

# Installation of RedHawk™ 7.5.2 Gold on the NVIDIA® Jetson Nano™

## Release Notes

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0898003-7.5.2-Nano



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# 1. Introduction

This document describes the process of installing the ARM64 version of RedHawk™ 7.5.2 on the Jetson Nano. The directions in this document supersede all others – they are specific to installing the software on Concurrent Real-Time's RedHawk systems.

## 2. Requirements

- Jetson Nano with Internet access
- An x86\_64 host system running Ubuntu 16.04 or 18.04 with Internet access; note that the host system should be up-to-date with the latest available Ubuntu package updates
- The *RedHawk 7.5.2 for the Jetson Nano* optical media disk

### NOTE

*Make sure that `/usr/bin/python` exists on the Ubuntu host system; install the `python` package if `/usr/bin/python` does not exist.*

## 3. Installation

### 3.1. Download SDK Manager onto the host system

On an x86\_64 host system running Ubuntu 16.04 or 18.04, download version 1.1.0-6343 of SDK Manager from the NVIDIA website via this URL:

<https://developer.nvidia.com/jetpack>

Click on the NVIDIA SDK Manager link to download the SDK Manager package (login may be required). You should also click on the Jetson Nano Developer Kit User Guide link to download the User's Guide PDF.

Place these downloaded files into a `nano` directory in the home directory of the current user.

### 3.2. Install the downloaded SDK Manager package

Open a terminal window and issue the following commands to install the SDK Manager:

```
$ cd ~/nano
$ sudo apt install ./sdkmanager_1.1.0-6343_amd64.deb
```

### 3.3. Use SDK Manager to flash JetPack 4.3 on the Nano

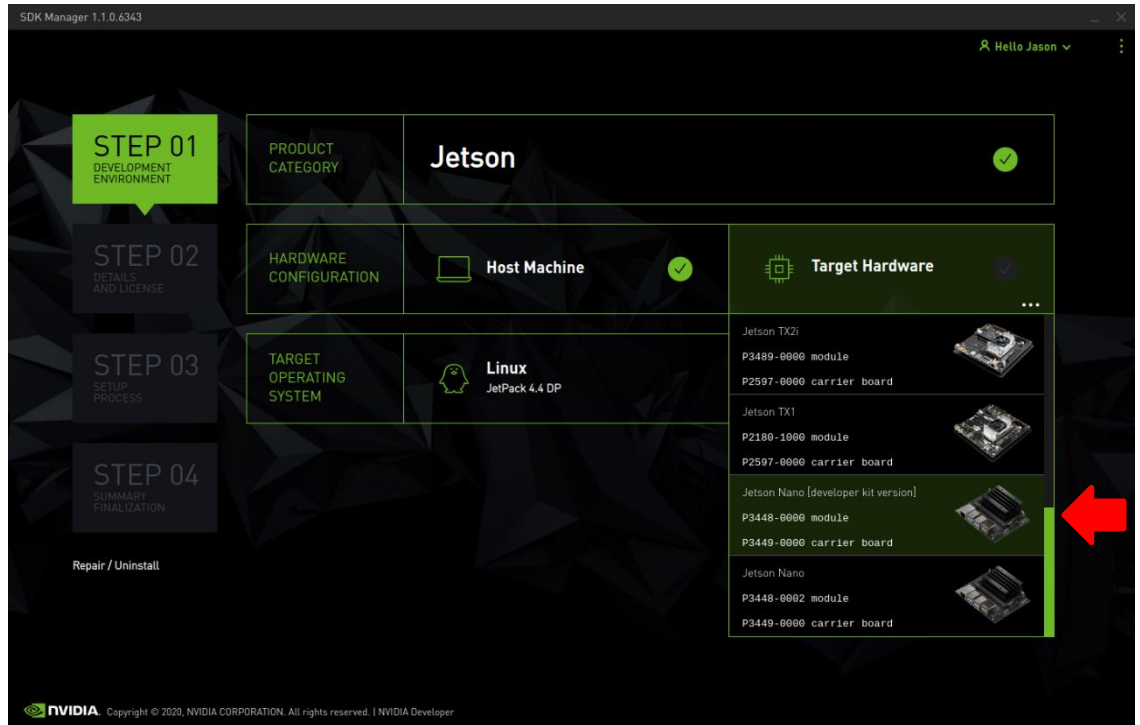
Invoke the following command as the current user to begin using the SDK Manager:

```
$ sdkmanager
```

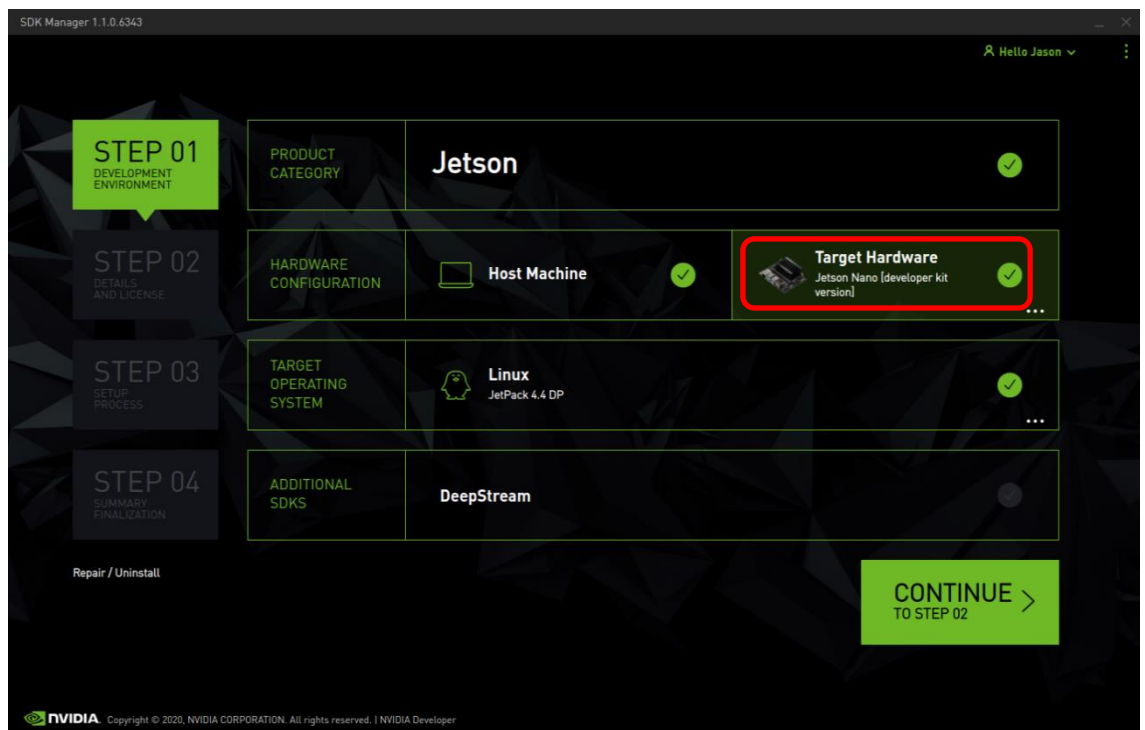
The first action required by the SDK Manager is to log into the `nvidia.com` website using your developer or partner account email address and password. Enter the appropriate information and press `LOGIN` to continue.


At this point, you can generally follow the instructions in the *Jetson Nano Developer Kit User Guide* along with the following RedHawk-specific instructions to install the Nano.

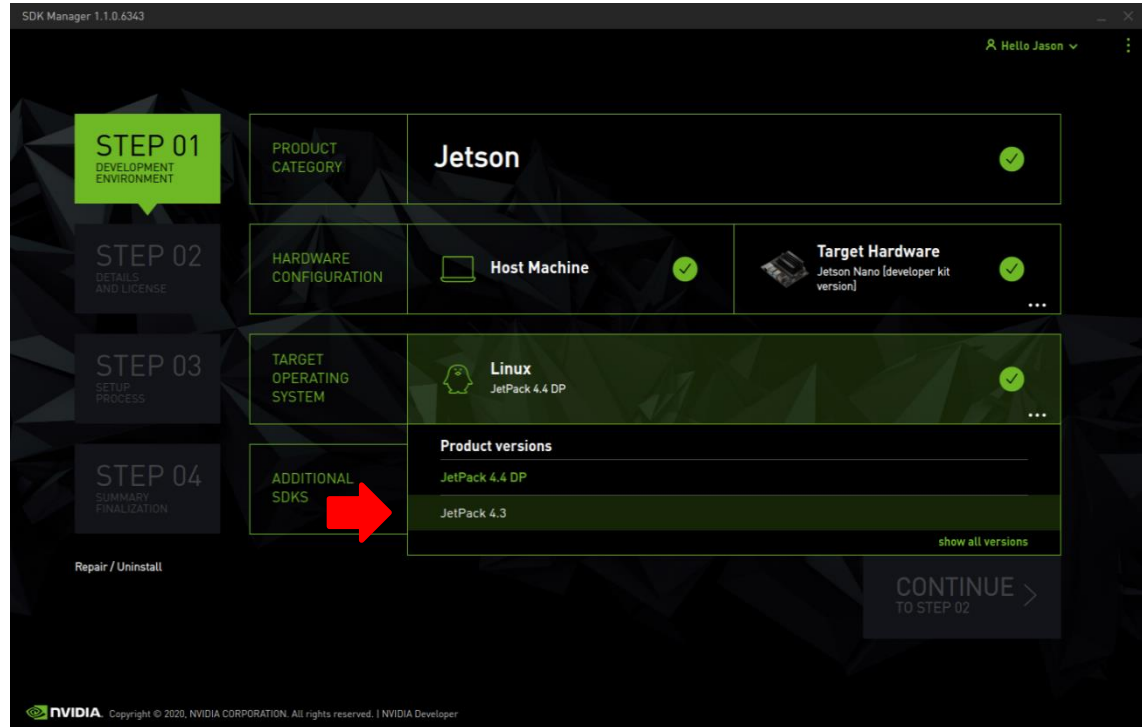
1. On the STEP 01 - DEVELOPMENT ENVIRONMENT screen, click on the ... icon in the Target Hardware box to reveal the list of supported hardware configurations, as shown in the following screenshot:



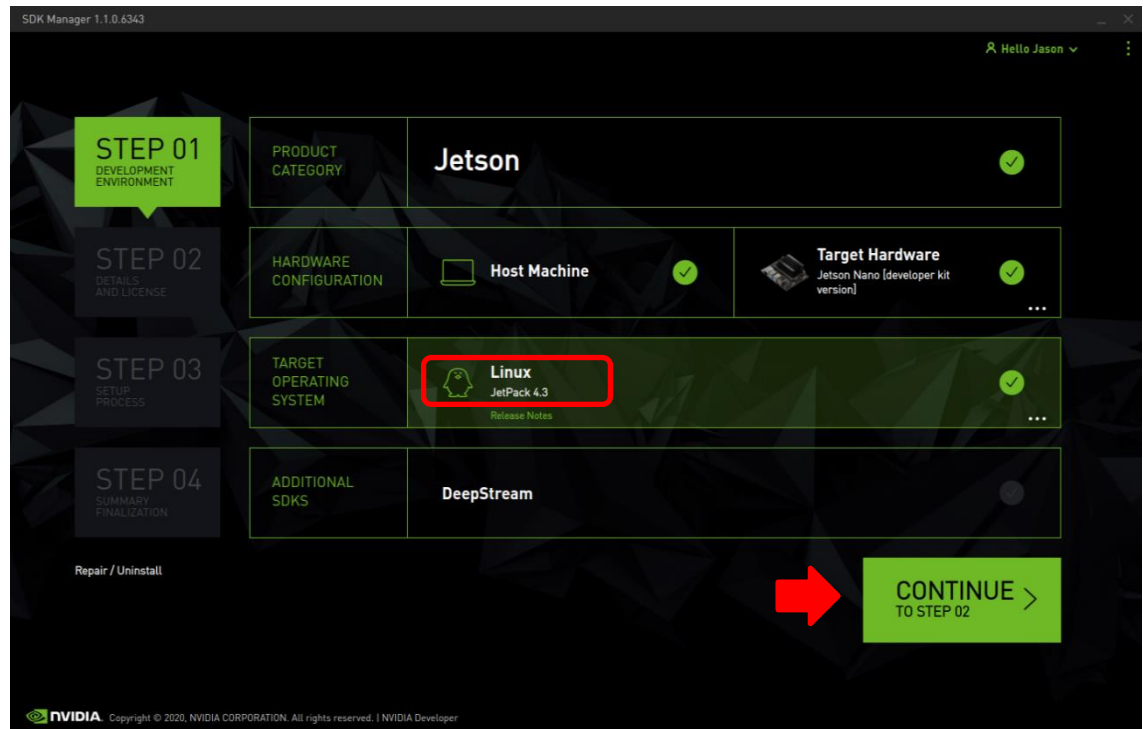
2. Click on the Jetson Nano (Developer Kit Version) target hardware option to make it the selected target, as shown in the following screenshot:



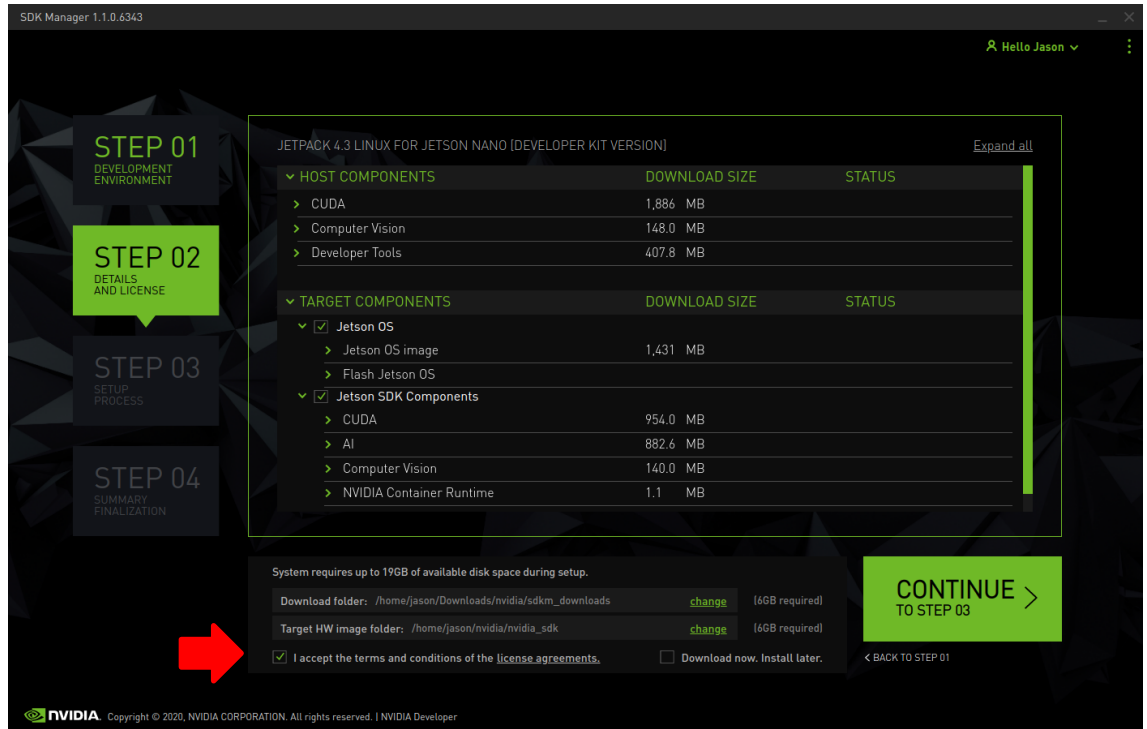
- Next, click on the  icon in the Linux box to reveal the list of supported JetPack Product versions, as shown in the following screenshot:



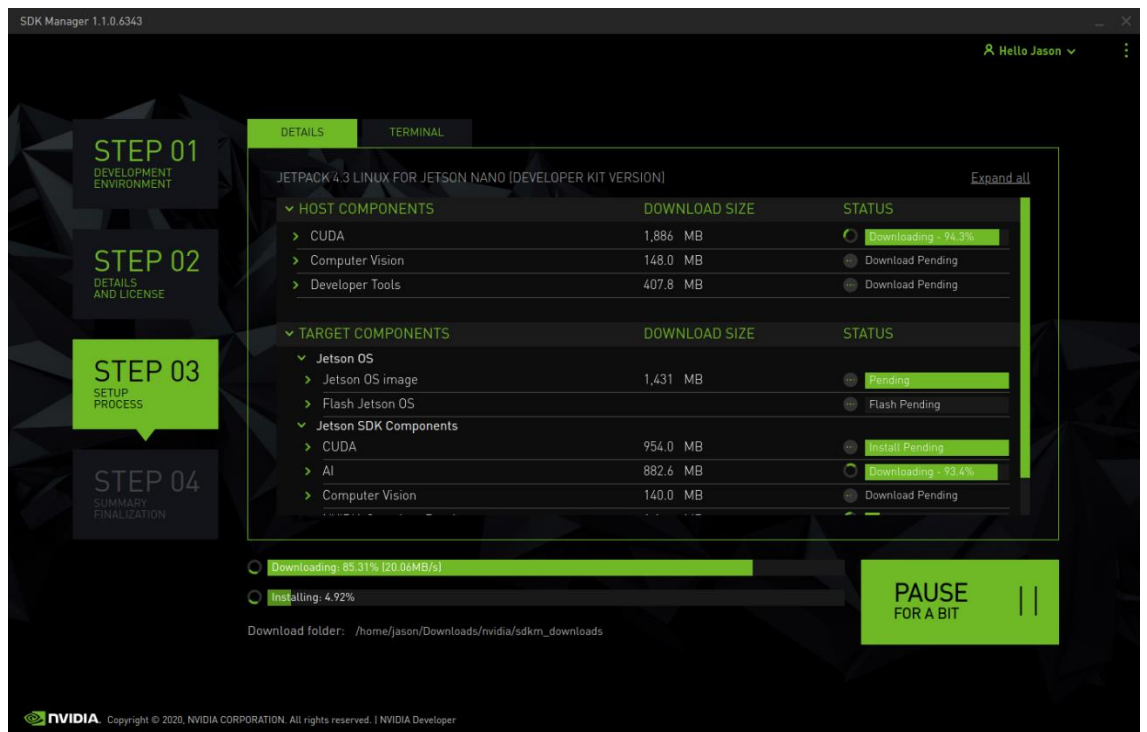
- Click on the JetPack 4.3 product version to make it the selected JetPack version, as shown in the following screenshot:



- Press Continue to advance to the STEP 02 – DETAILS AND LICENSE screen and click I accept the terms and conditions of the license agreements at the bottom of the window to accept the licenses, as shown in the following screenshot:

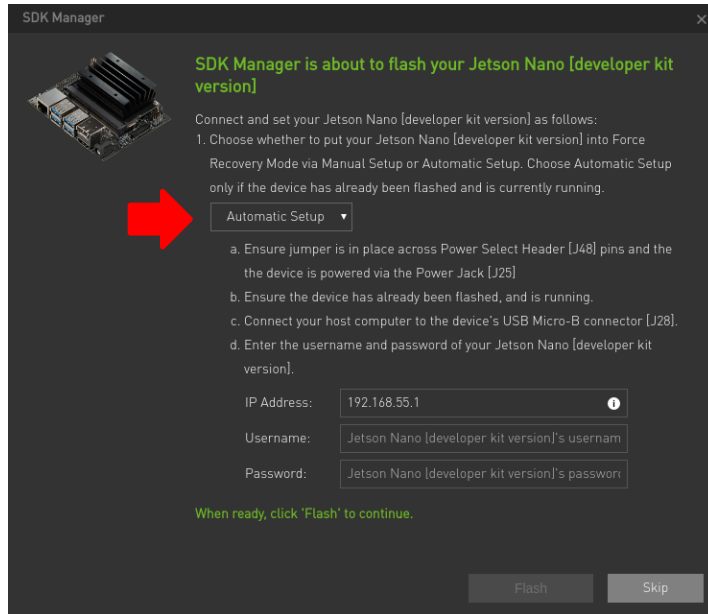


- Press Continue to advance to the STEP 03 – SETUP PROCESS screen and SDK Manager will begin downloading all the software components from NVIDIA, as shown below:

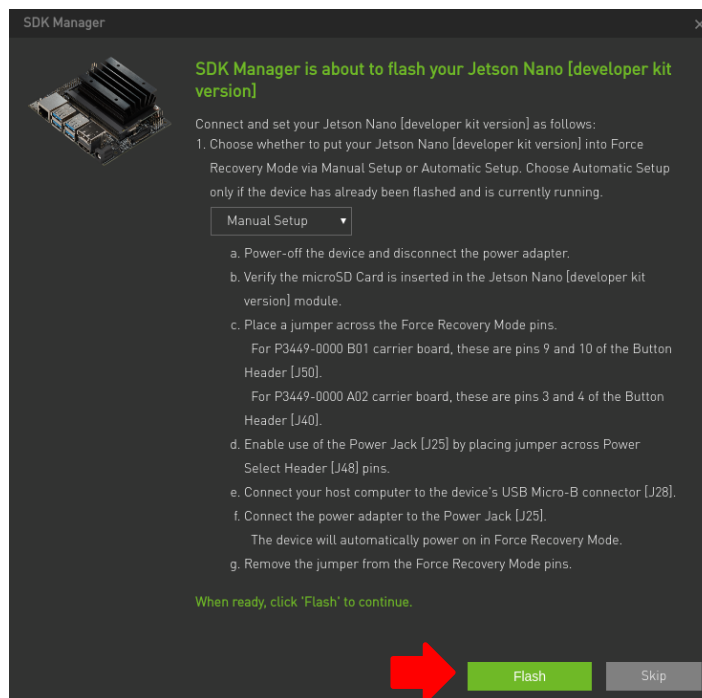


Depending on your network's speed, the download can take 30 minutes or more. During the download and setup, a detailed output log can be viewed under the TERMINAL tab.

- Once the download and setup has completed, you will be presented with a Flash dialog. Notice the Automatic setup pulldown menu as shown in the following dialog:



Click on Automatic setup and change the setting to Manual Setup as shown in the following dialog:



Follow the steps listed on the Flash dialog to place the Jetson Nano into recovery mode and then click the Flash button to begin flashing.

#### NOTE

*Issue the `lsusb` command on the host to verify that a single `NVIDIA Corp.` entry with device ID `0955:7f21` is displayed; this is the best indication that the Nano has successfully entered recovery mode and is ready for flashing.*

- Midway through flashing you will need to connect the Nano to a monitor, keyboard and mouse to click through the System Configuration dialogs. Accept the license and then choose values for all settings that are appropriate for your site.

Make sure to remember the username and password chosen because this information will be needed by the SDK Manager in the following step. Press Continue to exit the System Configuration dialogs and continue with flashing.

- During flashing the SDK Manager will prompt you to fill in Username and Password fields as shown in the following dialog.

SDK Manager

SDK Manager is about to install SDK components on your Jetson Nano [developer kit version]

To install SDK components on your device:

1. Complete the Ubuntu "System configuration wizard" on your Jetson Nano [developer kit version].
2. Wait for the OS login screen.
3. Enter the username and password of your Jetson Nano [developer kit version].
4. Click "Install" to continue.

IP Address: 192.168.55.1

Username: Jetson Nano [developer kit version]'s u

Password: Jetson Nano [developer kit version]'s p

Install Skip

Enter values for each field matching those entered into the System Configuration dialog in the previous step and then click Install to continue flashing.

- Once the flashing has completed you will automatically proceed to the STEP 04 - SUMMARY FINALIZATION screen.

SDK Manager 1.1.0.6343

Hello Jason

STEP 01  
DEVELOPMENT ENVIRONMENT

STEP 02  
DETAILS AND LICENSE

STEP 03  
SETUP PROCESS

STEP 04  
SUMMARY FINALIZATION

DETAILS TERMINAL

JETPACK 4.3 LINUX FOR JETSON NANO (DEVELOPER KIT VERSION) Expand all

HOST COMPONENTS	DOWNLOAD SIZE	STATUS
> CUDA	1,886 MB	✓ Installed
> Computer Vision	148.0 MB	✓ Installed
> Developer Tools	407.8 MB	✓ Installed

TARGET COMPONENTS	DOWNLOAD SIZE	STATUS
> Jetson OS		
> Jetson OS image	1,431 MB	✓ OS image ready
> Flash Jetson OS		✓ Success
> Jetson SDK Components		
> CUDA	954.0 MB	✓ Installed
> AI	882.6 MB	✓ Installed
> Computer Vision	140.0 MB	✓ Installed

✓ INSTALLATION COMPLETED SUCCESSFULLY. EXPORT LOGS

FINISH AND EXIT ✕

< BACK TO STEP 01

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Click Finish and Exit to exit the SDK Manager



## 3.4. Copy the RedHawk packages to the Nano

### NOTE

*This section assumes you are using the RedHawk 7.5.2 for Jetson Nano optical media disc. Alternatively, if you wish to install RedHawk from the network refer to Appendix B, "Install RedHawk from Concurrent Real-Time Repositories." Once installed, continue with section 3.6 below to finalize the installation.*

After SDK Manager has completed the Ubuntu installation on the Nano, insert the *RedHawk 7.5.2 for Jetson Nano* optical disc into the Ubuntu host's optical drive and it should automatically mount under the `/media/$USER` directory (e.g. `/media/jane/RedHawk 7.5.2 aarch64`).

Change to the mounted directory on the host and use networking to copy the RedHawk packages into the newly installed Nano, as illustrated by the following commands:

```
$ cd /media/jane/RedHawk 7.5.2 aarch64/Packages
$ scp *.deb user@host:/tmp
```

### NOTE

*Use the username, hostname and password chosen during flashing.*

## 3.5. Install RedHawk packages on the Nano

To install the RedHawk packages, log into the Nano (either via `ssh` or via the graphical console) and issue the following commands:

```
$ cd /tmp
$ sudo apt install ./ccur*.deb
```

Enter the password for the current user if the `sudo` command prompts for it.

### NOTE

*Several warnings may be displayed during package installation, including:*

- *Warning: couldn't identify filesystem type for fsck hook...*
- *l: The initramfs will attempt to resume from /dev/zram3*
- */sbin/ldconfig.real: Warning: ignoring configuration file...*
- */etc/ld.so.conf.d/aarch-linux-gnu\_EGL.conf: No such file...*
- *N: Can't drop privileges for downloading as file...*

*You can safely ignore these warnings as they are not relevant to RedHawk 7.5.2 on Jetson Nano embedded installations.*

At this point all the RedHawk packages, including the RedHawk kernels, should have installed successfully on the Nano. However, additional steps in the next section are required before you can boot into the RedHawk kernels.

## 3.6. Add RedHawk entries to the `extlinux.conf` file

Perform the following steps on the Nano to create boot entries for the RedHawk kernels:

1. Create a backup of the `/boot/extlinux/extlinux.conf` file.

```
$ cd /boot/extlinux
$ sudo cp extlinux.conf extlinux.bak
```

2. Open the `extlinux.conf` file in your preferred editor. For example, if using `vi`:

```
$ sudo vi extlinux.conf
```

3. Duplicate all the primary kernel entry text lines to create a second identical entry below the initial entry. For example:

```
TIMEOUT 30
DEFAULT primary

MENU TITLE L4T boot options

LABEL primary
    MENU LABEL primary kernel
    LINUX /boot/Image
    INITRD /boot/initrd
    APPEND ${cbootargs} quiet

LABEL primary
    MENU LABEL primary kernel
    LINUX /boot/Image
    INITRD /boot/initrd
    APPEND ${cbootargs} quiet
```

4. Customize the original first kernel entry to point to the desired RedHawk kernel. For example, to create an entry on the Nano for the RedHawk trace kernel:

```
LABEL redhawk-trace
MENU LABEL redhawk-trace kernel
LINUX /boot/Image-4.9.140-rt94-r32.3.1-tegra-RedHawk-7.5.2-trace
INITRD /boot/initrd.img-4.9.140-rt94-r32.3.1-tegra-RedHawk-7.5.2-trace
APPEND ${cbootargs} quiet
```

#### NOTE

*Modifying the first kernel entry will allow the NVIDIA kernel to be booted as a fallback if any typos were entered during the customization of the first entry. Failure to follow this guideline can render the Nano unbootable and require re-flashing if a typo is accidentally introduced during editing.*

5. Change the default kernel to the newly added RedHawk kernel by changing the DEFAULT entry at the top of the file:

```
TIMEOUT 30
DEFAULT redhawk-trace
```

Note that if your Nano has been set up with a serial console, you may choose to skip this step and instead interactively decide which kernel you wish to boot each time the system restarts.

## 3.7. Verify RedHawk kernel installation

The Nano should now be running the selected RedHawk kernel. To verify this, issue the following command:

```
$ uname -r
```

You should see output displayed like the following:

```
4.9.140-rt94-r32.3.1-tegra-RedHawk-7.5.2-trace
```

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

## 4. Known Issues

Special consideration should be given to the following areas.

### 4.1. Entropy gathering daemon interferes with real-time

Ubuntu 18.04 enables a new Hardware Volatile Entropy Gathering daemon (`haveged`) that continuously samples various hardware resources (e.g. cache, branch predictions, memory translation tables) to collect entropy and improve random number generation.

This daemon's constant hardware probing activity can negatively impact real-time performance even on shielded CPU cores, and the daemon should be stopped before starting real-time workloads by invoking the following command as the root user:

```
# systemctl stop haveged.service
```

Note that disabling the entropy gathering service is not recommended because some Ubuntu startup services require a minimum level of entropy to be gathered before they will start; this includes services required for the X Server to properly initialize. However, after the Nano has started with graphics displaying you can safely stop the service to improve real-time performance.

## 4.2. Warnings accessing `/dev/mem`

Attempting to directly access `/dev/mem` on the Jetson Nano is not permitted and will result in errors output to the systems console. For example, invoking the `dmidecode` application while a RedHawk kernel is running will output an error like the following:

```
Program dmidecode tried to access /dev/mem between f0000->100000.
```

Note that if the stock NVIDIA kernel is running, you may see hundreds of lines of `SError` messages output to the console, similar to the following:

```
CPU4: SError detected, daif=140, spsr=0x20000000, mpidr=800001020
CPU4: SError detected, daif=140, spsr=0x40000145, mpidr=800001020
ROC:IOB Machine Check Error:
Address Type = Secure DRAM
Address = 0x0 (Unknown Device)
...
```

These errors are only informational and can be ignored.

## 4.3. Change to PAM Capability module directory

The PAM Capability module directory that is documented in some versions of the *RedHawk User's Guide* is incorrect for the Jetson Nano. The correct PAM Capability module location for the Jetson Nano should be shown as:

```
/lib/aarch64-linux-gnu/security/pam_capability.so
```

If you wish to use the PAM Capability feature with services in the `/etc/pam.d` directory, then you should refer to the PAM Capability module as follows:

```
session required /lib/aarch64-linux-gnu/security/pam_capability.so
```

## 4.4. RedHawk Debug kernel modifications

The RedHawk Debug kernel has been compiled without `CONFIG_PROVE_LOCKING` enabled; this was necessary because the Nano kernel source code does not currently conform to strict lock dependency checking standards. It is hoped that future versions of the Nano kernel source code will address this deficiency.

## A. Serial Console Setup

Concurrent recommends setting up a serial console when using RedHawk on the Jetson Nano development board. This appendix provides details and tips for connecting a serial console.

### A.1. Purchase a Raspberry Pi serial cable

First, you will need to purchase a special cable that attaches to specific pins on the Jetson motherboard to provide a USB serial connection suitable for a desktop PC. Concurrent recommends using the following Raspberry Pi cable, but other similar products may also work:

- Adafruit Industries 954 USB-to-TTL Serial Cable, Raspberry Pi  
<http://www.amazon.com/ADAFRUIT-INDUSTRIES-954-SERIAL-RASPBERRY/dp/B00DJUHGH1>



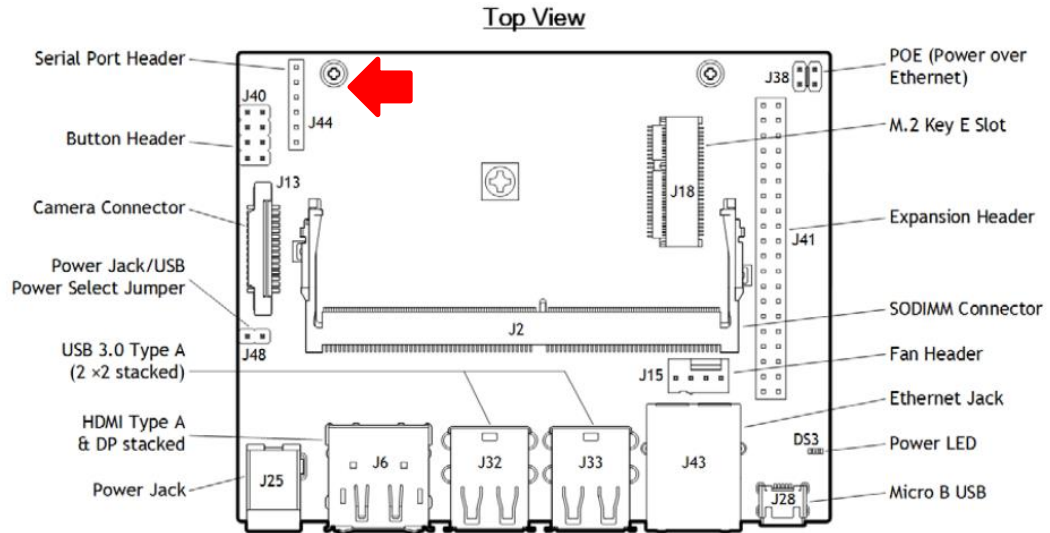
### A.2. Connect the serial cable to Nano and PC

Once you have the correct serial cable, follow the instructions in the video on this page to attach the cable to either the Jetson Nano and then to a desktop PC:

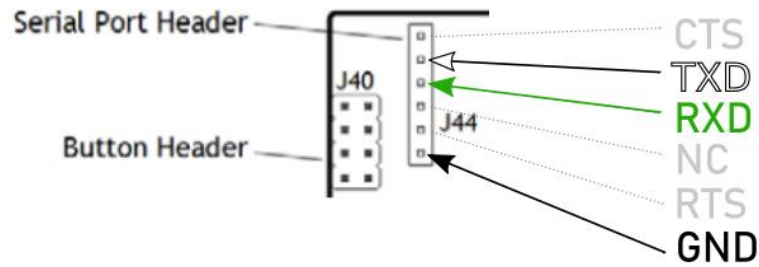
- Jetson Nano – Serial Console  
<https://www.jetsonhacks.com/2019/04/19/jetson-nano-serial-console/>

Following is a brief summary of the important information of this video:

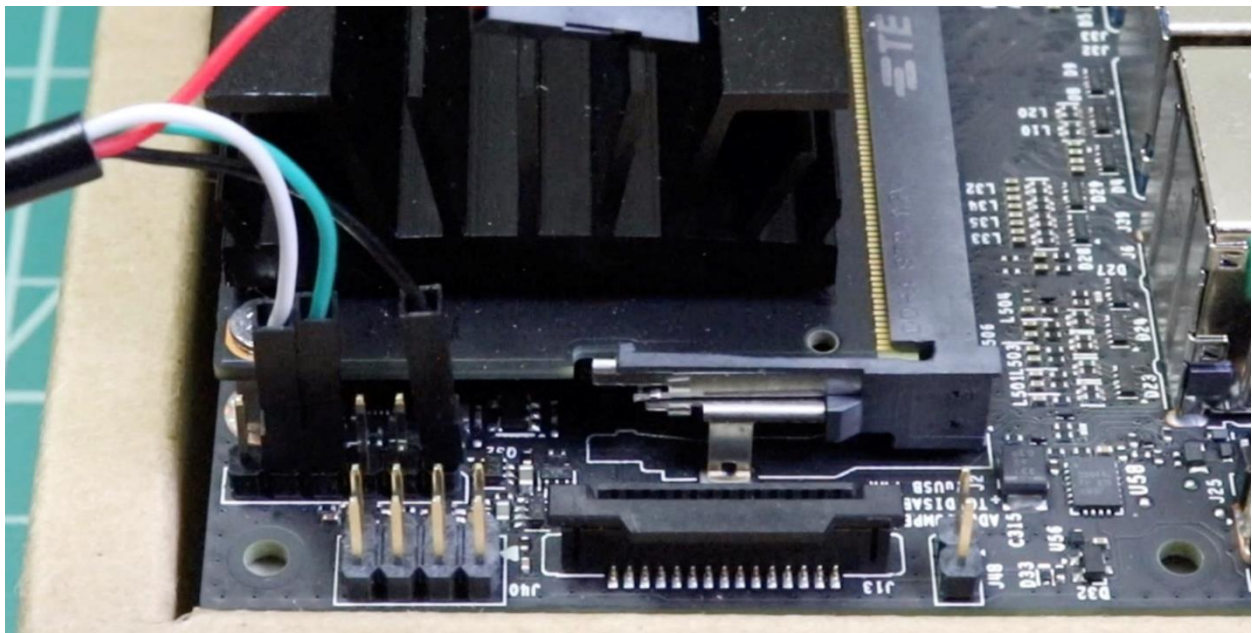
- The serial port header pins are marked J44 as shown in the Nano diagram below:



- The individual pins of J44 are connected as described below:



- To connect the USB serial cable, attach the **White** wire to TXD, the **Green** wire to RXD and the **Black** wire to GND as shown in the following picture:



- Note that the Red wire should not be attached to any of the pins in the header.

- On the host the minicom settings should be configured as shown below:

```
+-----+
| A -   Serial Device       : /dev/ttyUSB0
|
| C -   Callin Program      :
| D -   Callout Program     :
| E -   Bps/Par/Bits        : 115200 8N1
| F -   Hardware Flow Control : No
| G -   Software Flow Control : Yes
|
|   Change which setting? █
+-----+
```

## B. Install RedHawk from Concurrent Real-Time Repositories

RedHawk can be installed over the network utilizing the Concurrent Real-Time software repositories. This has the advantage that it will install the latest updates that have been released, however some up-front setup is required to perform the installation; follow the steps below to complete this setup.

### B.1. Install Concurrent Real-Time Public Keys

Concurrent Real-Time signs its APT repositories with a GPG-generated DSA and ElGamal key pair. You need to install Concurrent Real-Time's public key so that the APT system can authorize usage of the repositories.

You can download the `ccur-public-keys` file and import the key file as needed into APT's key ring. You should import the key file before attempting to access software from Concurrent Real-Time's repositories.

The following commands will download the public key and install it.

```
wget -q http://redhawk.concurrent-rt.com/network/ccur-public-keys
apt-key add ccur-public-keys
```

If you wish to check the authenticity of the public keys file you downloaded from Concurrent Real-Time's web site, request the key fingerprints from Concurrent Software Support and compare them to the fingerprints of the keys you downloaded.

You can obtain the fingerprints of the keys you downloaded with the following command:

```
gpg --with-fingerprint ccur-public-keys
```

### B.2. Install Repository Definition Files

Repository definition files tell the APT installation and update system how to access specific repositories. The definition files must reside in the `/etc/apt/sources.list.d/` directory and the file name must end `.list`; e.g. `/etc/apt/sources.list.d/ccur.list`.

Use the following format for the repository definition of the RedHawk 7.5 for Jetson Nano product:

```
deb http://redhawk.concurrent-rt.com/ubuntu/login/passwd/redhawk/nano 7.5.n core
```

For example, the following entry substitutes a fictional login and password:

```
deb http://redhawk.concurrent-rt.com/ubuntu/LR12345/t0ps3cr3t/redhawk/nano 7.5.n core
```

Note that if the NightStar tools have been purchased for this machine, then you should also add a repository definition for the NightStar tools below the previously added line. For example:

```
deb http://redhawk.concurrent-rt.com/ubuntu/LR12345/t0ps3cr3t/nightstar 4.6 rt
```

Once the repository definition file is in place the repository setup is complete. Run the following command as root to ensure that the software repositories have been added correctly:

```
sudo apt update
```

If you see errors or warnings produced that reference the newly added `ccur.list` file, then verify that all the above steps have all been completed as documented.



## B.3. Install RedHawk Packages

Now that the setup is done, simply issue the following command to install all the latest RedHawk 7.5 packages (and NightStar 4.6 packages if purchased) onto the current system:

```
apt install 'ccur-*
```

Once this command completes the RedHawk packages are installed. Continue with Section 3.5, "Flash desired RedHawk kernel using bootburn.sh," in order to finalize the RedHawk installation.

## B.4. Support

If you need assistance, 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.

You may also submit a request for assistance at any time by using the Concurrent Real-Time website at <http://concurrent-rt.com/support> or by sending an email to [support@concurrent-rt.com](mailto:support@concurrent-rt.com).