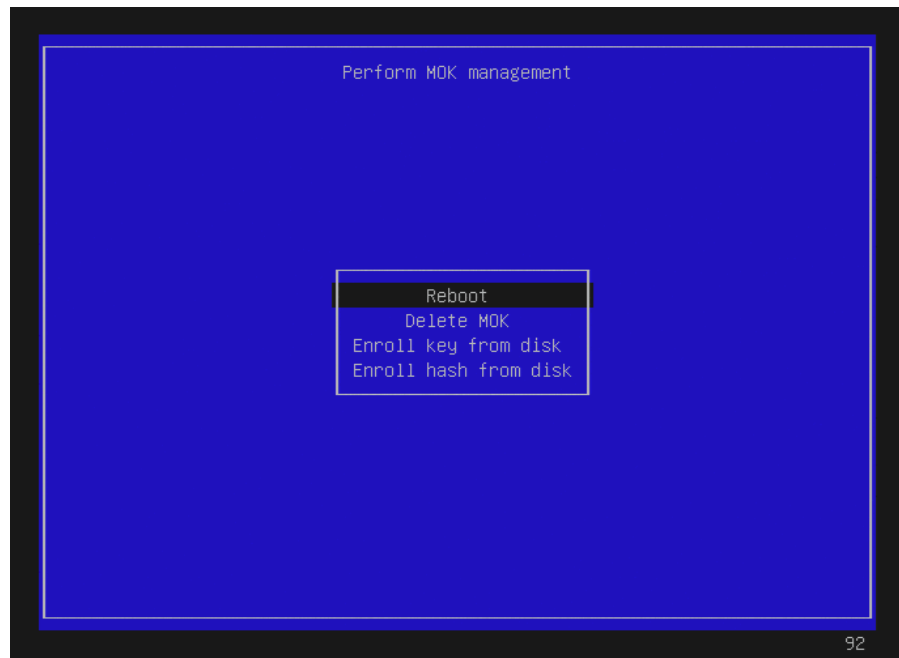
Next, a screen (not shown here) will give the option to verify the key or/and continue. Select view key to view the key and then press ENTER to go back. Select continue and press ENTER to continue. Below is an example of the key verification screen.



Select **Yes** to enroll the key and then press ENTER.



Select **Reboot** and press ENTER.



Note that on some systems, after successfully completing the enrollment, the reboot will take you back into the MokManager menu. If this happens, allow it to time out and continue booting.

7. Once booted, verify that you are booted on the RedHawk Linux trace kernel (**uname (1)**). Also verify that Secure Boot is enabled as follows:


```
dmesg | grep -i secure  
[ 0.017972] Secure Boot enabled
```


Overview

Turbo Boost is an Intel feature that enables Intel processors to run significantly faster than the processors' rated base frequencies when power usage and temperatures are within certain limits. Not all Intel processors provide the Turbo Boost feature, but for processors that do, the feature must be enabled in the system's firmware settings to be utilized.

Core Performance Boost (also known as Turbo Core) is an AMD feature that implements a similar processor speed boosting behavior for AMD processors when power usage and temperatures are within certain limits. Not all AMD processors provide the Core Performance Boost feature, but for processors that do, the feature must also be enabled in the system's firmware settings to be utilized.

The most recent versions of RedHawk Linux now include a system service called **turbo** that can enable and disable processor speed boosting at run-time through the operating system. This appendix explains how to use this service, and also provides information to help customers decide whether or not to enable processor speed boosting when running their real-time applications.

Configuration

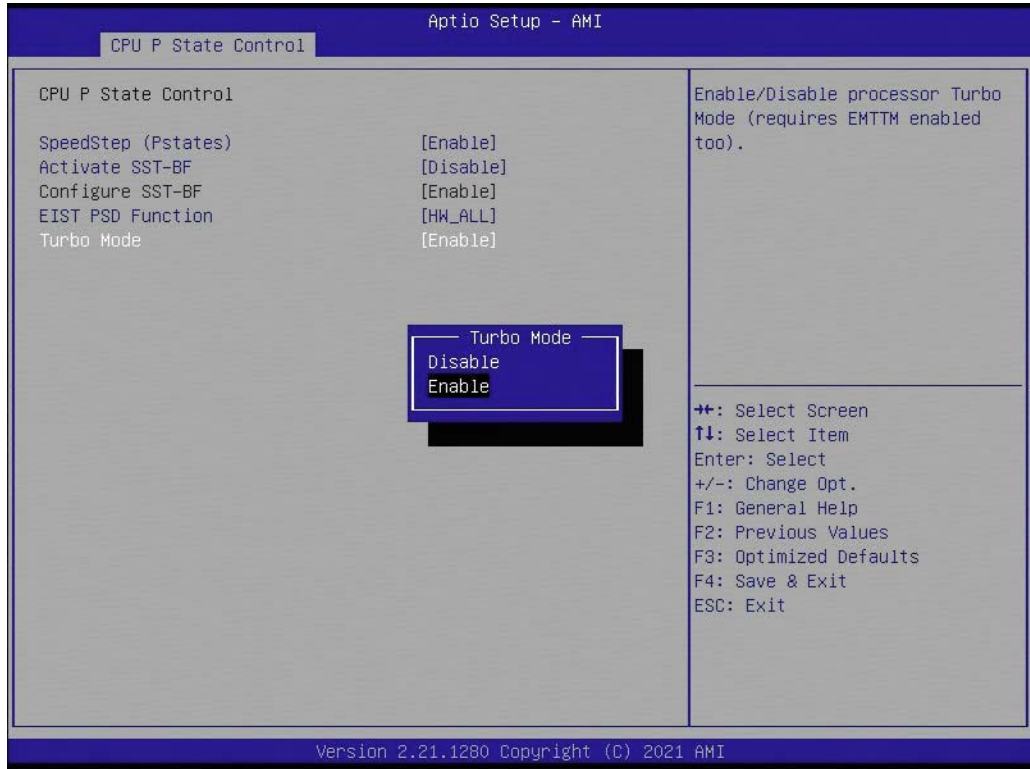
The **turbo** service is added to the system during RedHawk installation, but the service is initially installed in a default disabled state. After installation, users are free to override the default and change the state of the **turbo** service as they see fit.

See "Real-Time Implications" on page D-5 for information on how processor speed boosting can impact real-time performance.

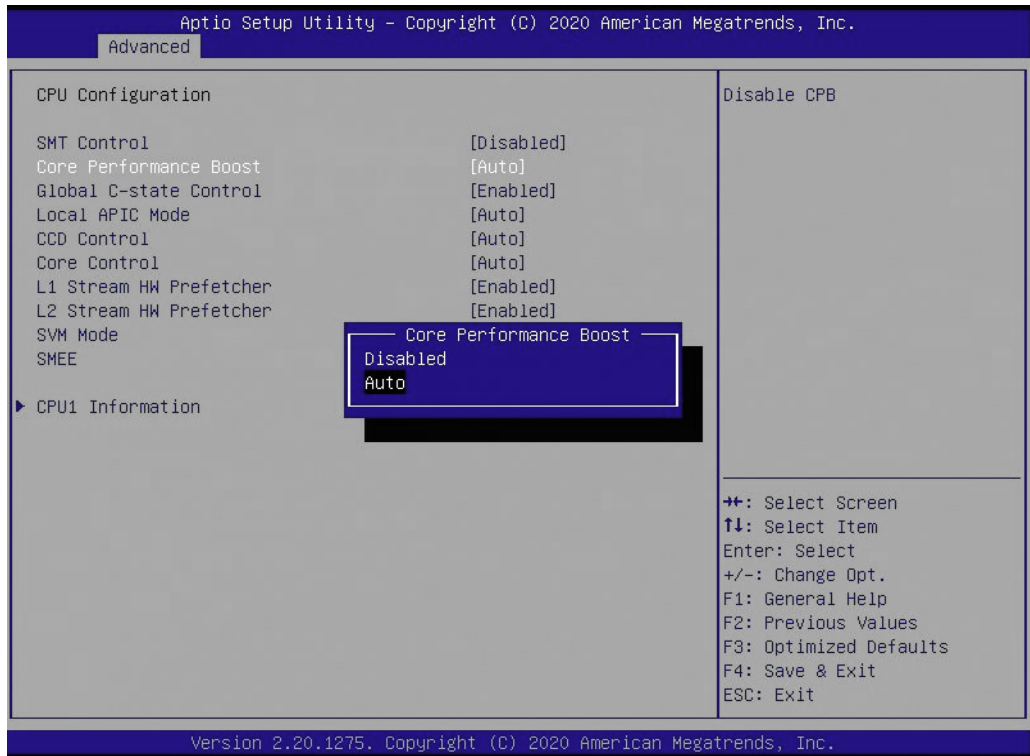
Firmware Settings

Processor speed boosting must first be enabled in the system's firmware settings before it can be utilized. For most systems, the setting will be located in the firmware settings under the Advanced ⇒ CPU Configuration page.

For systems using Intel processors, the Turbo Boost setting can usually be found under Advanced ⇒ CPU Configuration ⇒ Advanced Power Management Configuration ⇒ CPU P State Control and resembles the following display:



For systems using AMD processors, the Core Performance Boost setting can usually be found under Advanced ⇒ CPU Configuration and resembles the following display:



Service Enabling

To enable the **turbo** service and allow processor speed boosting, issue the following commands as the root user:

```
systemctl enable turbo
systemctl start turbo
```

Once enabled and started, processor speed boosting will be allowed whenever possible, and this behavior will be preserved across reboots.

To verify the **turbo** status is enabled, issue the following commands as the root user:

```
systemctl status turbo
```

Output like the following should be displayed:

```
• turbo.service - Enable or Disable Turbo Boost
  Loaded: loaded (/usr/lib/systemd/system/turbo.service; enabled; vendor preset
  Active: active (exited) since Tue 2021-11-16 14:36:48 EST; 14min ago
  Main PID: 3925678 (code=exited, status=0/SUCCESS)
  Tasks: 0 (limit: 1648261)
  CGroup: /system.slice/turbo.service

Nov 16 14:36:48 ihawk systemd[1]: Starting Enable or Disable Turbo Boost...
Nov 16 14:36:48 ihawk turbo.init[3925678]: Enabling Turbo Boost...
Nov 16 14:36:48 ihawk turbo.init[3925678]: CPU Vendor:           GenuineIntel
Nov 16 14:36:48 ihawk turbo.init[3925678]: CPU Scaling Driver:  acpi-cpufreq
Nov 16 14:36:48 ihawk turbo.init[3925678]: Turbo Boost Enabled
Nov 16 14:36:48 ihawk systemd[1]: Started Enable or Disable Turbo Boost.
```

The above output confirms that the **turbo** service is enabled and was started, and that the Turbo Boost feature has been enabled by the operating system.

Service Disabling

To disable the **turbo** service and prevent processor speed boosting, issue the following commands as the root user:

```
systemctl stop turbo
systemctl disable turbo
```

Once disabled, processor speed boosting will be prevented, and this prevention will be preserved across reboots.

To verify the **turbo** status is disabled, issue the following commands as the root user:

```
systemctl status turbo
```

Output like the following should be displayed:

```
• turbo.service - Enable or Disable Turbo Boost
  Loaded: loaded (/usr/lib/systemd/system/turbo.service; disabled; vendor prese
  Active: inactive (dead)
```

```
Nov 16 15:17:10 ihawk systemd[1]: Stopping Enable or Disable Turbo Boost...
Nov 16 15:17:10 ihawk turbo.init[3926503]: Disabling Turbo Boost...
Nov 16 15:17:10 ihawk turbo.init[3926503]: CPU Vendor:           GenuineIntel
Nov 16 15:17:10 ihawk turbo.init[3926503]: CPU Scaling Driver:  acpi-cpufreq
Nov 16 15:17:10 ihawk turbo.init[3926503]: Turbo Boost Disabled
Nov 16 15:17:10 ihawk systemd[1]: turbo.service: Succeeded.
Nov 16 15:17:10 ihawk systemd[1]: Stopped Enable or Disable Turbo Boost.
```

The above output confirms that the **turbo** service is disabled and was stopped, and that the Turbo Boost feature has been disabled by the operating system.

Service Errors

Note that starting the **turbo** service on a system may result in an error being displayed, as shown below:

```
# systemctl start turbo
Job for turbo.service failed because the control process exited with error code.
See "systemctl status turbo.service" and "journalctl -xe" for details.
```

If this occurs, check the status of the **turbo** service as indicated in the error output, as shown below:

```
# systemctl status turbo
● turbo.service - Enable or Disable Turbo Boost
   Loaded: loaded (/usr/lib/systemd/system/turbo.service; disabled; vendor prese
   Active: failed (Result: exit-code) since Tue 2021-11-16 16:06:03 EST; 34s ago
   Process: 3052534 ExecStart=/usr/lib/ccur/turbo.init start (code=exited, status
   Main PID: 3052534 (code=exited, status=1/FAILURE)

Nov 16 16:06:02 ihawk systemd[1]: Starting Enable or Disable Turbo Boost...
Nov 16 16:06:03 ihawk turbo.init[30]: Error: Intel Turbo Boost disabled in BIOS.
Nov 16 16:06:03 ihawk systemd[1]: turbo.service: Main process exited, code=exite
Nov 16 16:06:03 ihawk systemd[1]: turbo.service: Failed with result 'exit-code'.
Nov 16 16:06:03 ihawk systemd[1]: Failed to start Enable or Disable Turbo Boost.
```

The above output indicates that an error occurred because Turbo Boost has not been enabled in the system's firmware settings, however, the same error can also occur if the system's processors do not support the Turbo Boost feature.

To correct this situation, check the processor vendor's data sheet for the system's specific processors to determine whether the Turbo Boost feature is present. If the Turbo Boost feature is present, reboot the system and modify the firmware settings to enable Turbo Boost, restart the system, and then enable the **turbo** service again.

AMD Caveats

Note that AMD processors do not provide a mechanism to determine if Core Performance Boost is enabled in the system's firmware settings while RedHawk is running. Due to this limitation, the **turbo** service will always appear to start successfully with AMD processors, even if the processors do not support the Core Performance Boost feature or the feature is disabled in the system's firmware settings.

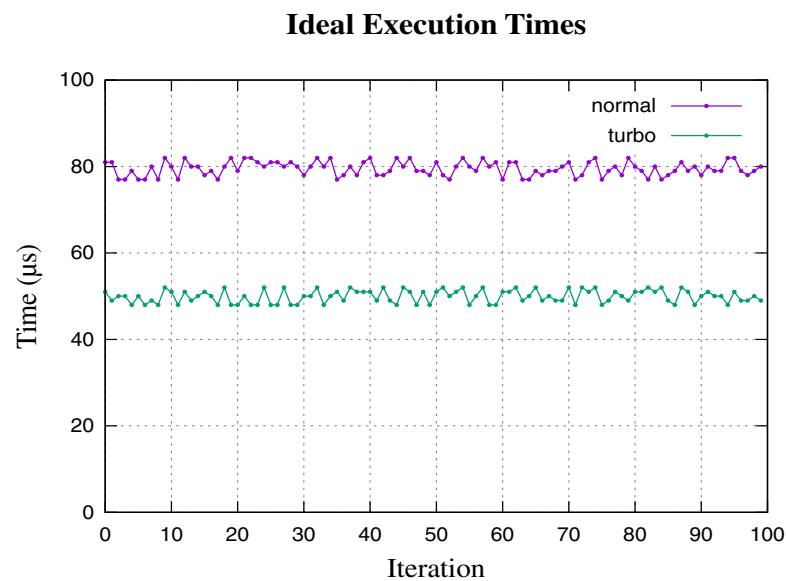
For this reason, customers with systems that utilize AMD processors must ensure that the Core Performance Boost feature is present and enabled in their system's firmware before they can expect any processor speed boosting to occur on their systems.

Real-Time Implications

The **turbo** service is disabled on RedHawk Linux by default because it can potentially confuse users and cause them to draw misleading conclusions about their system's true real-time performance capabilities. This section discusses why this confusion can occur and recommends steps that users can take to more accurately determine their system's capabilities.

Ideal Case

Ideally, enabling processor speed boosting would guarantee that real-time execution times are always uniformly faster, and ensure that power usage and temperature limits are never exceeded. If this was possible, you would expect the real-time performance for boosted execution times to always be faster than the normal, non-boosted execution times, and the following example graph illustrates this ideal case:



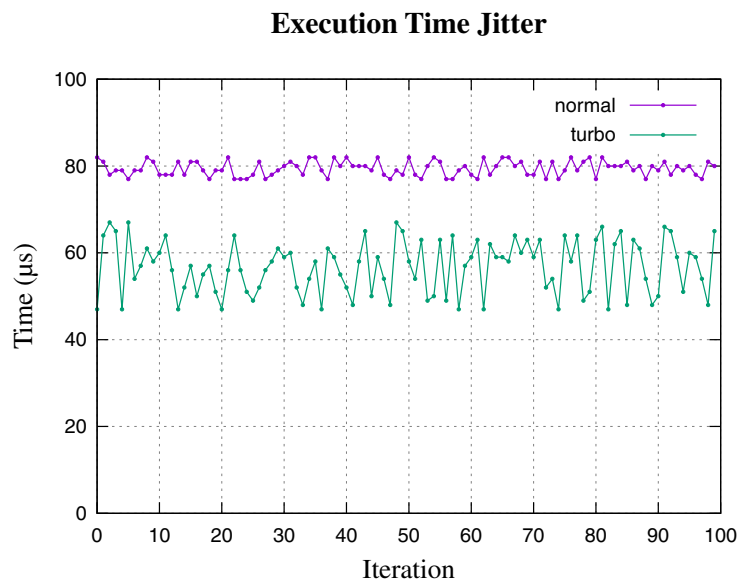
Unfortunately, while this graph may sometimes accurately represent the best and average case execution times, actual power usage and temperature limitations make this ideal case unattainable, especially for worst case execution times.

The next sections illustrate the more realistic cases that users are likely to see.

Increased Jitter

Processor speed boosting will generally always improve average and best case execution times, however, fluctuations of power usage and temperatures over time can negatively impact real-time determinism resulting in significantly increased jitter.

For example, a real-time task that has a normal, non-boosted average execution time of 80 μs , with a variance of $\pm 5 \mu\text{s}$, might be improved by processor boosting to have an average execution time of 57 μs , but with an increased variance of $\pm 10 \mu\text{s}$, as illustrated in the following graph:

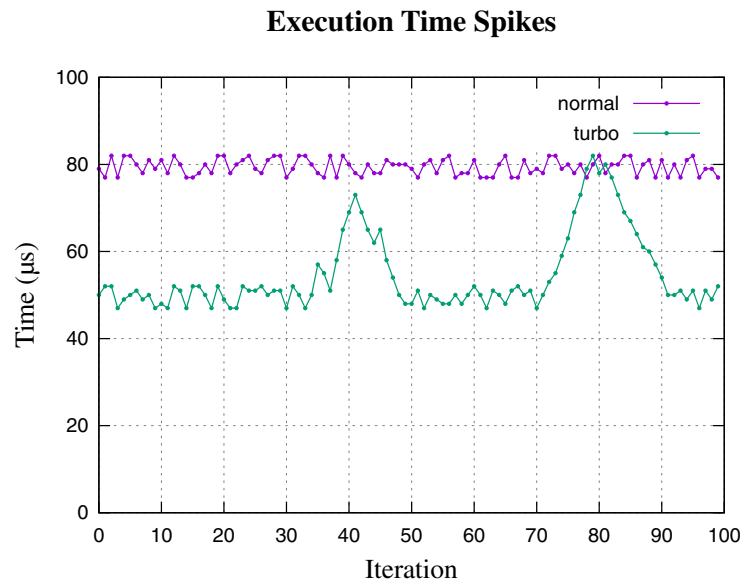


For some real-time applications, an increase of execution time jitter is less important than the benefit of decreased average and best case execution times, however, for other real-time applications this increase in non-determinism is unacceptable. Users must determine which behavior is appropriate for their specific real-time applications.

The improvements to best and average case execution times may appear to suggest that enabling processor speed boosting always results in faster execution times than normal, non-boosted execution times. However, execution times are not always faster, and the next section explains why processor speed boosting can mislead users into miscalculating their true worst case execution times.

Worst Case

While processor speed boosting almost always improves best and average case execution times, increased power usage and temperatures occurring under excessive system loads can cause speed boosting to be suspended, temporarily returning execution times to their normal, non-boosted levels, as illustrated in the following graph:



The temporary suspension of processor speed boosting under these conditions should make it clear that, while processor speed boosting may improve best and average case execution times, true worst case execution times will remain unchanged regardless of whether processor speed boosting is enabled or disabled.

For this reason, it is always recommended that users measure the true worst case execution times for their real-time applications with processor speed boosting disabled.

Summary

Users must decide whether to enable or disable the **turbo** service based on the specific requirements of their real-time applications. Concurrent recommends considering the following guidelines when deciding:

1. Enabling the **turbo** service will almost always result in faster best case and average case execution times for real-time applications.
2. Enabling the **turbo** service will almost always increase the amount of execution time jitter for real-time applications.
3. Enabling the **turbo** service will not improve true worst case execution times for real-time applications.

