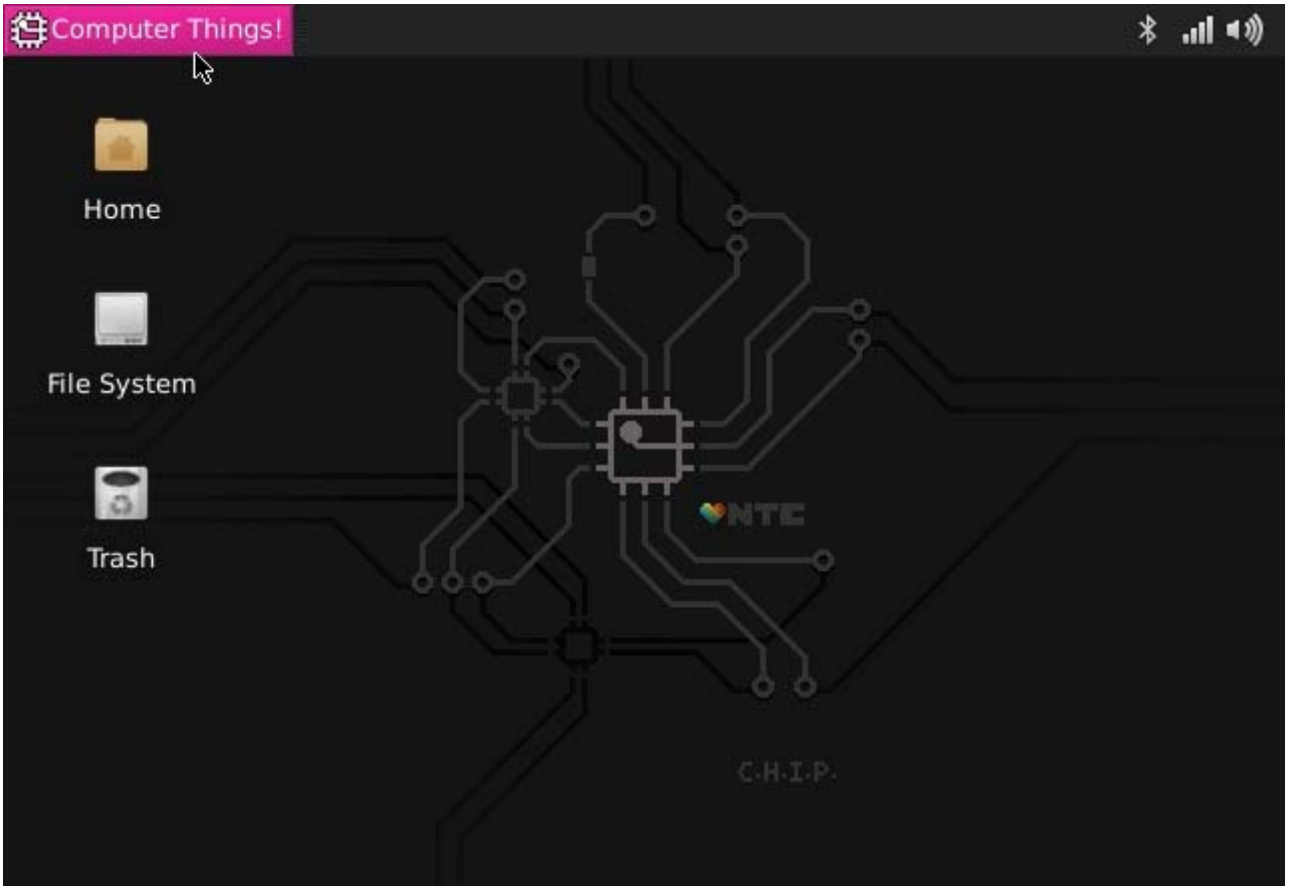

# Introduction

Welcome to Next Thing Co documentation.

# Welcome to The CHIP Operating System

We made a computer. *A $9 computer*. And every computer needs an operating system.

Ours is The CHIP Operating System. Grab an old TV (or any screen with a composite video input), a keyboard and mouse, and stick some electricity in the micro USB port. In a few seconds, you'll have CHIP's operating system on your screen, ready to do **computer things.**




CHIP is built for making - we've packed a powerful processor, 4 GB of storage, stereo audio, video out, and lots of connections for playing and making your projects and products.

The CHIP Operating System is built for doing: browse the 'net, send email, play video games, listen to music, write a novel, watch a video, or learn programming. And because it's based on the popular Linux Debian, if there's something you need, you can probably install it.

So how do use this thing? Let's get started.

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# Start CHIP. Boot CHIP.

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First things first. Let's boot CHIP into the CHIP Operating System and do some computer things! Add some power, turn on the wireless network, and even connect a bluetooth keyboard to get rid of those annoying cables.

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## Power Up

The single most important thing to using any electronic device is getting electricity to the right places. We're going to cover how to turn CHIP "on". This might seem so straightforward that it doesn't deserve several paragraphs, but CHIP is pretty clever, so there's actually a few things worth knowing.

#### WHAT'S IT NEED?

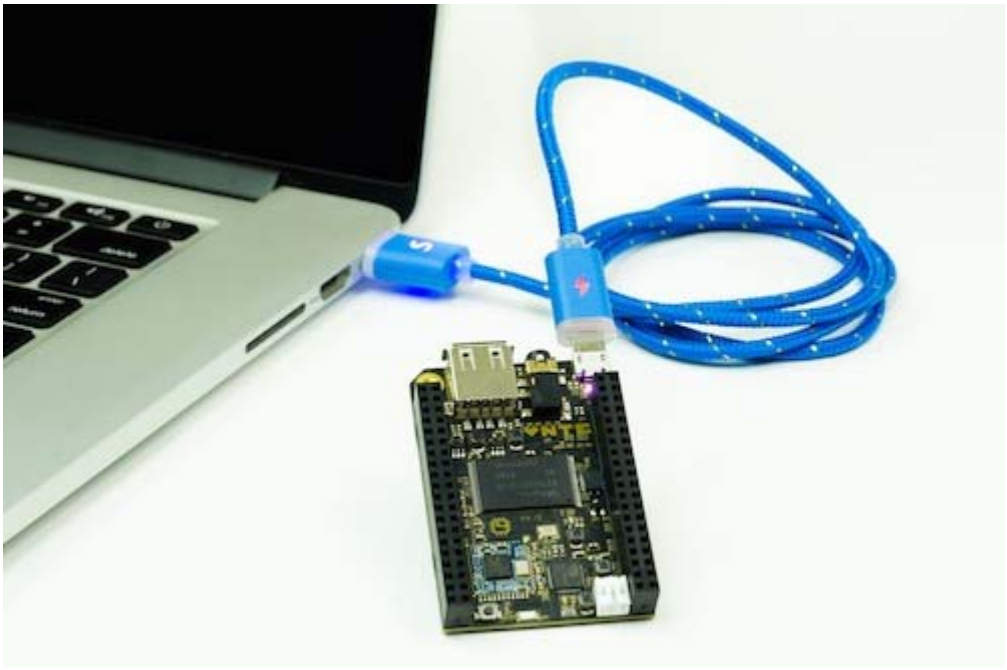
In general, CHIP is powered by a 5-volt source like a USB port or phone charger, and draws about 500mA peak (at boot time), runs on around 200mA, and rests with around 80mA with the processor totally unloaded. To make sure you have enough headroom, we recommend that you use a 5v power supply with 2 Amps current available (you could go as low as 900mA, but you risk brown-outs). This may be more than you need to know if you just want to plug it in to the wall, but, as you build projects with CHIP, you'll be happy to know there's a lot of ways to get the electricity flowing.

#### HOW DO I KNOW CHIP IS ON?

CHIP is silent. It doesn't take much energy, so it's not very hot. It has no discernible smell. As a result, many of your senses are not great indicators that it is working. There are two LEDs next to the USB micro connector. When CHIP is on, you should see the PWR LED light up nice and bright.

#### POWER FROM THE WALL

The CHIP's microUSB connector is used to provide power from most any USB power source. USB wall-wart adapters are probably littered all over your house. If for some reason you don't have one, you can buy one at any electronics retailer. We recommend a 5V powersupply with 2 Amps current available. Just plug a USB-A-to-microUSB-B cable (that's the same cable most phones, tablets, and whatnot use to charge) into the wall-wart and CHIP, and you'll see the PWR LED light up. This CHIP is using the power from a computer's USB port:



#### POWER FROM A BATTERY

CHIP can also be battery powered. Specifically, any single cell (1S) 3.7V Lithium Polymer (LiPo) battery with a 2-pin JST-PH 2.0mm end can be connected to the JST-PH socket.

The JST can only plug it in one way: if you are having a hard time lining things up, turn it around! Needless to say, do not force the battery connector into the socket if something doesn't feel right!

If you have added a connector to your own battery, make sure you have the JST wired correctly: the (-) connection should be on the **outside** edge of CHIP.

What's really great is that if you plug in to a charger and plug in a battery, the battery will charge - all the power management is on CHIP itself. Roughly, it takes about four to six hours to charge a 3000 mAh LiPo battery from a 5V 2A power source. Also, our delightful little Power Management IC, the AXP209, handles pass-through power, so while on and charging a battery, CHIP is basically running on a un-interruped power supply – If charge power fails, CHIP seamlessly switches onto battery power without shutting off.

Now you're ready to connect CHIP to a screen, keyboard and mouse or even work on CHIP from another computer.

#### BUTTON

There is a tiny tiny button on CHIP next to pin header U13 that is used for turning CHIP on or off. If CHIP is off and connected to a power source, hold down the button for one second to power it up. To turn CHIP off (rather brutally), hold the button for 10 seconds. We recommend using the operating system to power CHIP off, but if you need to, you can use this button.

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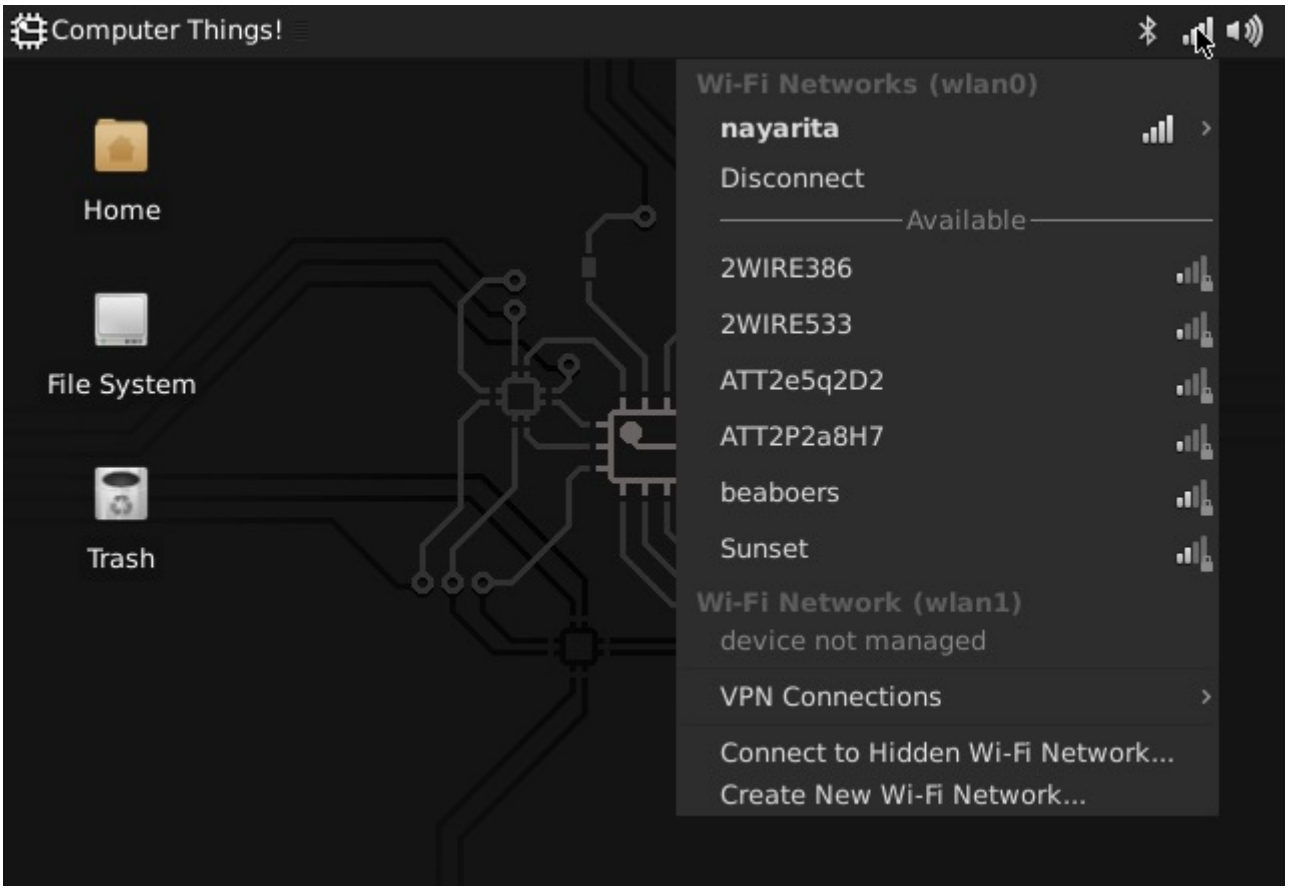
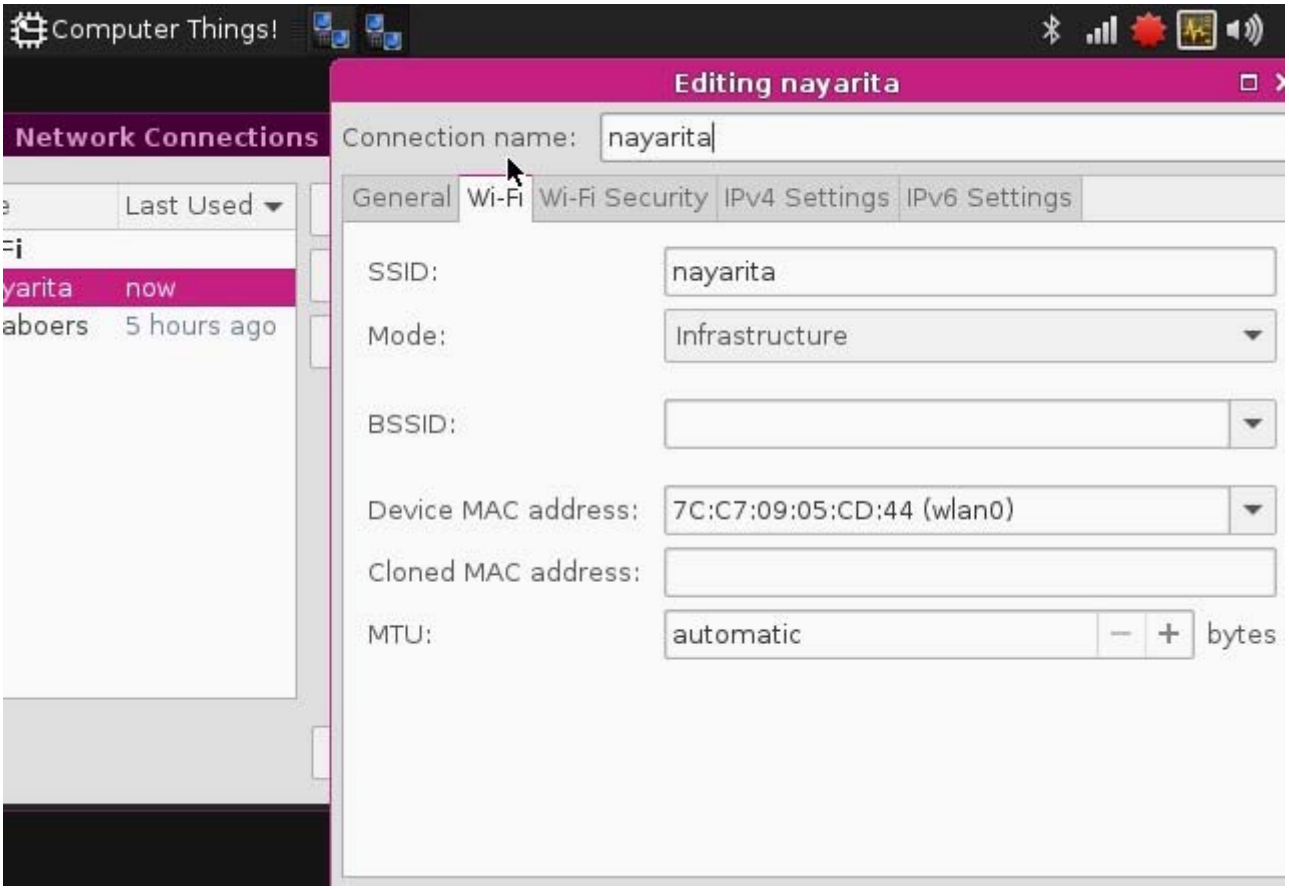
# Connect To WiFi

Connecting to a WiFi network is easy using the WiFi icon the top right system tray. Just select a network to initiate a connection. If the network requires a password you'll be prompted for it. You can also set up Wi-Fi from the command line.

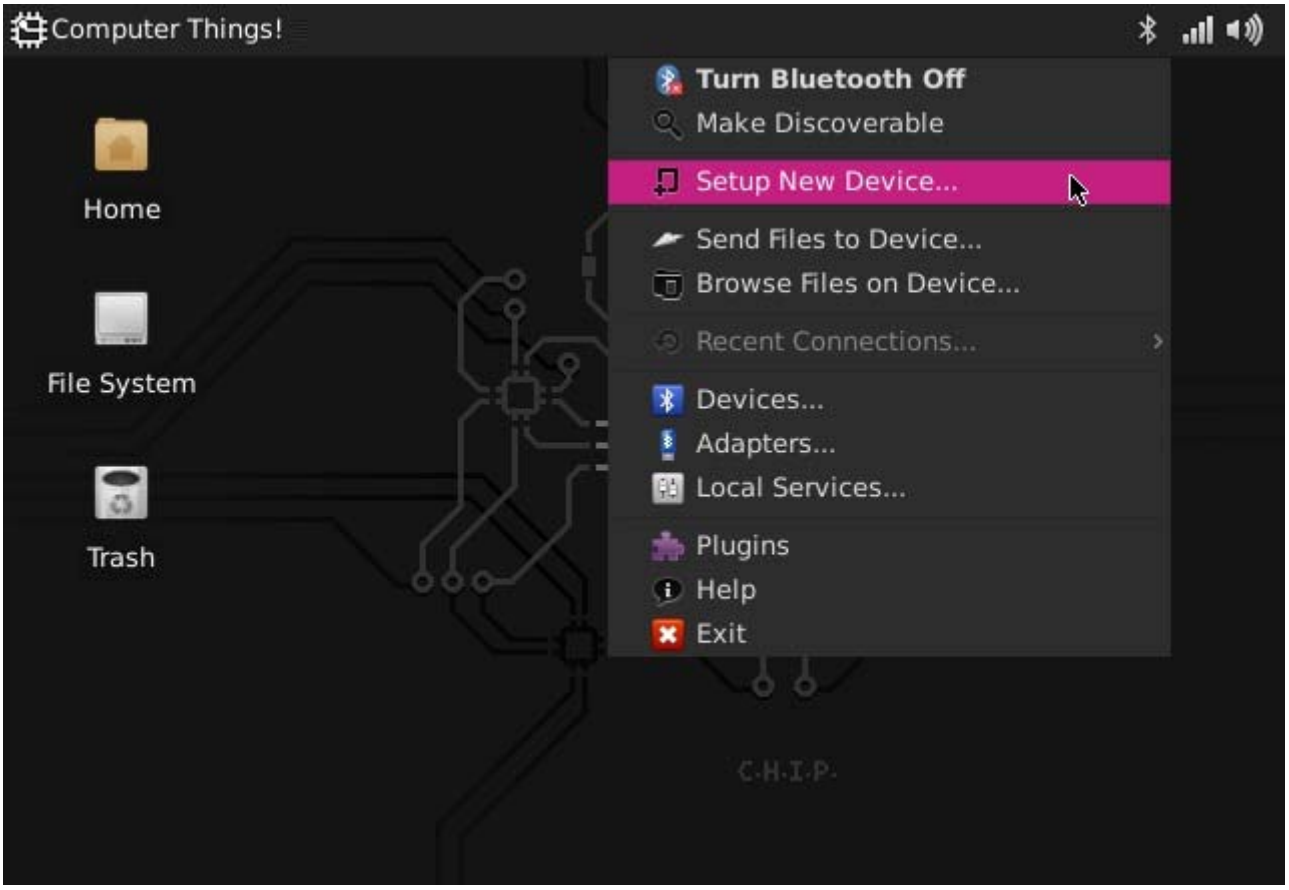



If you need more control and information over your network connection, use the Settings->Network Connections panel to show your connections. Double click on a connection to bring up the connection editor:




## Connect Bluetooth

Bluetooth device setup can be accessed using the Bluetooth icon in the top right system tray.



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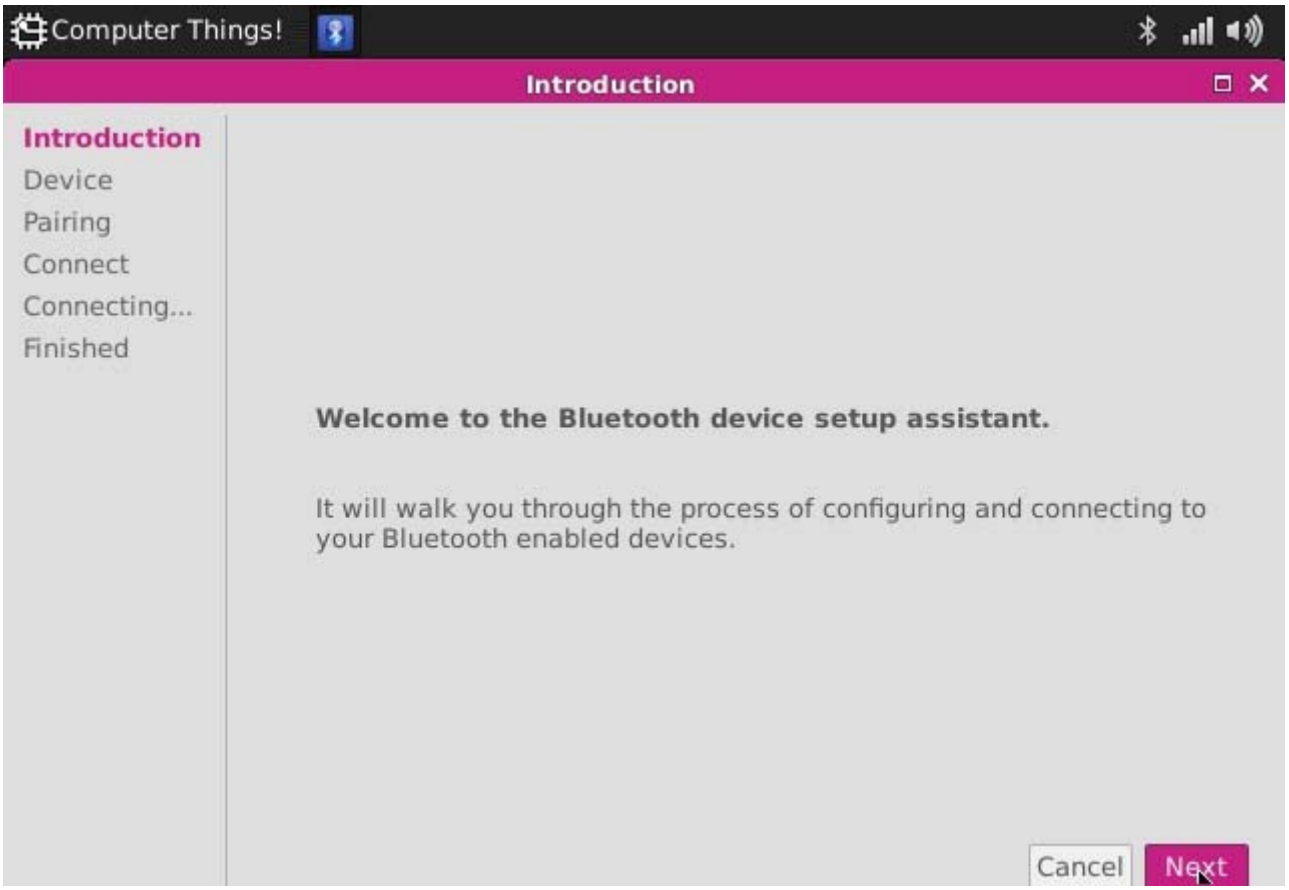
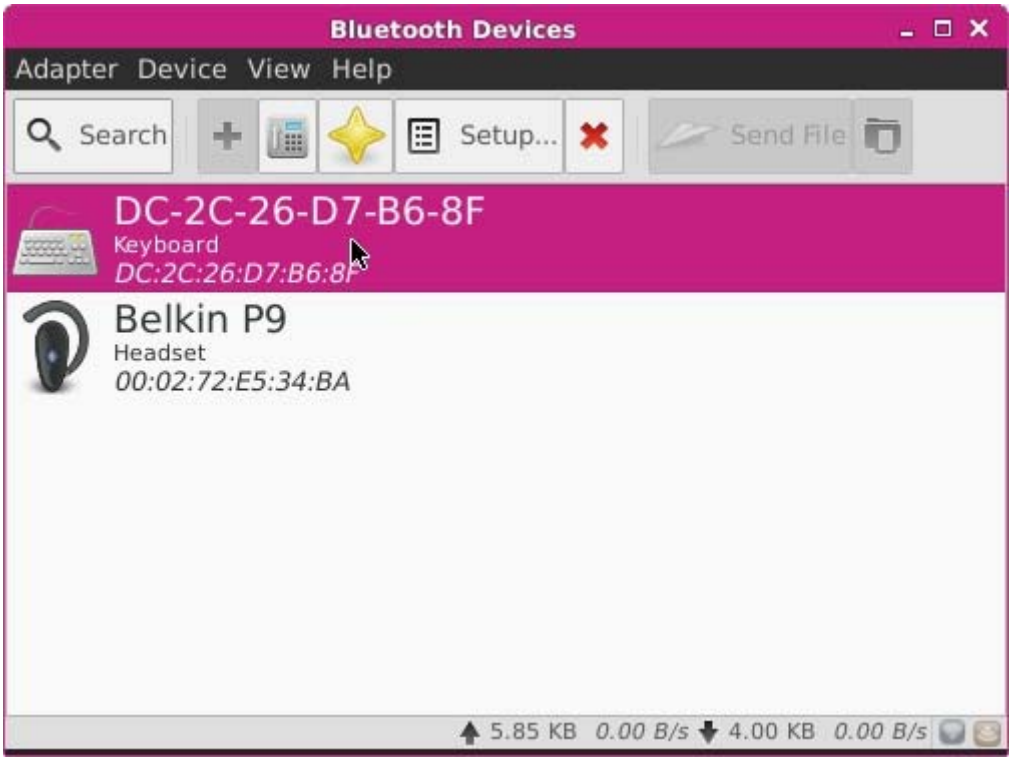



You can manage, and also connect to, your devices using the the Bluetooth Devices panel, accessed from the Bluetooth system tray:




## Using The Terminal

One of the great powers of Linux is the so-called “command-line.” This simple text interface for computing unveils many of the gears and levers that make a computer tick. Many find it easier to get things done, as it is a focused and terse way to interact with the computer.

When you first use the Terminal Emulator program, you may quickly find that you do not have permission to do something. That is because many commands are safely reserved for “root” access, and you are automatically logged in as the “chip” user. Don’t fear: you can often use the `sudo` command and use the default password `chip` to execute these restricted commands.

Finally, it is probably wise to change the default password on your CHIP. You can do with with

```
passwd
```

or

```
sudo passwd root
```

and you’ll be asked for a new password. Don’t forget it!!

If you are such a fan of the command line, you may want to boot with out the desktop and window system. Instructions for that are here

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# Terminal for Beginners Glossary

One of the great things about Linux is the terminal application. While it may look unfriendly and terse, if you want to really extend the capabilities of CHIP, you’ll often find yourself in the terminal. If you’re a beginner, here’s a quick reference of some really important and common commands. You can simply add `-h` to get some hints on how to use a command, such as `cp -h` or you can read a manual page using `man cp`. Most unix commands have a variety of options that can be executed in the command with *flags*, such as `ls -l -a`. Even better, search the internet! This primer is simply here to help you understand what a command might be doing, not to help you use it to its full ability.

- **cd** change directory. open a folder. ex: `cd ~/Pictures` changes your current directory to the home Pictures folder, so you can easily access the files within.
- **mkdir** make directory. create a folder. ex: `mkdir Vacation` makes a folder named *Vacation* in the current directory. `mkdir ~/Pictures/Vacation` makes a `Vacation` folder in the home Pictures directory.
- **ls** list files in the current directory so you know what is in it. Some options are `ls -l` to list in long format to provide information about permissions, size, and date. `ls -a` to show hidden files that start with the `.` character.
- **mv** move a file from one directory to another, or to give it a new name. Ex: `mv this.one that.one` renames a file. `mv this.one ~/Pictures/Vacation/` puts the file *this.one* into the `Vacation` directory.
- **cp** copy a file from one place to another. Ex: `cp this.one this_01.one` will copy `this.one` to another file `this_01.one`. Add directories for more fun: `cp ~/Pictures/Vacation/saturn.jpg /Users/otherone/Pictures/Vacation/saturn.jpg`.
- **rm** remove a file. delete it, and beware!. Use the `-r` to make it recursive to delete a directory. Ex: `rm this.one` deletes that file. `rm -r ~/Pictures/Vacation` to forget the good times.
- **sudo** super user do. many commands need administrator-like privileges, otherwise they won’t work. `apt-get` is a command that needs to be run with `sudo` to allow files to be written to protected directories. You’ll see `sudo` as the first word in a lot of commands - all it is doing is giving the command the necessary access. You’ll be asked for a password the first time you use `sudo`. The default password and user is “chip”.
- **apt-get** the command used for installing, removing, and finding software for Debian Linux systems, such as the CHIP Operating System. `sudo apt-get install puredata` installs the Pure Data program and any dependencies. `sudo apt-get remove puredata` will remove the program. `sudo apt-cache search image` will search apt repositories for the keyword *search*. And so on.
- **pwd** present working directory. In case you forget where you are. Not much to it: `pwd` will output the directory name, such as `/Users/home/chip/Pictures/Vacation/`
- **grep** a tool used for searching through files. It’s quite deep and can be complicated, but if you see the word `grep` in some command, you know it’s searching for a match.
- **| (pipe)** a command used to redirect data into an application.
- **< (redirect)** a command use to redirect data into a file.
- **cat** and **echo** concactenate. append data to a file. Ex: `echo "Last line of text" >> sometext.txt`. Merge files: `cat append.txt >> main.txt` will put all the text in append.txt into main.txt. Overwrite: `echo "New contents of text file" > whatevs.txt` will replace all text in the file with the text in quotes. Display text in file: `cat showit.txt` will print the contents in the terminal window. Create: `cat > new.txt` will let you create a new text file in the terminal by typing lines (ctl-c to exit).

- **less** makes it so you can paginate and read a text tile. Ex: `less longtext.txt` will fill the screen with the first part of the longtext.txt file. Use the space bar to view the next page. Type `q` to exit.
- **nano** a text editor. You'll often see commands that call `nano` so you can edit a configuration. Ex: `nano /etc/avahi/services/afpd.service` to edit the avahi Apple file service file.
- **find** look for files in the filesystem. Ex: `find ~/Documents -name particular.txt -type f` will look for the file with the name `particular.txt` in the Documents directory.
- **chmod** change mode. Used for file permissions, which can be important when sharing things on the network, scripting actions, and many more reasons.
- **htop** display the processes currently alive on the CPU. If things seem slow, or you want to see how much CPU or memory a program is using, just type `htop` to see a table of all running processes, then type `q` when you want to exit.
- **scp** secure copy. copy a file from one computer to another over a network. Ex: `scp Pictures/Vacation/motel.jpg Pictures/Vacation/accident.jpg chip@otherchip.local:~/Pictures` copies a couple jpegs to another computer on the network.
- **ssh** secure shell. access another computer on the network and use the terminal commands to make changes and control it. Ex: `ssh chip@chip.local` to access your CHIP on a local network.
- **CTRL C** if you can't use the terminal because a process is taking too long, type CTRL-C on your keyboard to cancel the most recent command.

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# Connecting Accessories

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CHIP has a lot of connectors, some for building, some for doing normal computer things. This section covers the normal computer things, like audio, video, and input.

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## Recommended Accessories

CHIP is a minimal computer. Many CHIP users may never connect common peripherals, instead using CHIP as a "headless" computer. Like desktop computers from Best Buy, you may find that certain accessories will improve the overal usability of CHIP. We recommend:

- Bluetooth Keyboard
- USB mouse
- Monitor with a composite video input
- USB cable: USB-A to microUSB-B
- TRRS to RCA connector
- 2A, 5V USB power supply

Additionally, some of the advanced tutorials require:

- Speakers with RCA audio input
- Jumper wire
- USB to UART cable
- Single cell Lithium Polymer battery

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## Powered USB Hub

You'll find that a simple powered USB hub is pretty essential if you want to use a lot of USB devices with CHIP. Not only is there only one USB port (keeping CHIP nice and small), but CHIP's micro USB power port can only provide so much power for the USB port. If you don't have a powered USB port, you'll quickly max out power if you attach too many accessories.

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## Keyboard and Mouse

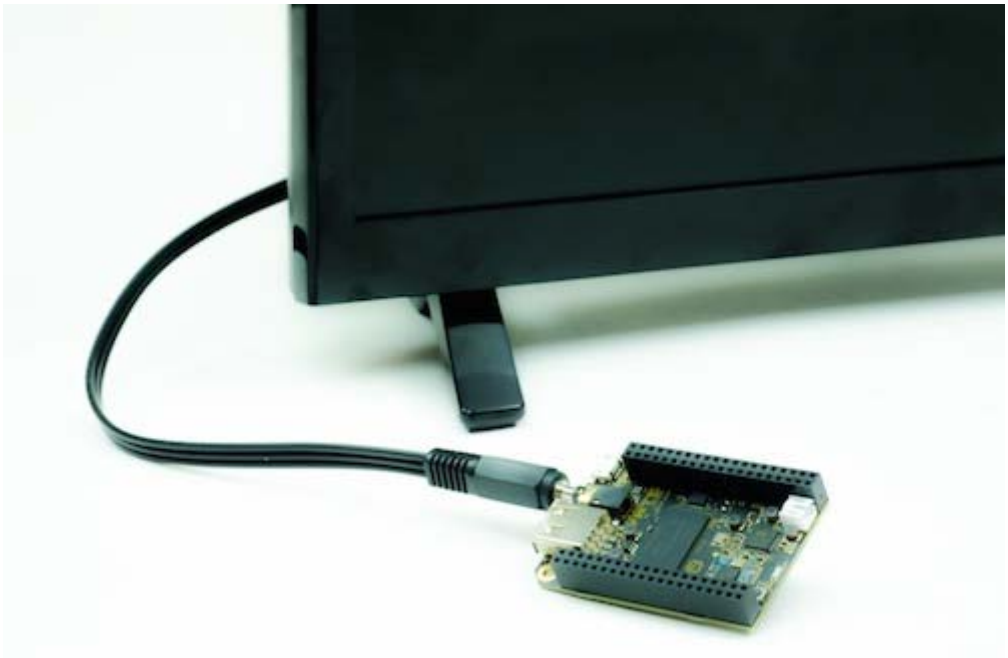
Many keyboards have USB hubs built-in, so you can attach a mouse to the keyboard, attach the keyboard to CHIP, and immediately have control. However, it's likely the two will draw too much current, so you'll want to connect to a powered hub before you connect.

## Bluetooth Keyboard and Mouse

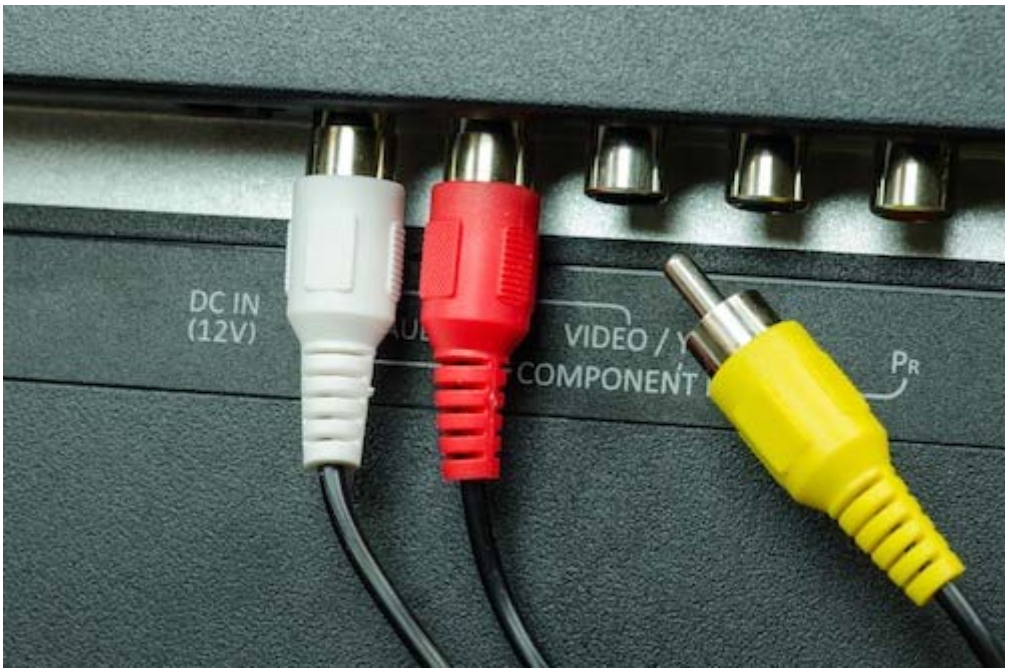
As you know, CHIP has built-in bluetooth. If you want to use a keyboard and mouse, you can keep your USB port free for other things (like mass storage or a MIDI controller!) and keep your desk clean. See connecting to bluetooth section

## Monitor

In the spirit of keeping things small, CHIP packs all the audio and video into a small TRRS (Tip-Ring-Ring-Sleeve) connector. Built-in video output is restricted to standard composite video resolution of 640x480. Higher video resolutions are possible using the VGA and HMDI DIP boards.



Here's what the other end of the cable looks like, attached to a monitor with stereo audio inputs (red and white) and the composite video plug, moved so you can see the label on the monitor:




**ABOUT THE TRRS CONNECTOR**

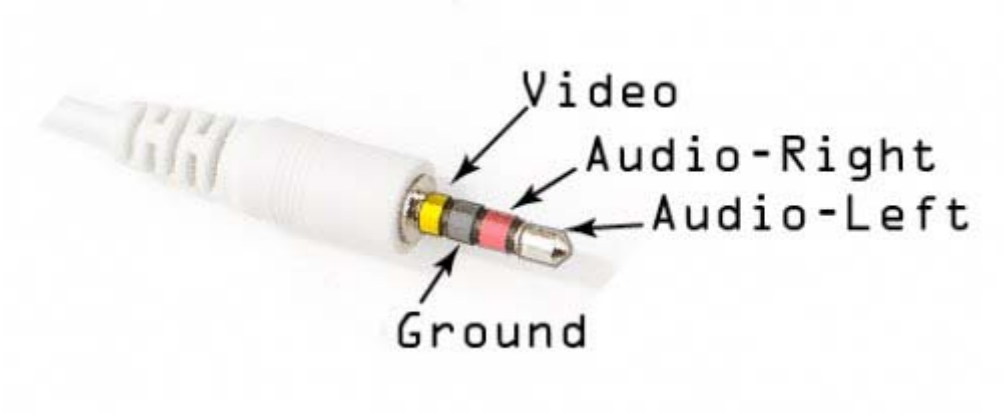
CHIP has a 1/8" (3.5mm) Tip-Ring-Ring-Sleeve (TRRS) output jack, capable of carrying stereo audio, and either composite video out, or microphone in.

This is a fairly common port, but there are a few different arrangements of the conductors, so not all cables are equal. Fortunately, CHIP uses the same conductor arrangement as Pi, Zune, and iPod audio/video cables, so the most common "mini to RCA A/V" cables should work just fine.

Some cables will route signals a bit differently, using the Red RCA cable for Video instead of Yellow. If video out isn't working through the yellow cable, see if red works. If not, your cable may be a version that's arranged in a way that it just won't work with CHIP:

- yellow : video
- red : stereo audio right channel
- white : stereo audio left channel

The conductors on the TRRS plug are arranged like this:




If you want to learn even more about TRRS connectors and the general lack of standardization with them, this page has even more details.

#### NTSC OR PAL

The composite video format is NTSC by default. If you need to hook up to a monitor that only uses a PAL signal, you'll need to change that at u-boot time. First, connect to CHIP with a UART cable. Then power up CHIP, and press a key on the keyboard to boot into u-boot mode to change the environment variable manually.

```
printenv video-mode
setenv video-mode (mode data)
saveenv
reset
```

where *mode data* can be, for NTSC and PAL respectively:

```
setenv video-mode sunxi:640x480-24@60,monitor=composite-ntsc,overscan_x=40,overscan_y=20

setenv video-mode sunxi:720x576-24@50,monitor=composite-pal,overscan_x=40,overscan_y=20
```

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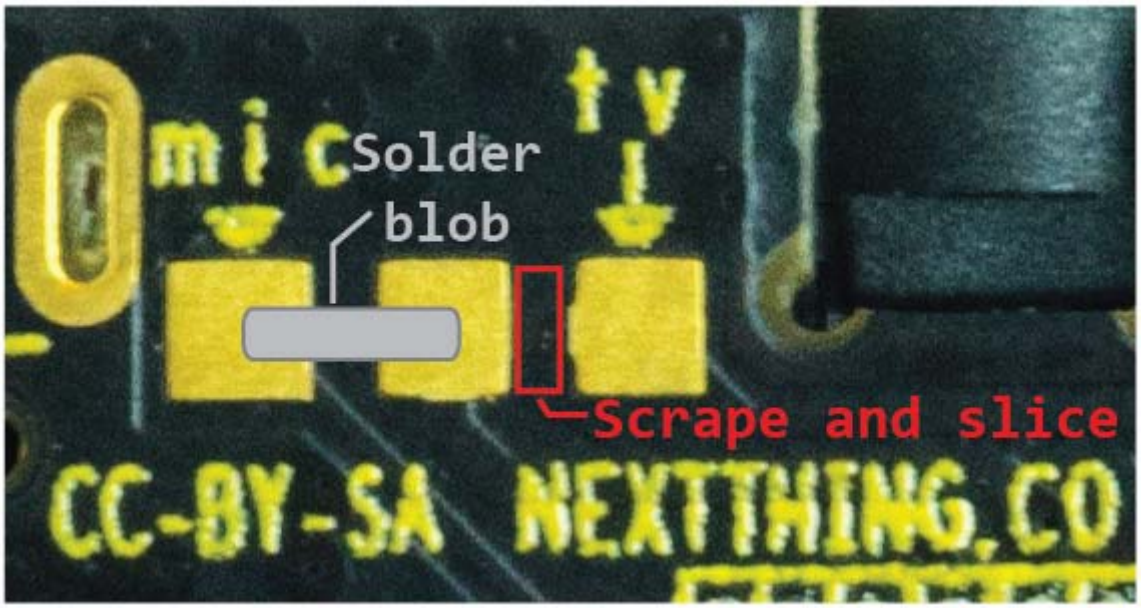
## Headphones

The audio and video connector on CHIP can be dedicated to audio output suitable for headphones or connecting to an amplifier for filling a room or public space with glorious sound. Just connect a standard 3.5 mm (1/8") TRS audio plug into CHIP's a/v jack. Of course, if headphones are plugged in, there will be no room for a composite video output jack. You can also get audio left, common, and right output from pins 4, 6 & 8 on header U14.

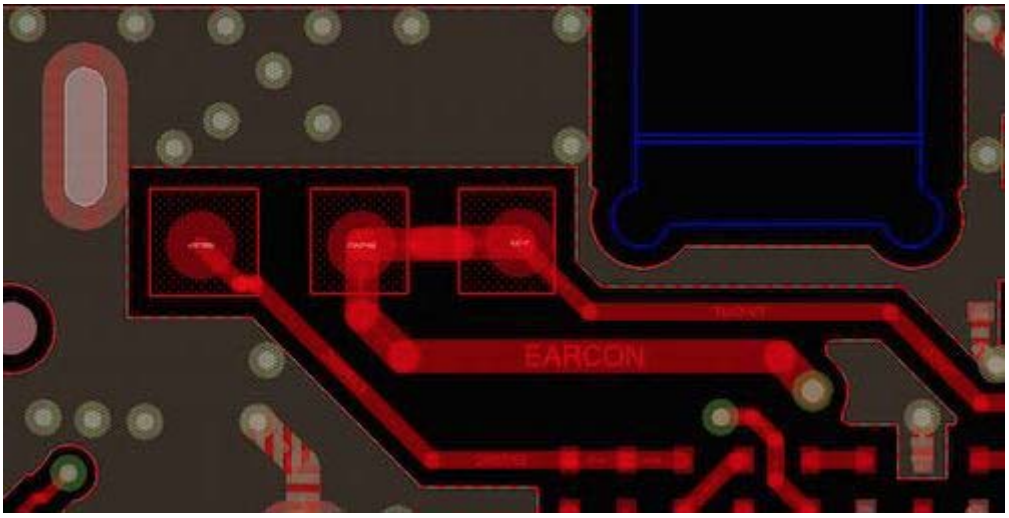
## Microphone and Audio Input

If you want to use audio input, you might find it easiest to use the pins on pins 10 and 12 on header U14. However, if you want to use the 1/8" TRRS connector, you can modify the CHIP board to replace the composite video connection with an audio input connection.

If you look at the bottom of CHIP with the audio and USB jacks pointed up, you'll see three small contact pads to the left of the audio jack. The left pad has a small label of **mic** and the right pad has a **tv** label. Between the middle pad and the **tv** pad is a trace that can be carefully cut with an Exacto or utility razor blade. Once that is cut (check with a volt or continuity meter), you can put a solder blob between the **mic** and middle pad. Now the outer ring can be used for audio input.



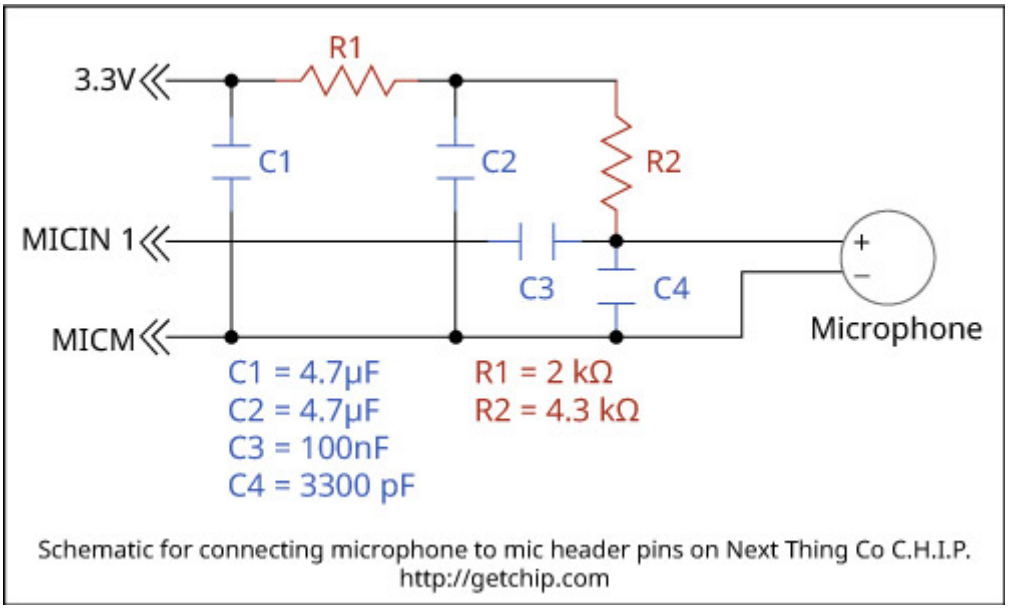

As another reference, if you had X-ray vision and you were looking from the **bottom** of CHIP, you'd see a trace like this:




If the composite video connection is needed again, just reverse the process: desolder the connection between **mic** and the middle pad, then solder a bridge between **tv** and the middle pad.

#### MICROPHONE WITH HEADER PINS

If you want to use the pins 10 and 12 on header U14, you'll most likely need to add some additional circuitry to get a good input signal. Here is a schematic of the simple circuit:




You'll need two 4.7 microfarad capacitors, one 100 nanofarad capacitor, and a 3300 picofarad capacitor. You'll also need one 2 kilo-ohm and one 4.3 kilo-ohm resistors.

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## USB Storage

If you have files that you want to modify, use, or transfer to CHIP's internal storage, you can attach a USB thumb drive, card-reader, or hard drive. Open the file manager and access the files.

## USB Audio

CHIP can use Class-compliant USB audio devices. A popular, and inexpensive choice for audio devices are USB dongles based on the C-Media chipset. These have been tested successfully with CHIP and can often be purchased for less than $10. Some good resources for linux and audio compatibility are on the linux audio and alsa project websites.

Many of the drivers have not been tested with CHIP - as CHIP matures, more information will be available. For now, we recommened USB Class-compliant or “plug-and-play” audio devices.

## Battery and Charging

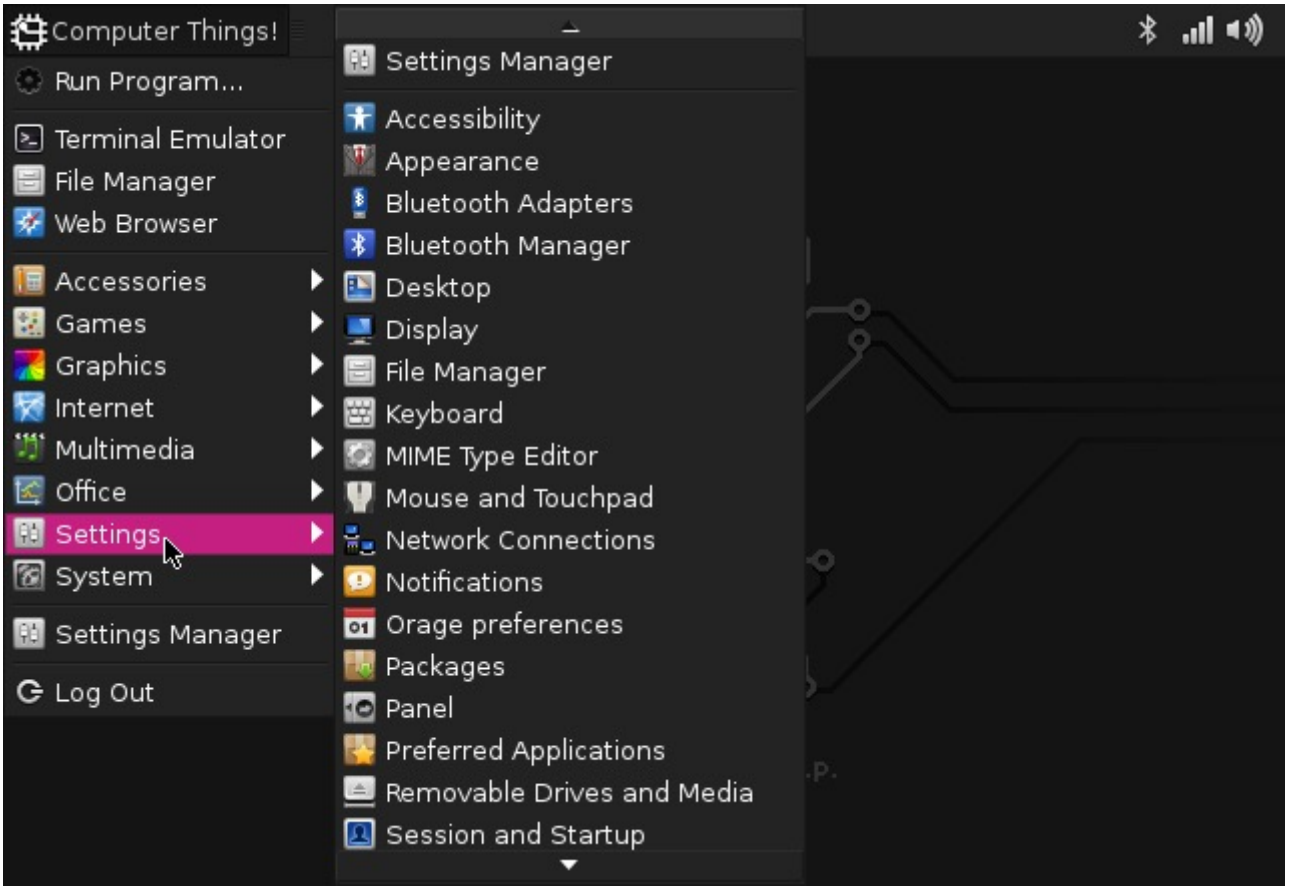
Like any modern laptop, CHIP can run and charge any single-cell LiPo battery. Read more in the powering CHIP section.

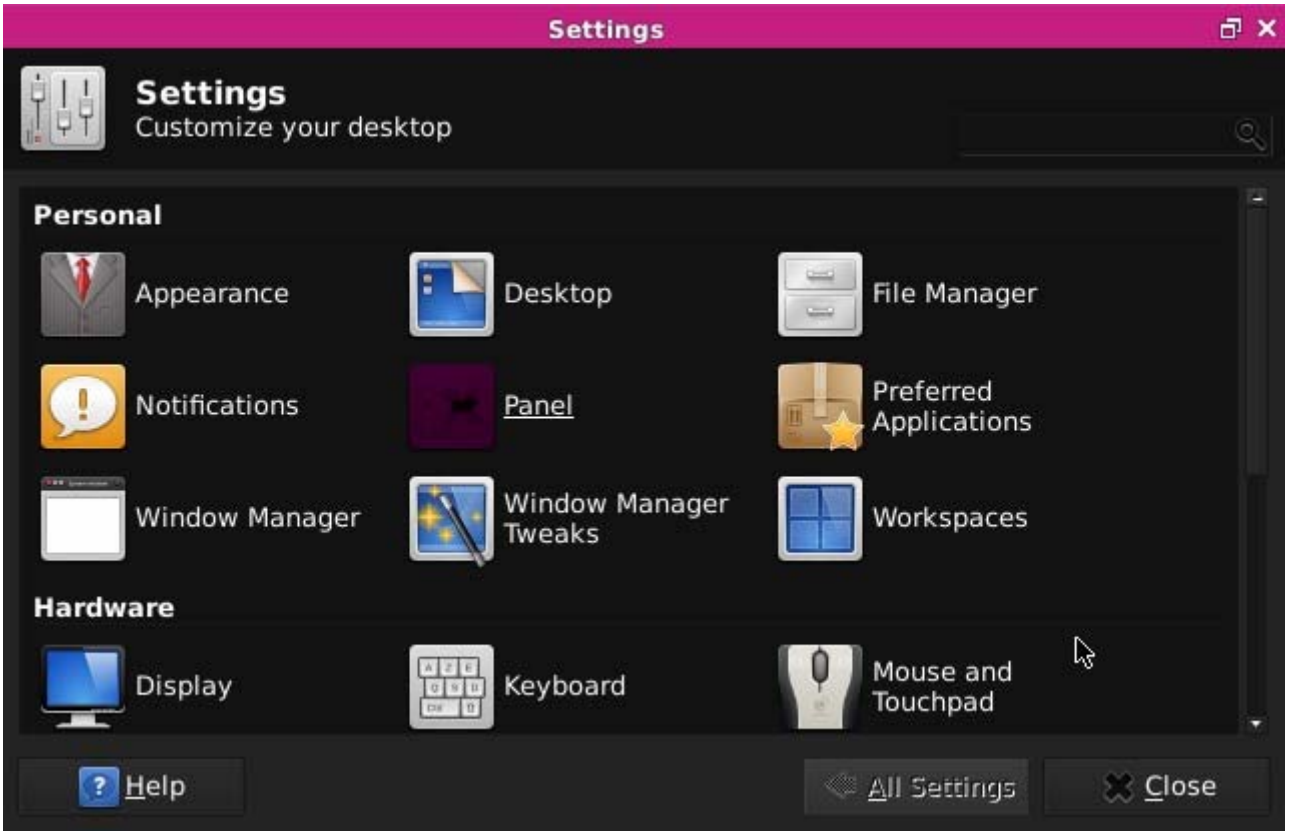
# Using The CHIP Operating System

If you’ve used a desktop or laptop computer before, the CHIP Operating System should be pretty familiar. There are menus, icons to click, menus with more stuff when you right-click, keyboard shortcuts, applications to run, and settings to set. CHIP is small, so we keep our operating system simple. Almost everything can be accessed from the **Computer Things** menu: settings, launching apps, and access to files. There’s also a few convenient functions in the top right **system tray.**

## Settings and Configuration

Most of the settings for the computer and for the desktop can be set using the apps in the “Computer Things” menu. Select the appropriate app from either the Settings Menu or the Settings Manager.

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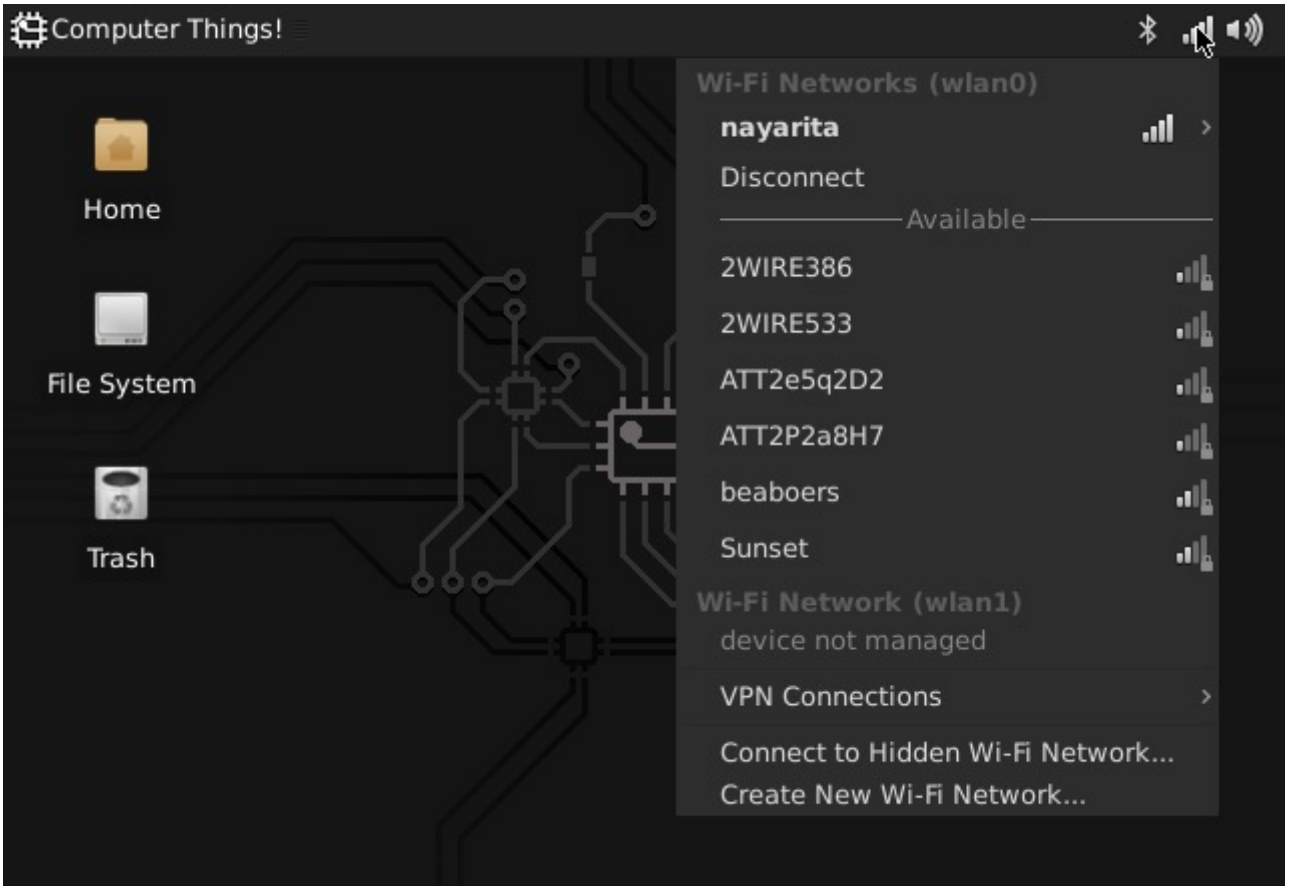


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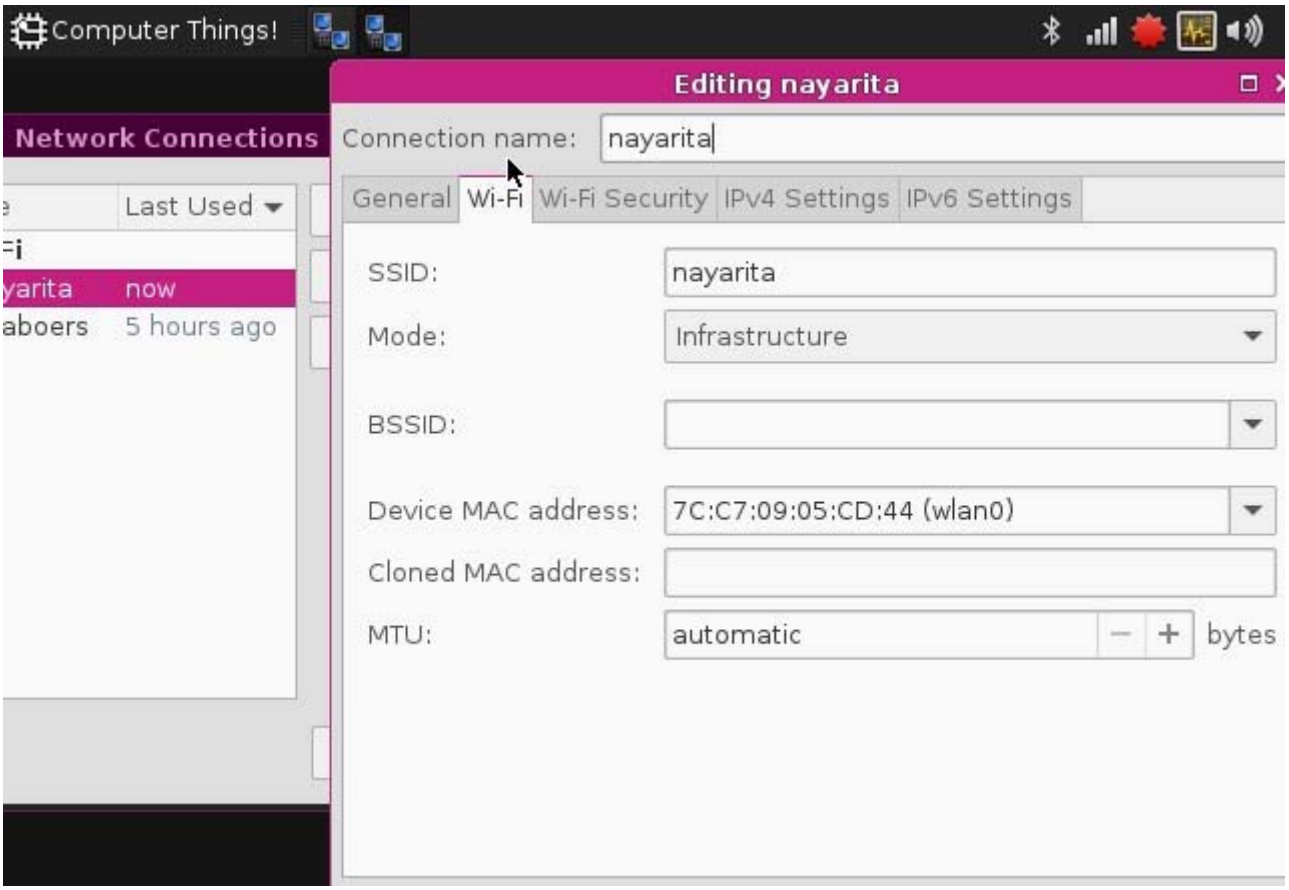


#### BLUETOOTH

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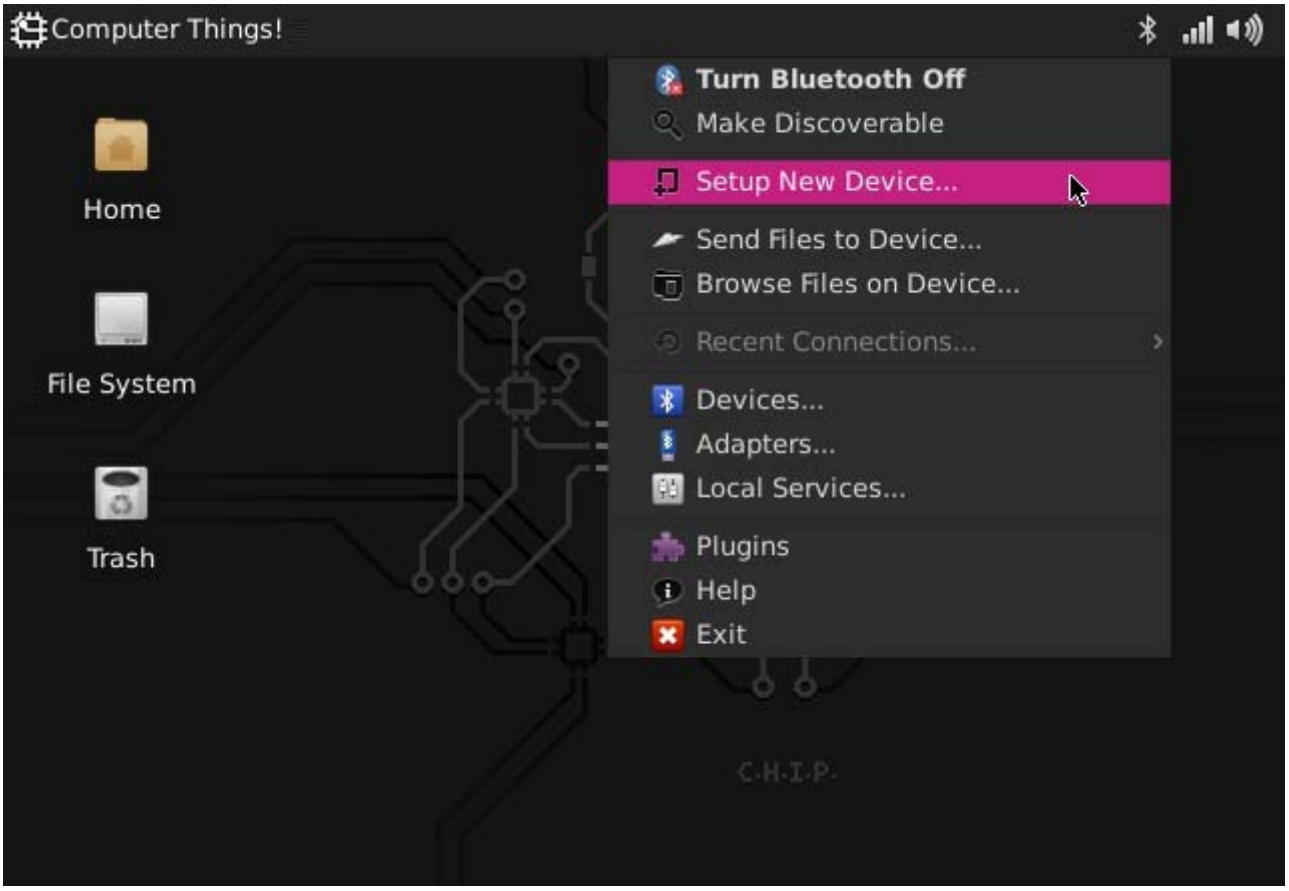


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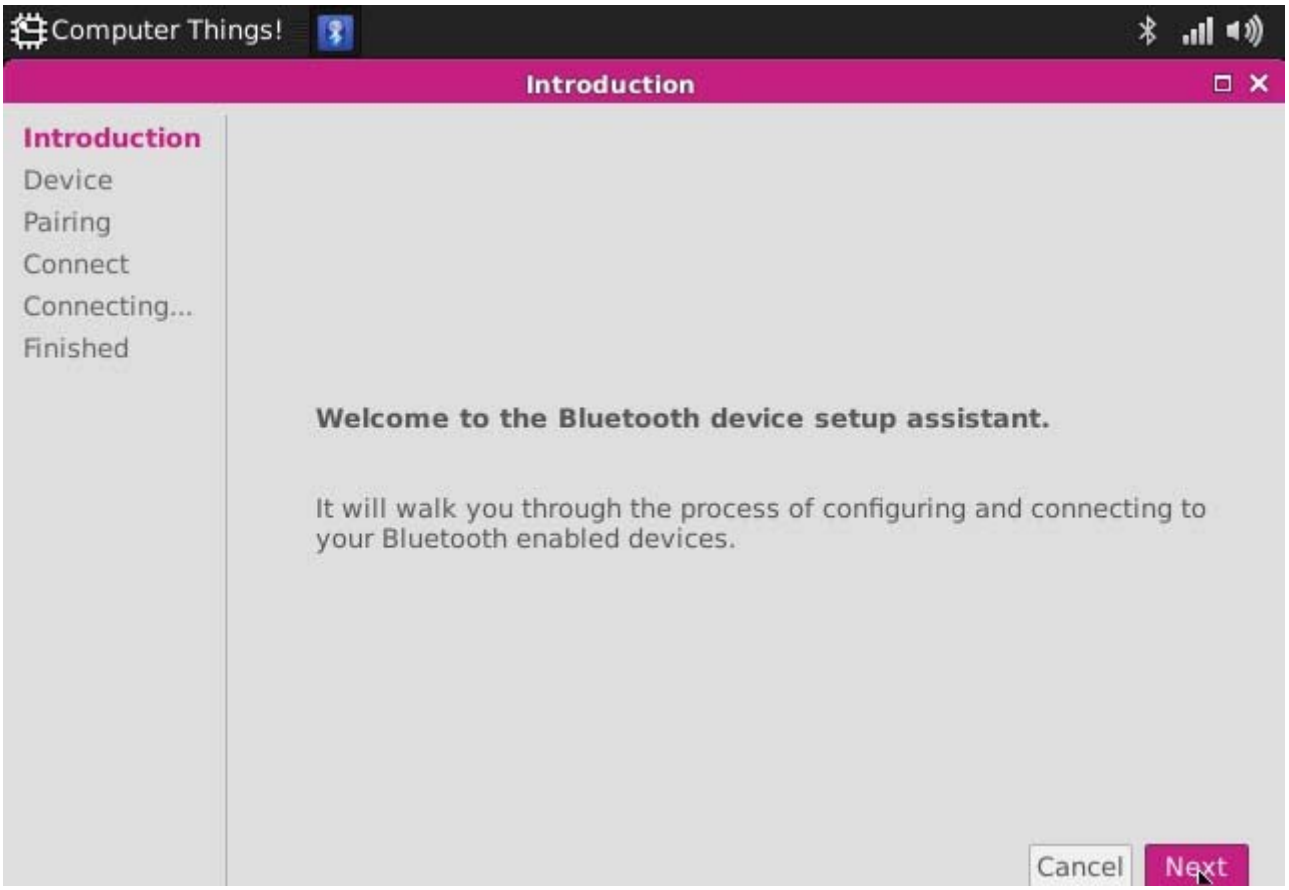


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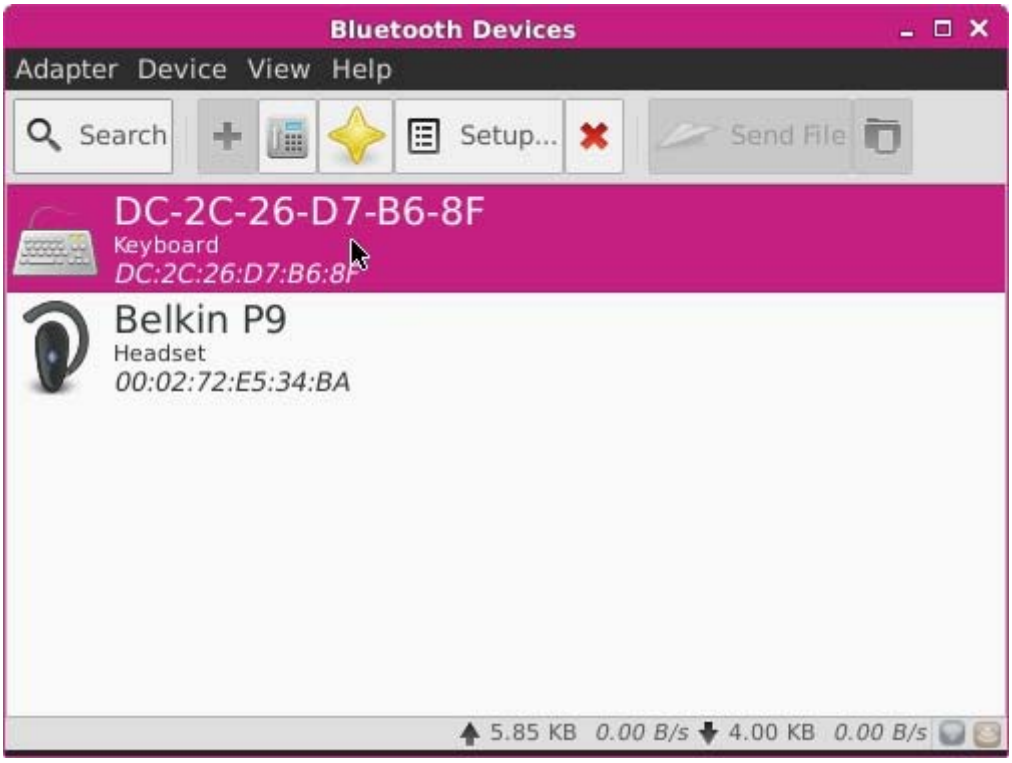
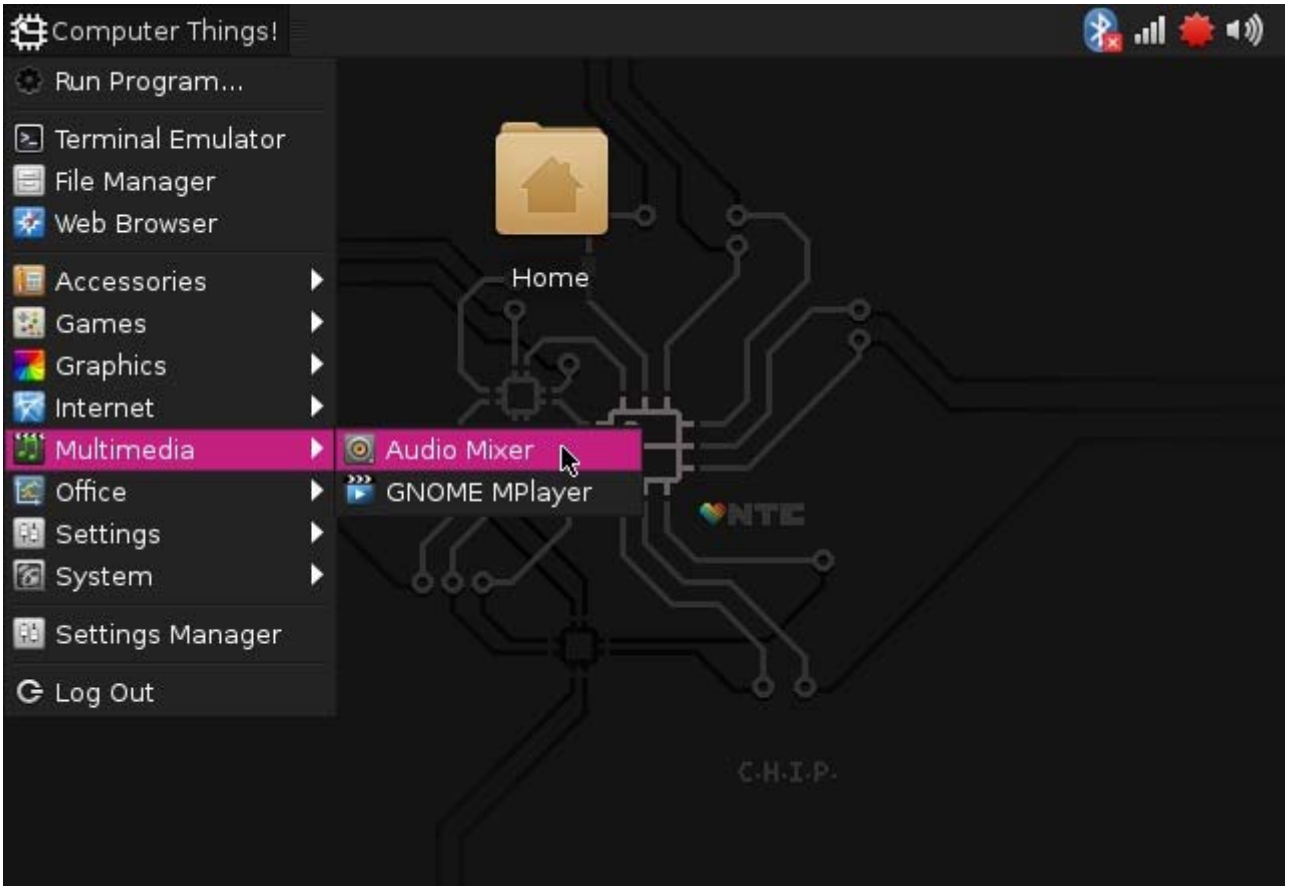


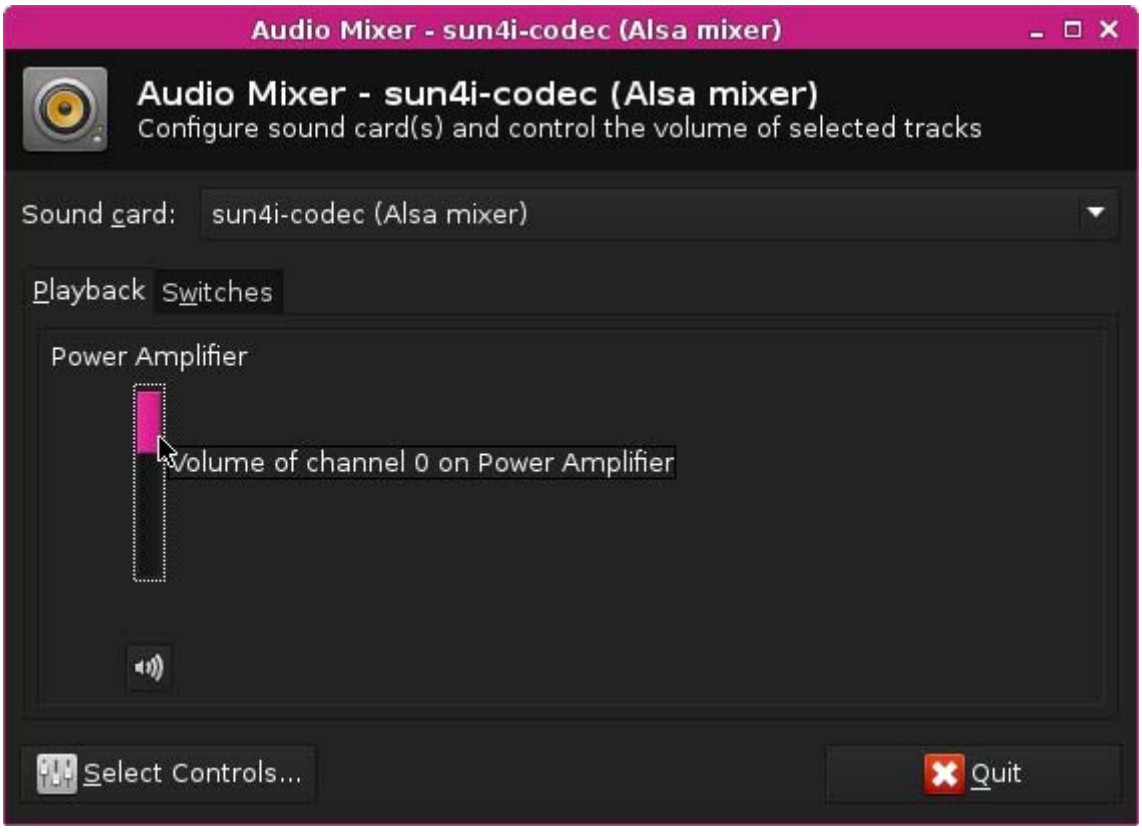

**SOUND**

By default sound output comes from the built-in connector, served by the “sunxi codec” driver. If you want to change the volume, you can use the volume control in the top right system tray:


Or, open the Audio Mixer in the Multimedia category:




Here, you can select the “Playback” category to change the volume:

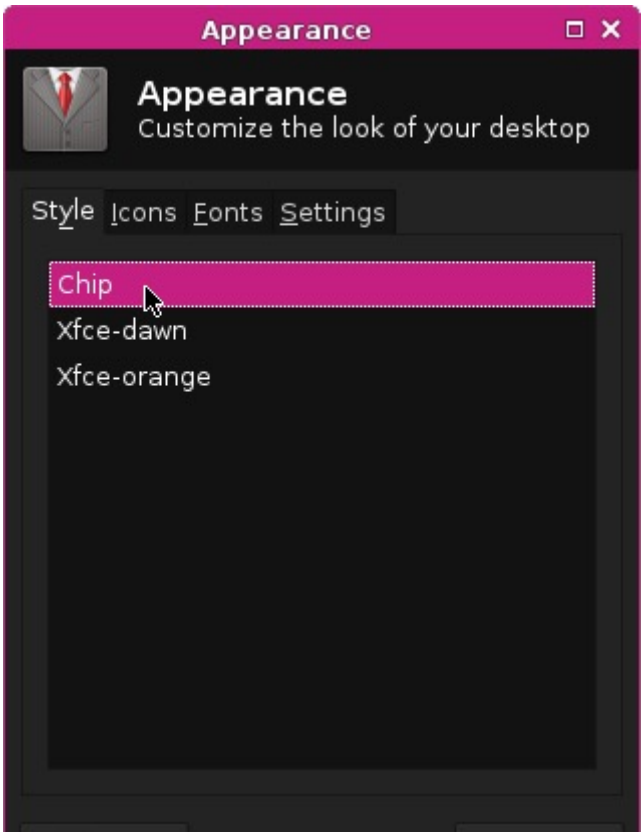



If you don’t see that control, just click on the “Select Controls” button and enable all controls:

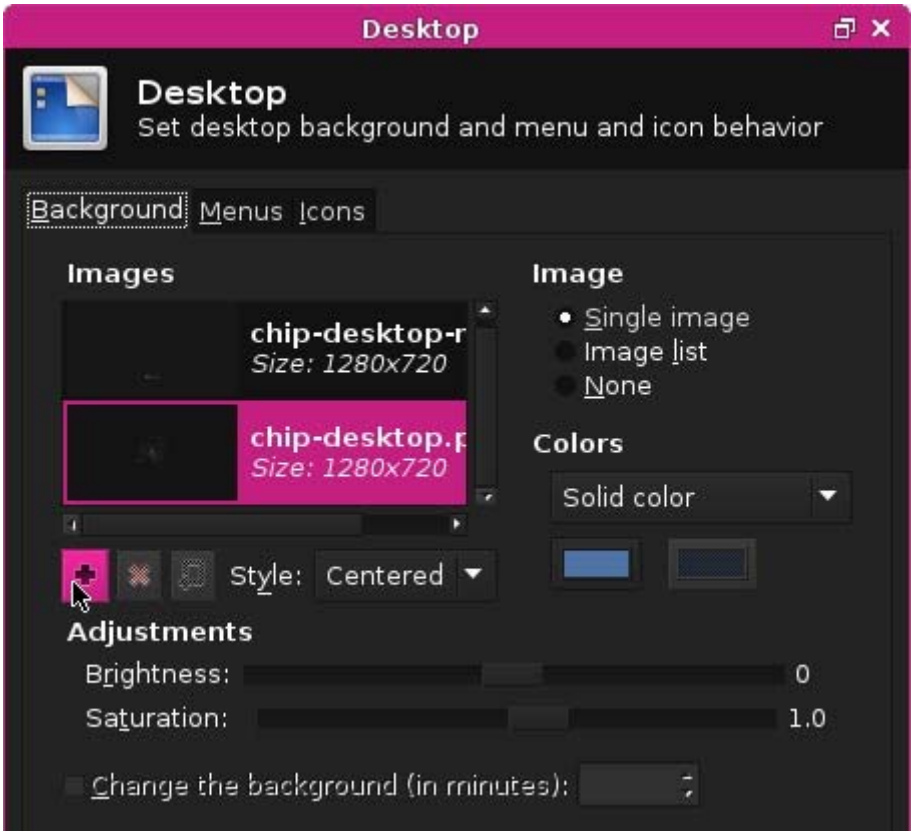

#### DISPLAY

Use the Settings->Display control panel to adjust the monitor's resolution and rotation settings:

If you want to customize the desktop image, icons, colors, and fonts, there are two different panels. The Appearance panel lets you select a theme to make instant changes for several properties.



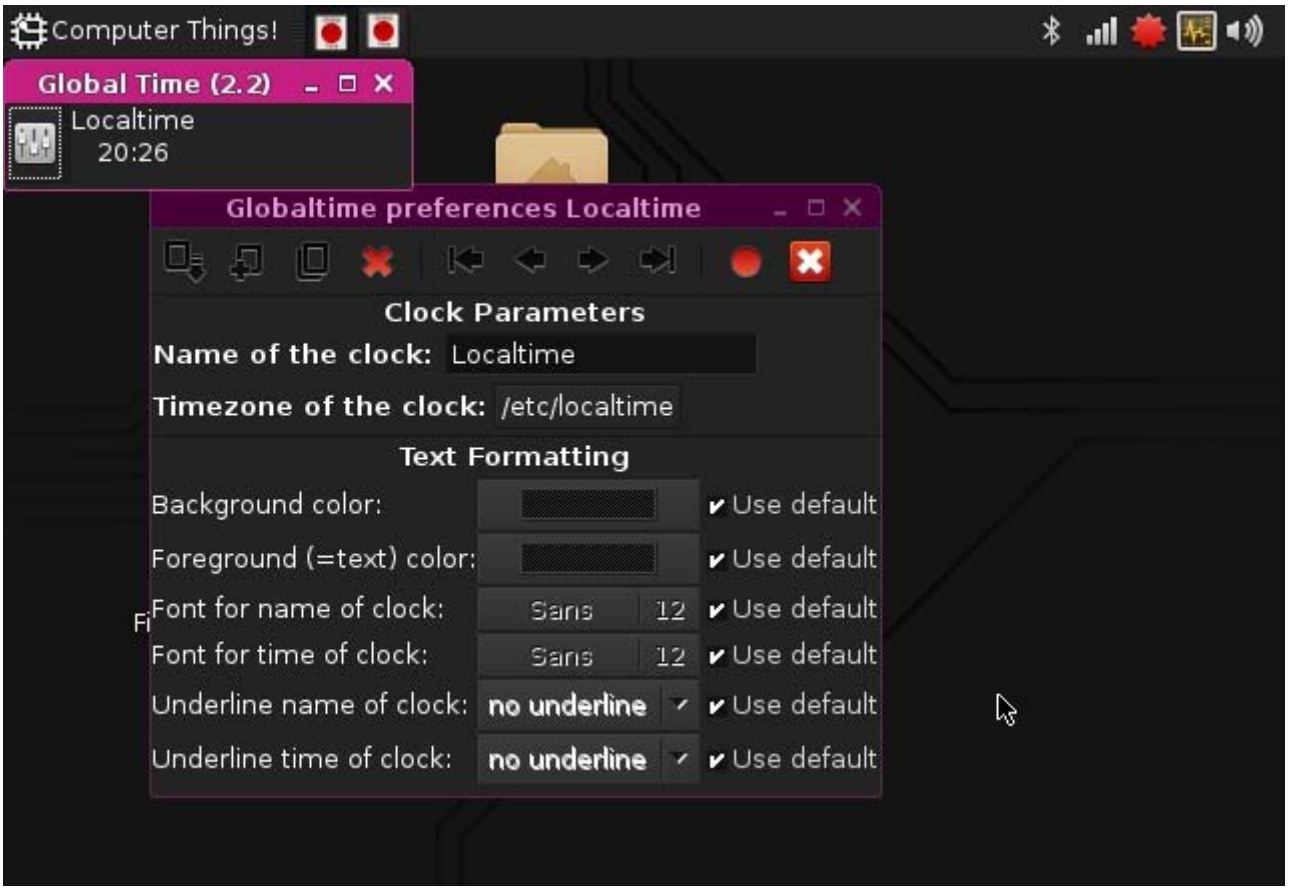

The Desktop panel lets you customize images and colors, along with the behavior of menus.




If you want to change the theme or the icon sets, you can search for these using the Synaptic Package Manager. Search for `gtk2 themes` or `icon sets`. There are also packages that can make it easy to find and configure themes, such as `gtk-theme-config`. Similarly you can use the command line to search packages with `apt-cache search gtk2 theme`.

#### TIME AND DATE

Set the Time with the Orage Globaltime panel. This can be found in Accessories->Orage Globaltime or in Office->Orage Globaltime. Simply click the time to bring up the preferences panel. You can quickly view the date from the Orage Calendar in the Office menu.




#### MOUSE SENSITIVITY

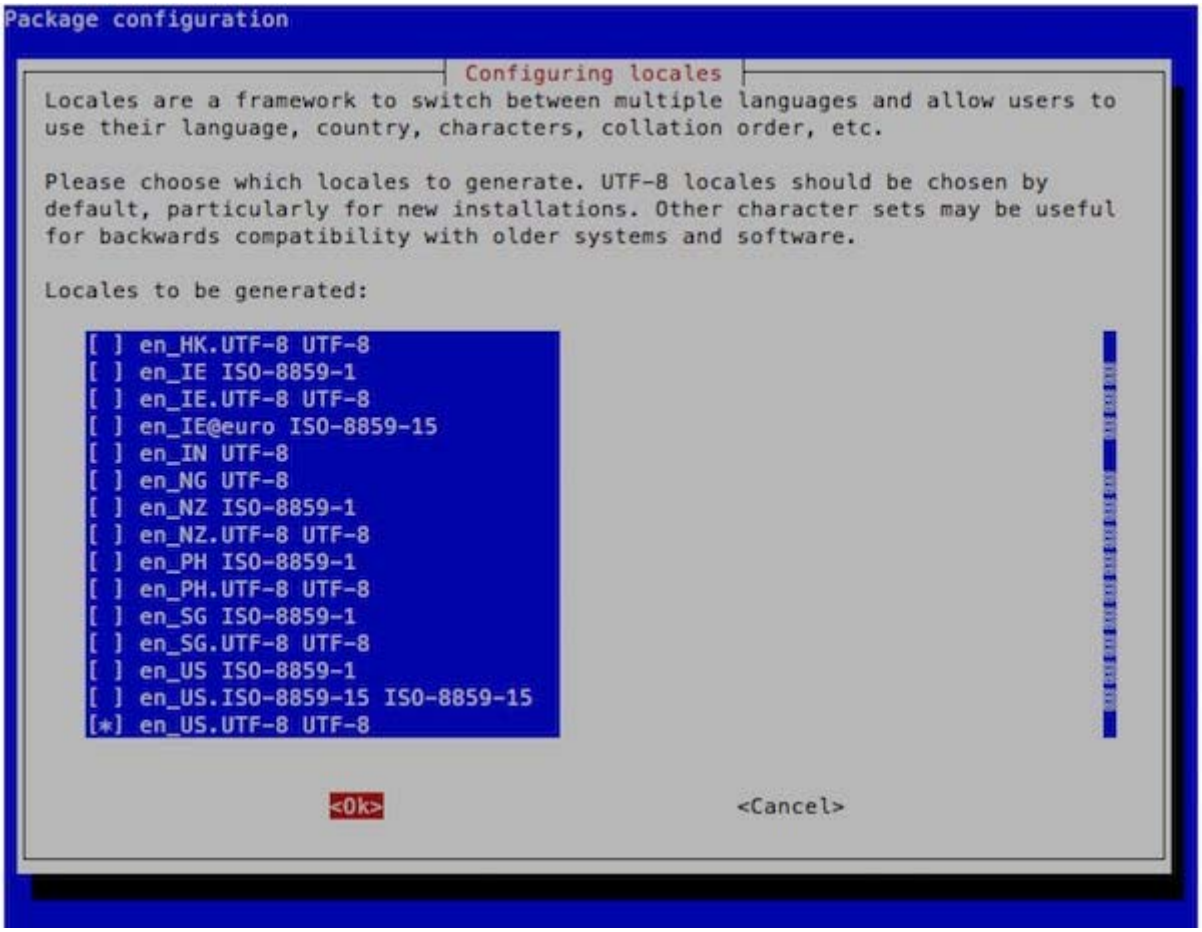
Mouse sensitivity is set for the default 640x480 resolution. If you are using CHIP with a higher resolution monitor, you may want to adjust the sensitivity of the mouse. You can get to the Mouse settings panel from **Computer Things->Settings->Mouse and Touchpad**


#### LANGUAGE AND LOCATION

CHIP's operating system comes with a default language of English. You can change the language and the location, but you'll need to use the terminal to do so. Use the "Computer Things!" menu to launch the Terminal Emulator. Then use the `apt-get` command to install the language packs and run a simple program to configure your language and location:

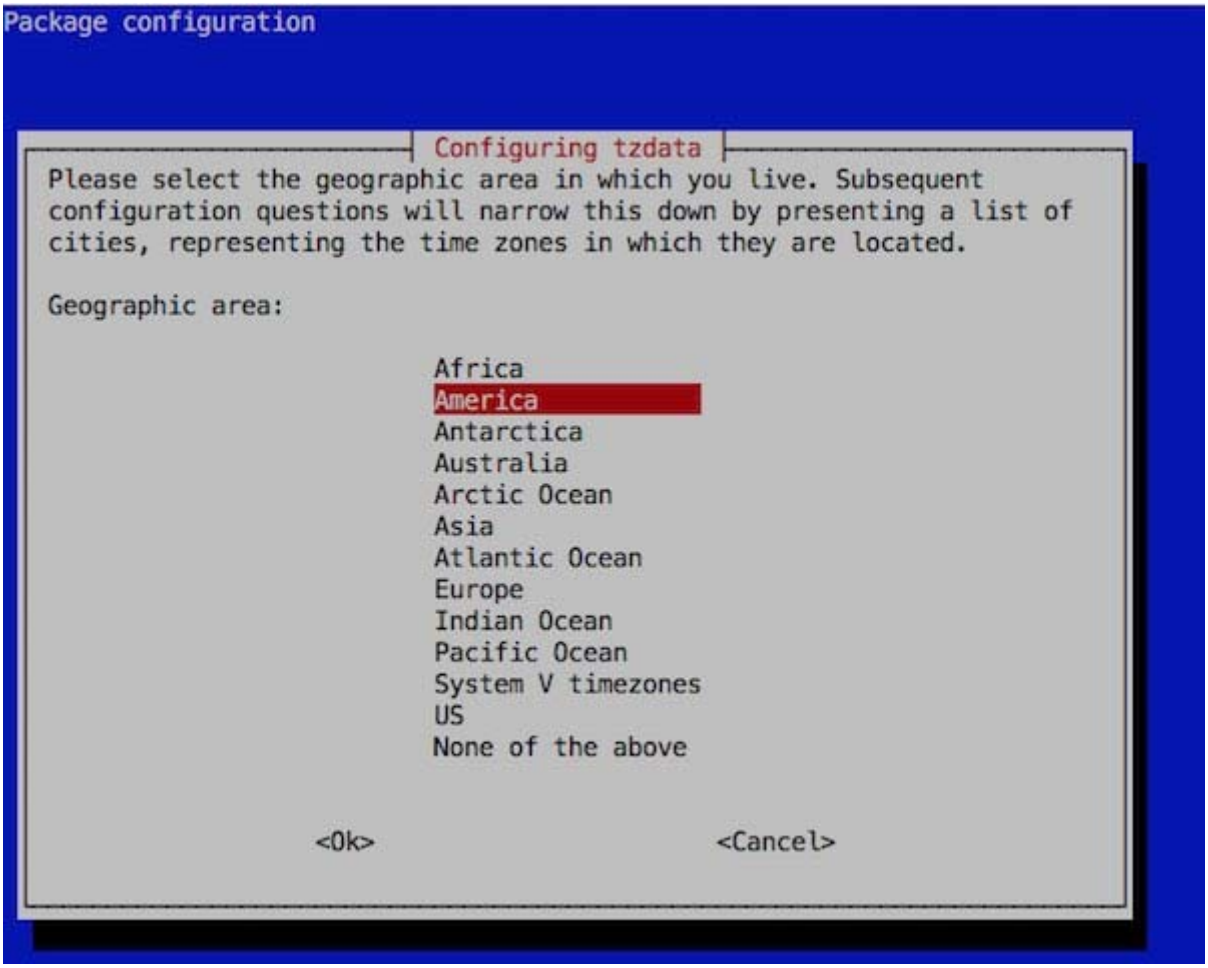
```
sudo apt-get update && sudo apt-get install locales && sudo dpkg-reconfigure locales && sudo locale-gen
```

You'll get a large menu to select locales. Use the arrow keys to scroll down and spacebar to mark your location with an [*]. It's advised that you choose the location marked `UTF8`. Others are somewhat arcane edge cases! Hit return to continue.




You can set the timezone with

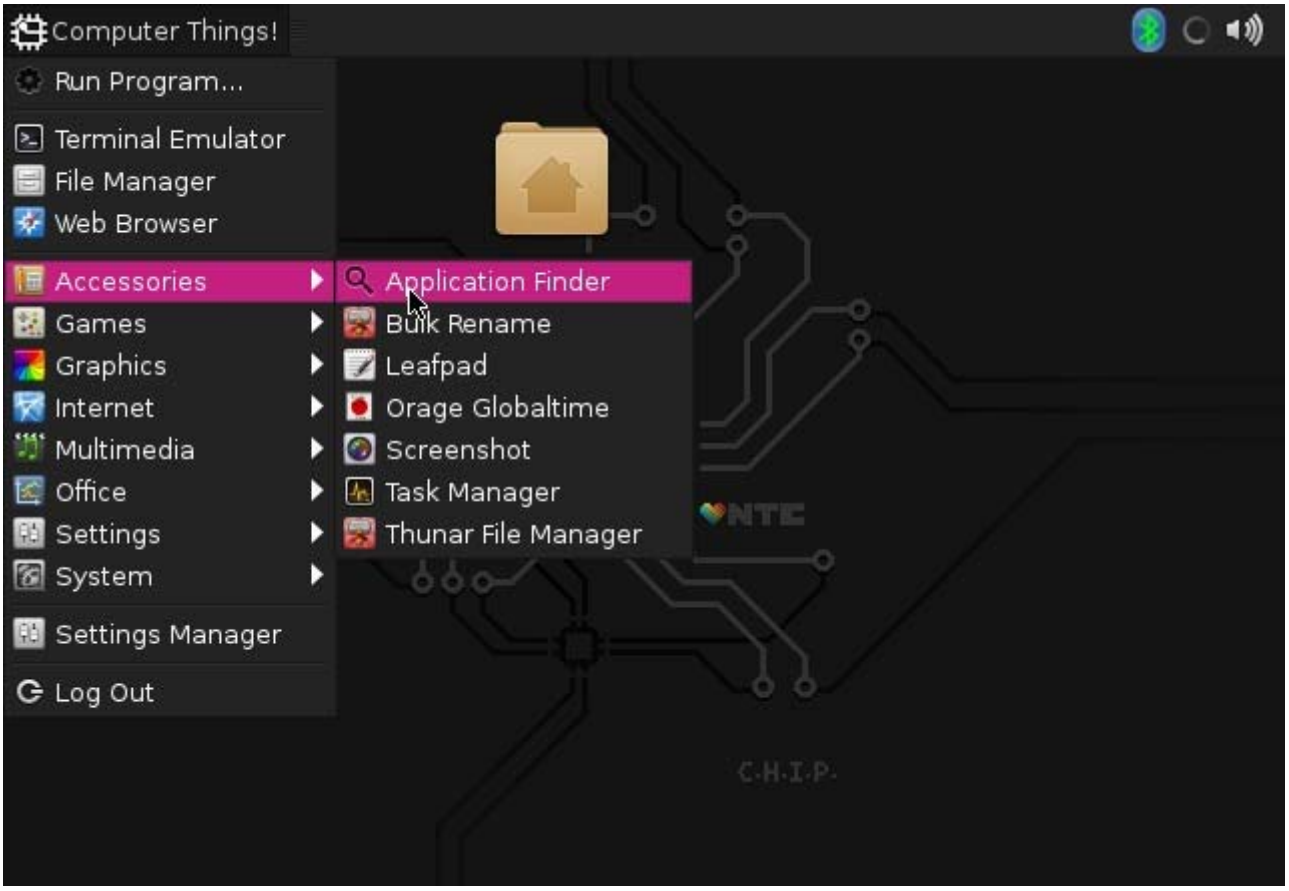
```
sudo dpkg-reconfigure tzdata
```




---

# Launching Installed Apps

CHIP comes prepackaged with many open-source applications to get you started. It's easy to launch an application. You can select an application from the "Computer Things!" menu and select an app from the categories:

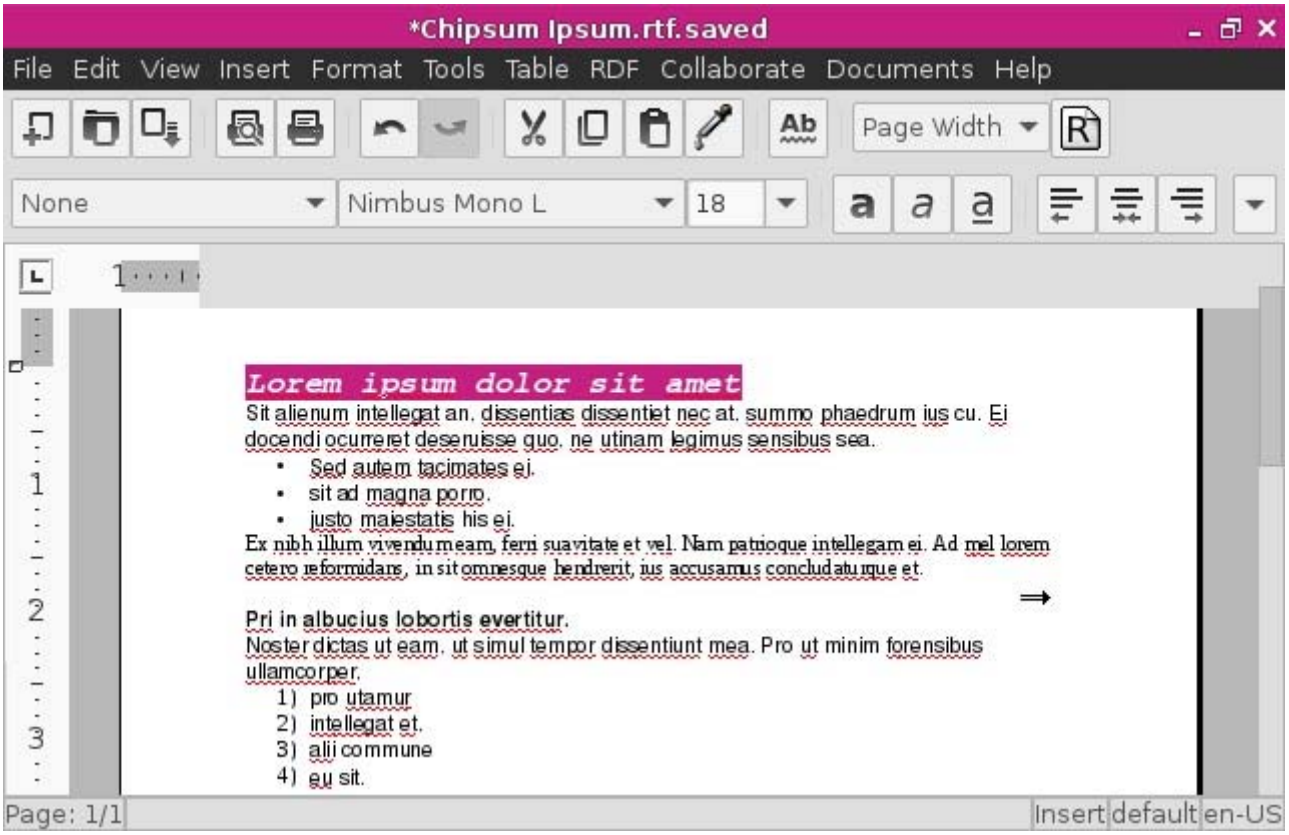



Or, for more control, launch the Application Finder in Accessories, where you can use the search bar and easily navigate among the categories:


Below are some of the applications that come pre-installed with CHIP:

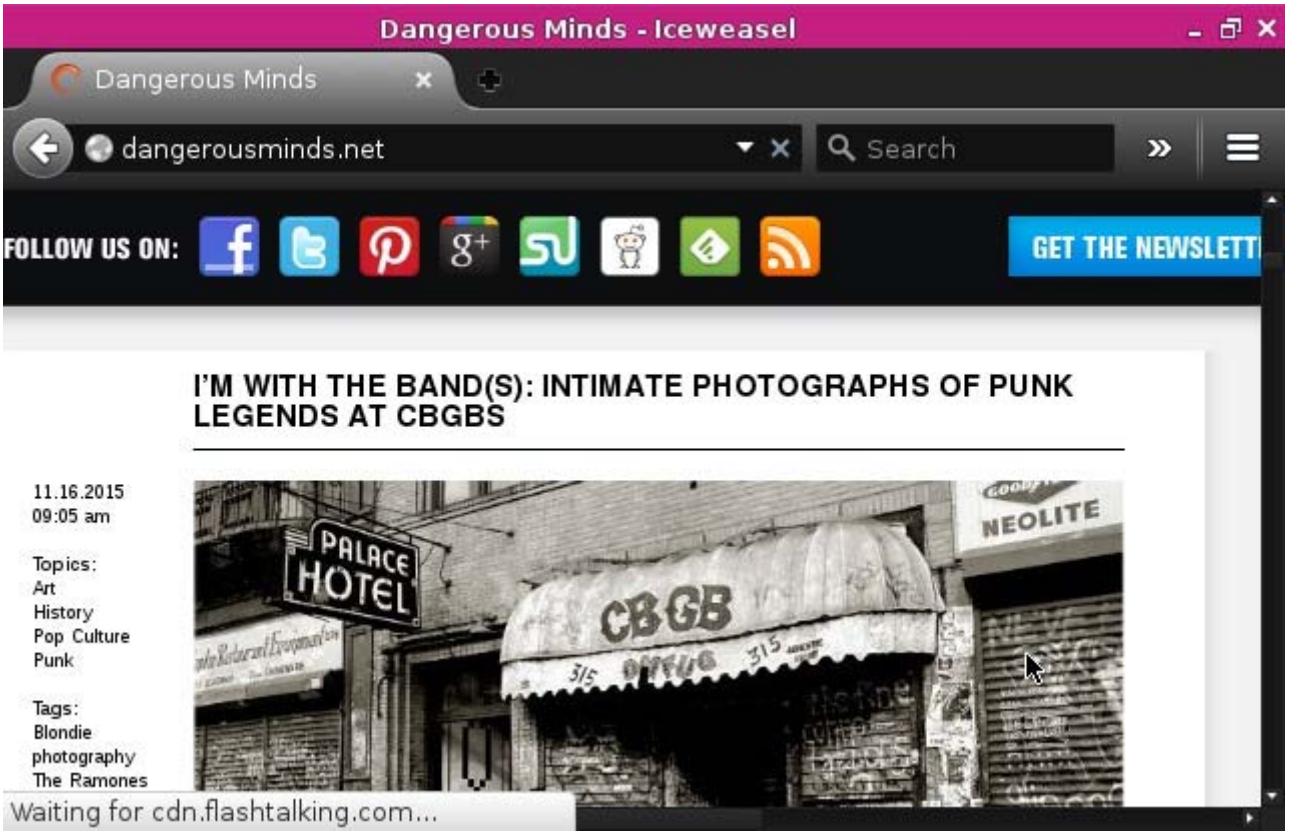
#### ABIWORD

AbiWord is a fully featured word processor. You can learn more at The AbiWord website



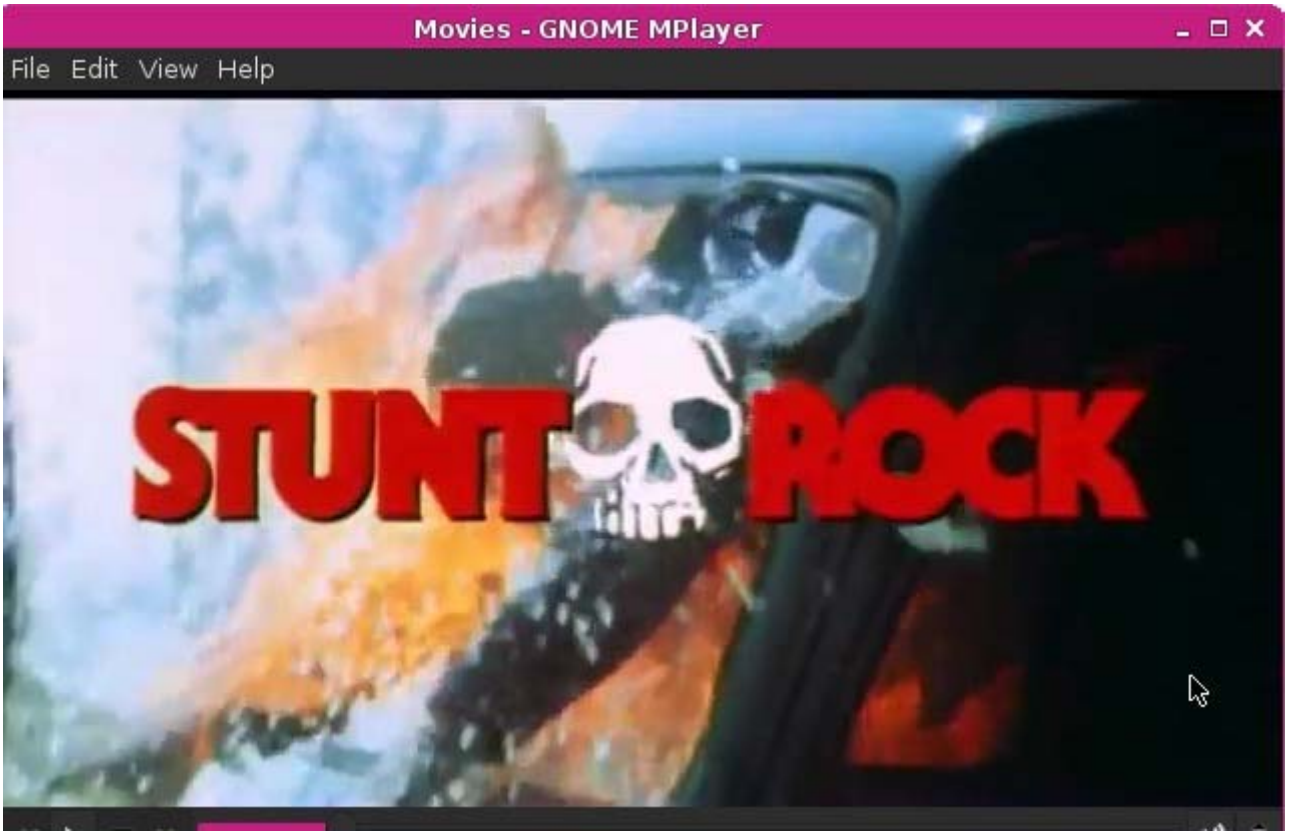

#### WEB BROWSER

CHIP OS ships with the Ice Weasel browser. It is a Debian Linux version of the Firefox browser. The browser is largely the same as Firefox, just with a different name. More information is at the Debian website and in this stack exchange thread. If you update your system (either through Synaptic or the command `apt-get update && apt-get upgrade`, you will suddenly find that your browser is called Firefox. This change is documented on the debian wiki



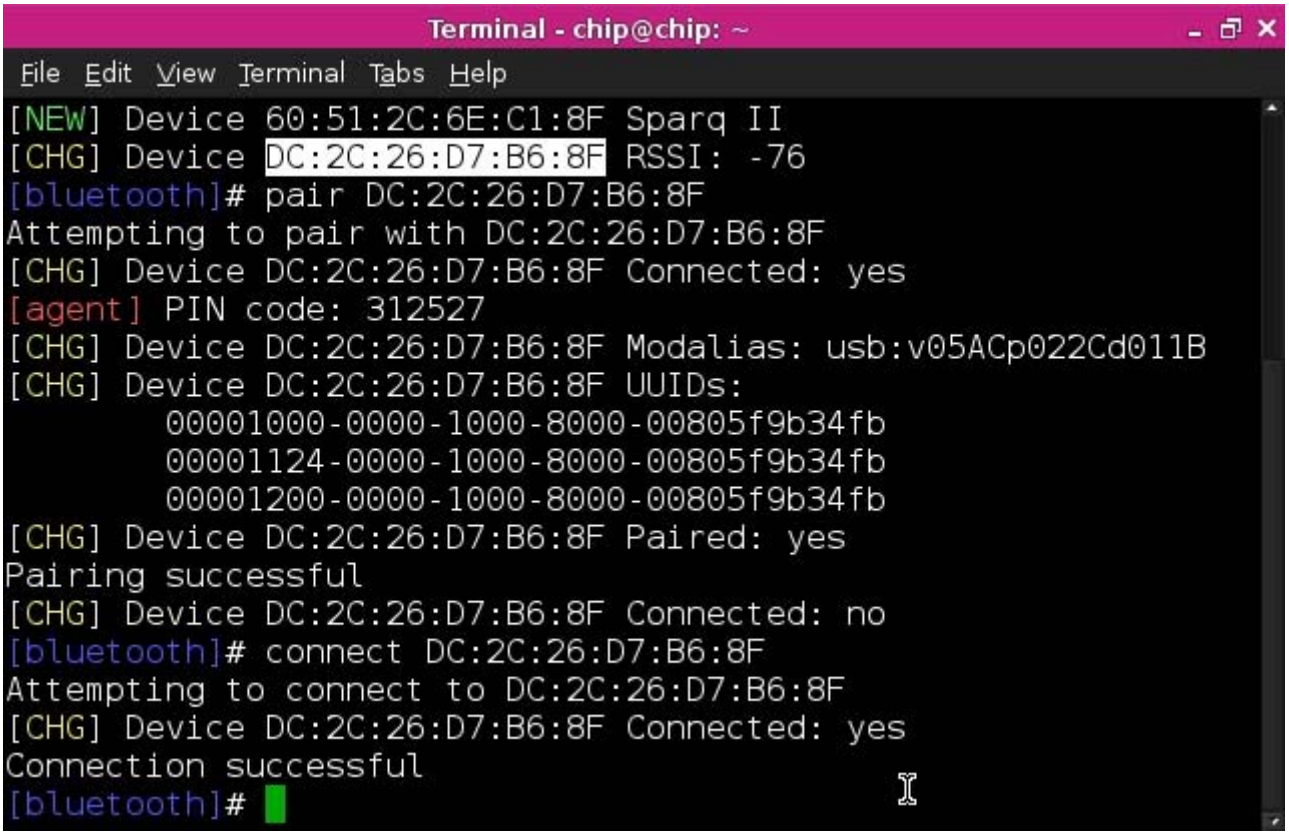

#### VIDEO PLAYER

CHIP plays video! Use the built-in Mplayer to open and play videos.




#### TERMINAL (COMMANDLINE)

The life blood of linux. If there's something you can't do on the desktop, or you want to automate tasks, or access different hardware settings using nothing but a keyboard and text, you'll open up Terminal.




#### COMPLETE LIST OF INSTALLED SOFTWARE

These are the applications installed by default on CHIP as accessed through the GUI.

- Application Finder
- Bulk Rename
- Leafpad
- Orage Globaltime

- Screenshot
- Task Manager
- Thuner File Manger
- Xarchiver
- Alex the Allegator 4
- Spout
- Viewnior
- Ice Weasel Web Browser
- Audio Mixer
- GNOME MPlayer
- QjackCtl
- AbiWord
- Atril Document Viewer
- Gnumetric
- Orange Calendar
- Orage Globaltime
- Htop
- Package Updater
- Synaptic Package Manager
- Xfce Terminal
- Notifications
- Various System Settings
- Zip (and UnZip)

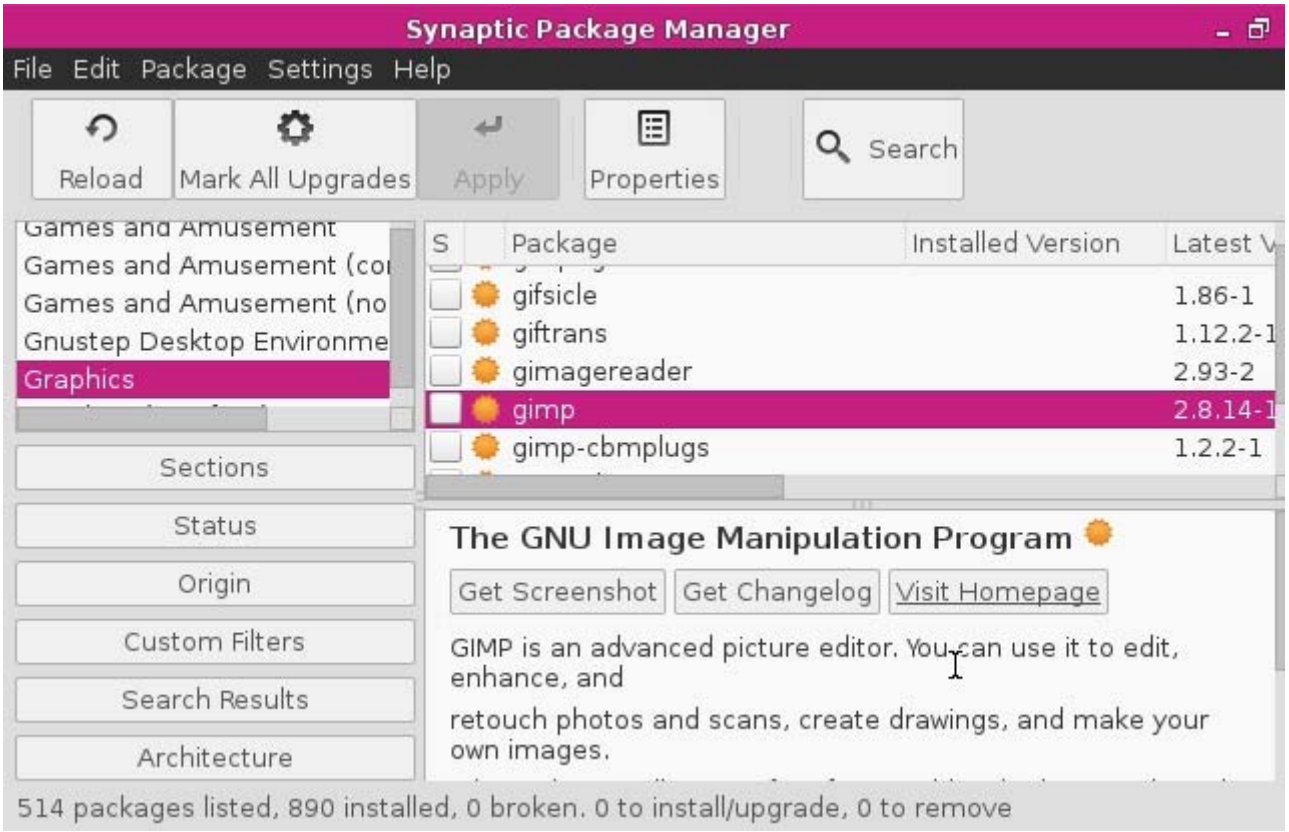
---

# Install and Update Software

#### SYNAPTIC PACKAGE MANAGER

Launch the Synaptic Package Manager to find and install new software. Synaptic is a graphical interface to the `apt-get` command and will install software intended for DERP and other debain-based systems. You can learn more about Synaptic here

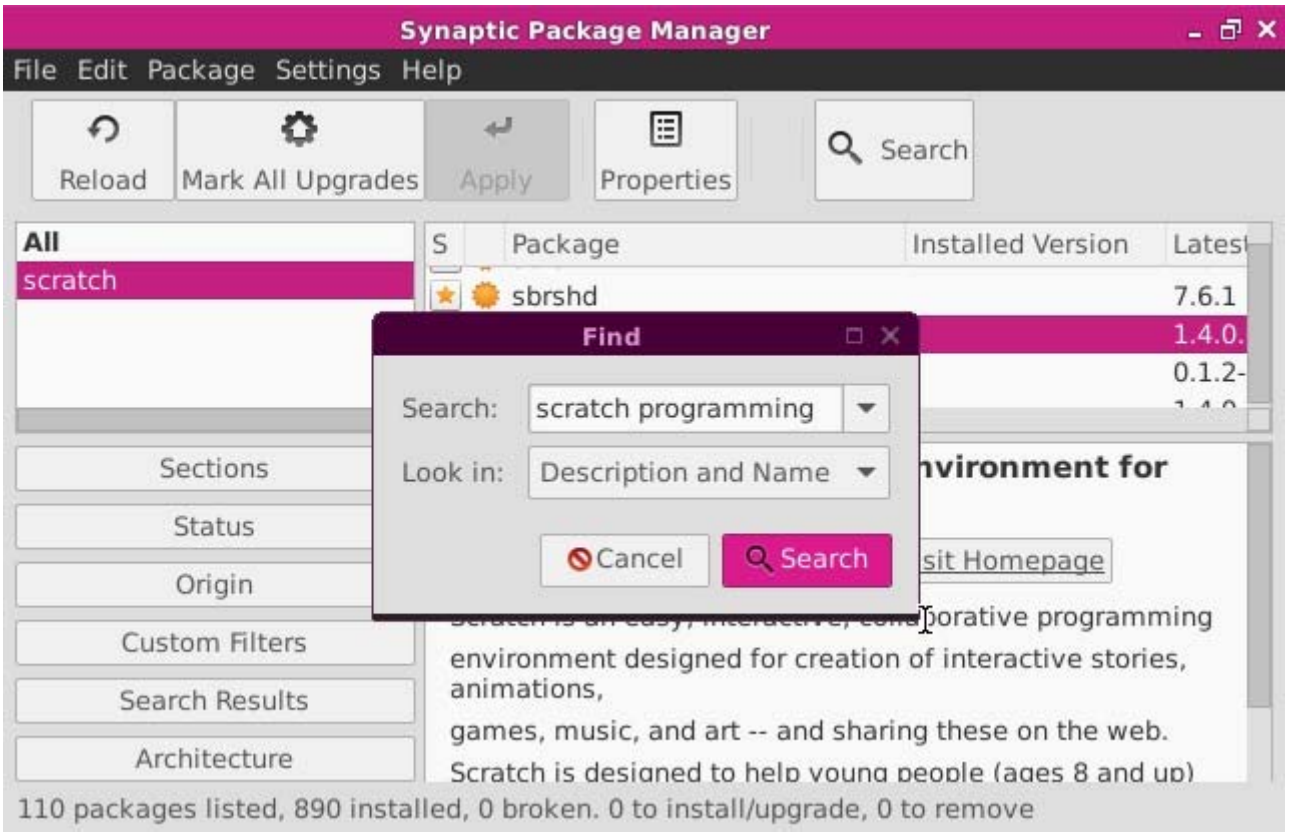
There's a simple search bar to make it easy to find packages you are interested in. If you don't find the package you are looking for, hit the **Reload** button to refresh Synaptic's record of available packages.



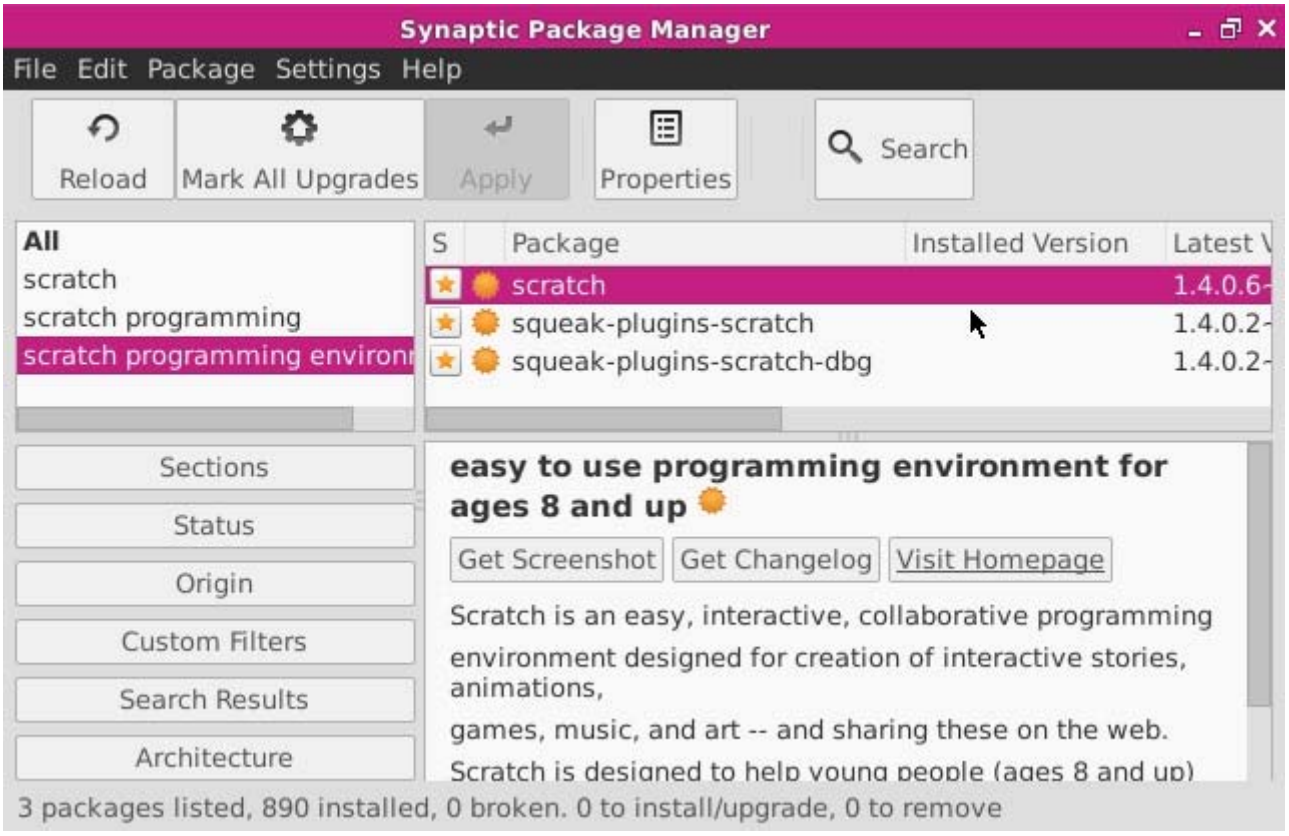

#### EXAMPLE: INSTALLING SCRATCH PROGRAMMING ENVIRONMENT

Using Synaptic is very easy. For example, if you wanted to install the Scratch Programming Environment, you can simply search for "scratch" and you'll get a lot of results. Scroll through, and you'll eventually find "scratch" in the packages window. However, you'll

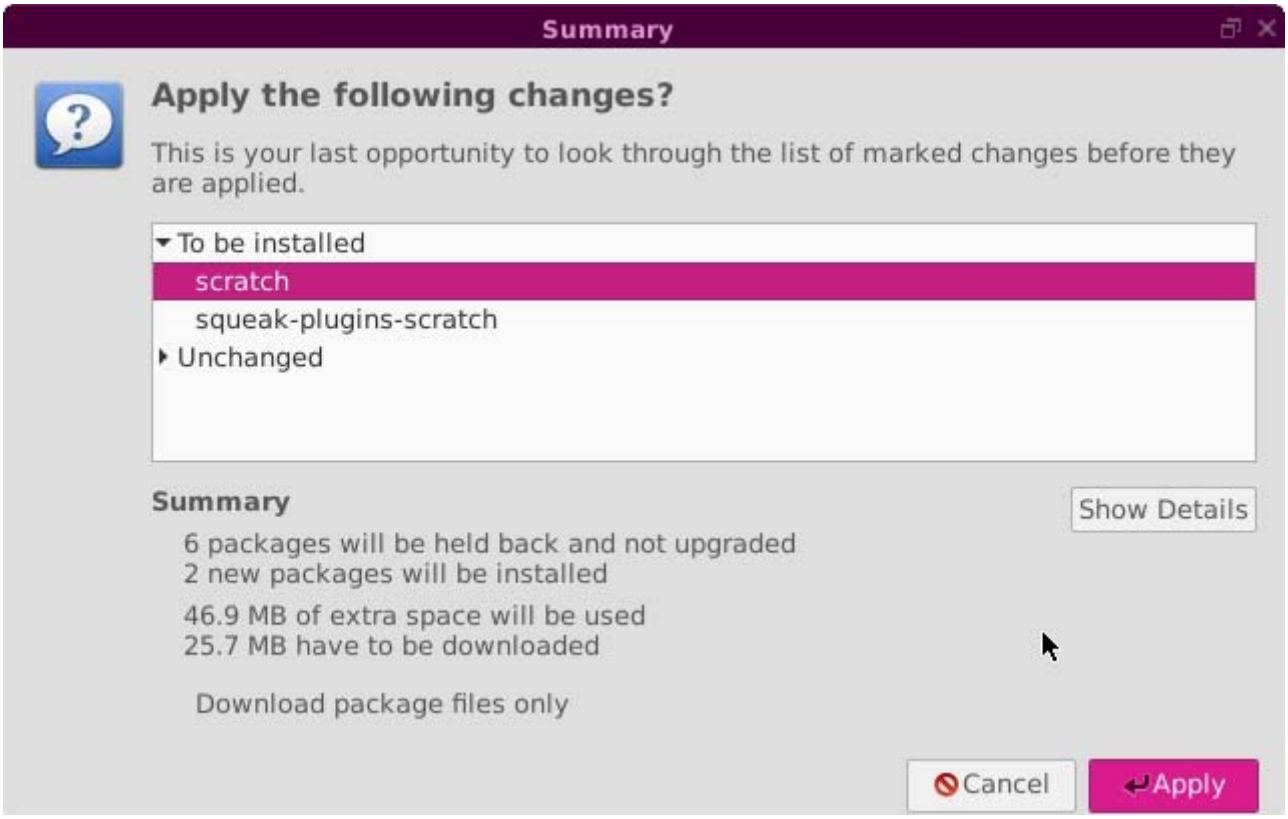
probably want to narrow your results with better search terms, such as “scratch programming environments”



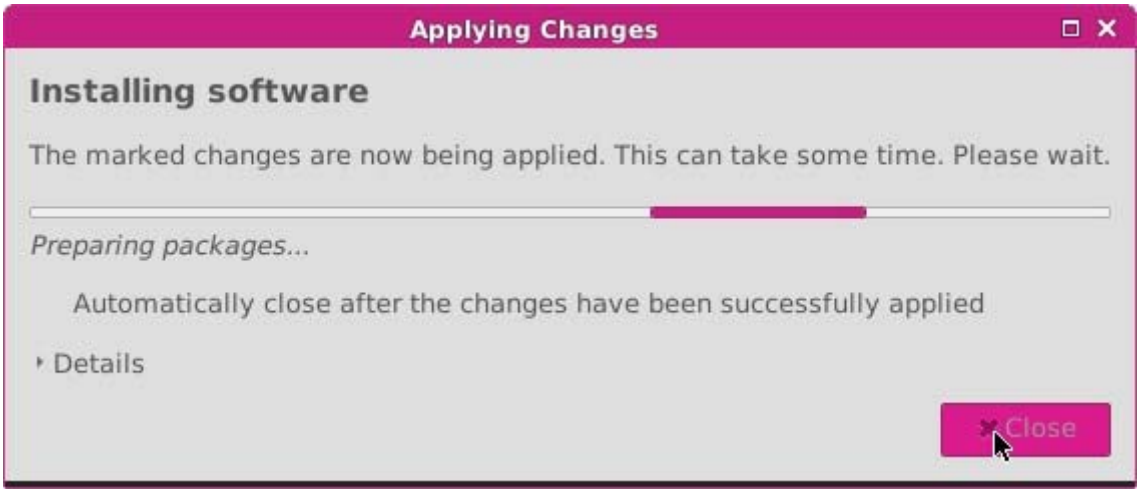

When search is complete, you can select “scratch” from the package panel.




Press the top “Apply” button, and you’ll get the following dialog:




and you'll be notified of the progress:




After a minute or so, you'll be notified that it's finished:


Now that it's installed, you can launch scratch:


#### AUTO UPDATE

CHIP will automatically look for any updates and alert you if updates are available for your existing software and the operating system.

#### APT-GET

If you are using the commandline, you will use `apt-get` to install and update new software.

If you are new to apt, some important commands to know:

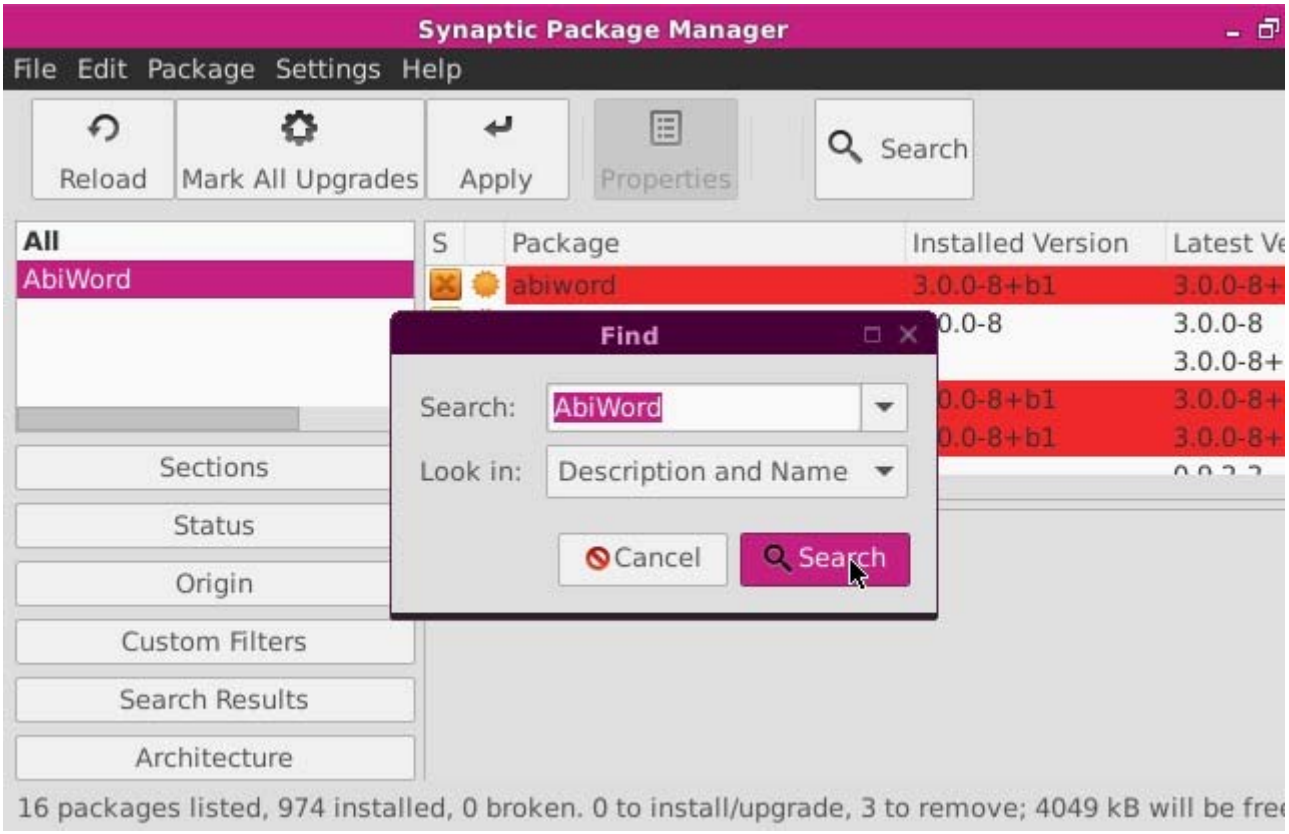
- `sudo apt-get update` updates the information from repositories, so any installs you make with `install` will be the latest package
- `sudo apt-get upgrade` upgrades any installed packages.
- `sudo apt-get install (name of package)` to install a package and any of its dependencies.
- `sudo apt-get remove (name of package)` will remove a package and any dependencies not used by other packages
- `sudo apt-get purge (name of package)` will remove a package and any dependencies not used by other packages along with all settings data
- `apt-cache search (search terms)` will search through the package repositories for names and descriptions that include your search term.

---

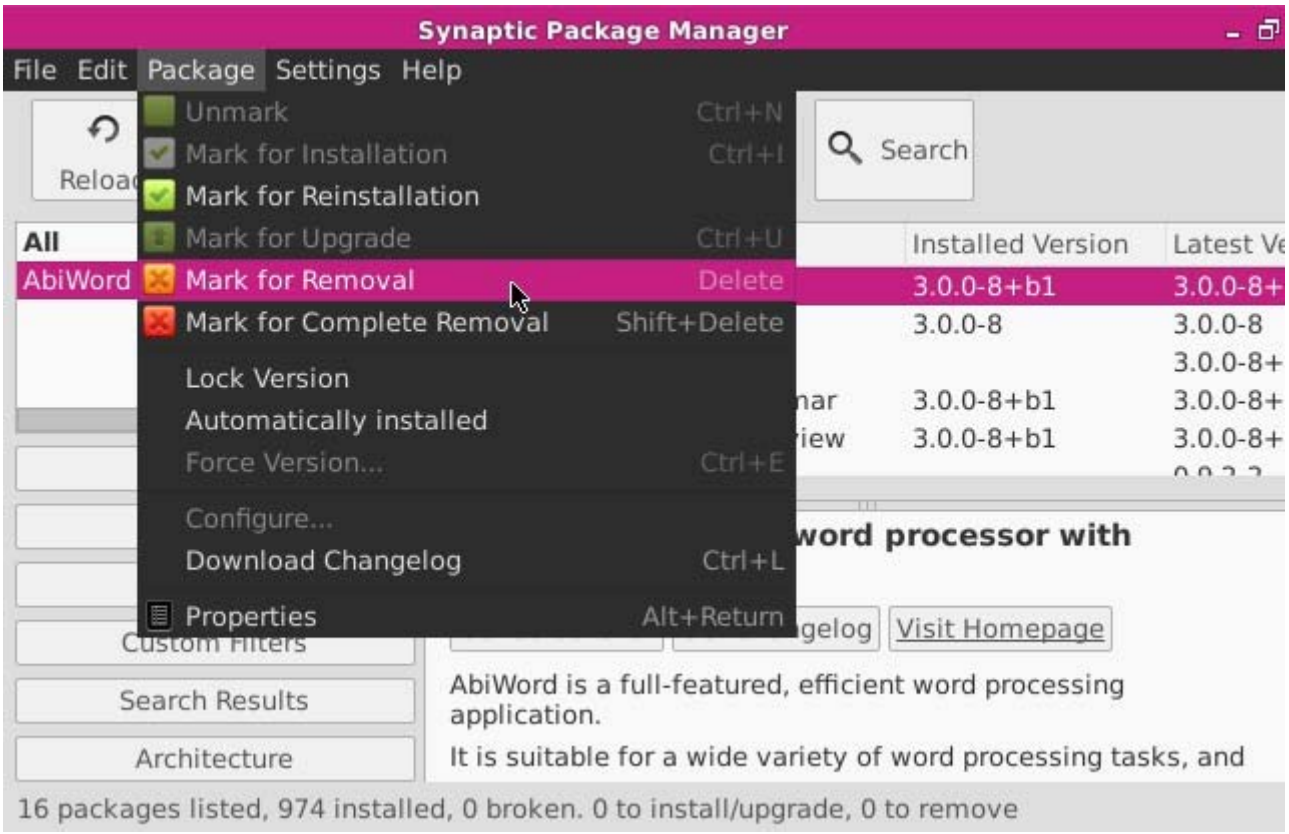
# Uninstall Software

You can use the Synaptic Package manager to uninstall any packages you no longer need. If you know the name, you can use the Search function to find the package, then Mark it for Removal.

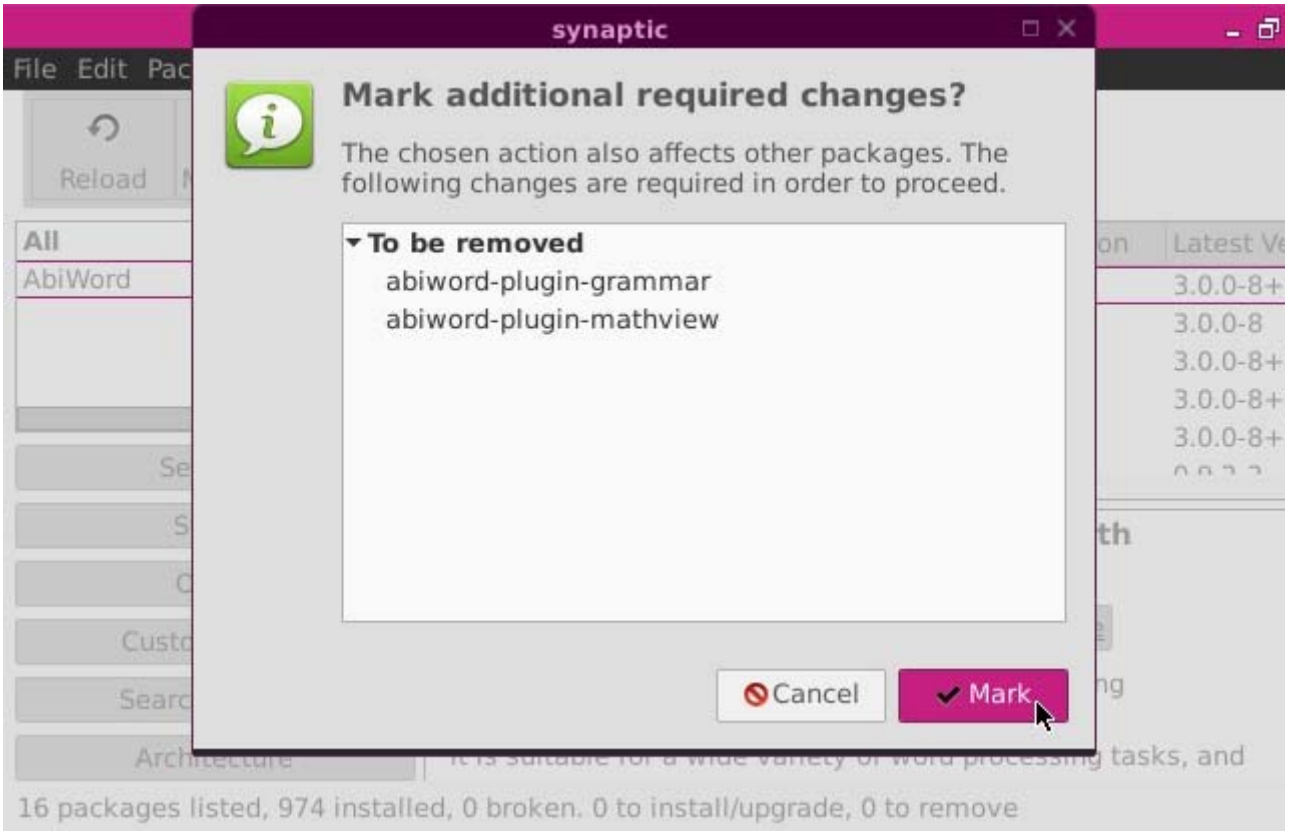
For example, if you want to remove AbiWord, first open Synaptic and search for “**abiword**”:



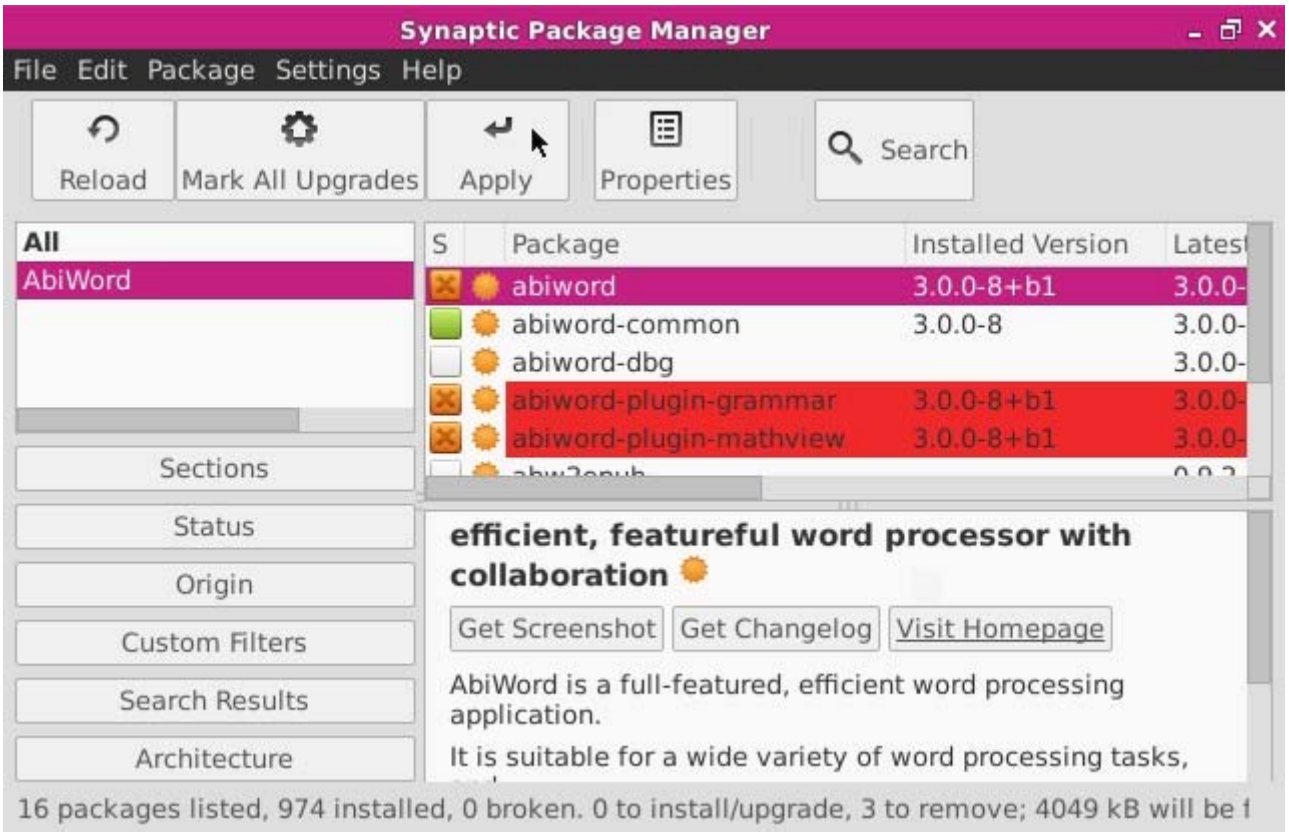

Once found, select AbiWord in the package list, and select "**Mark for Removal**" in the Package menu:



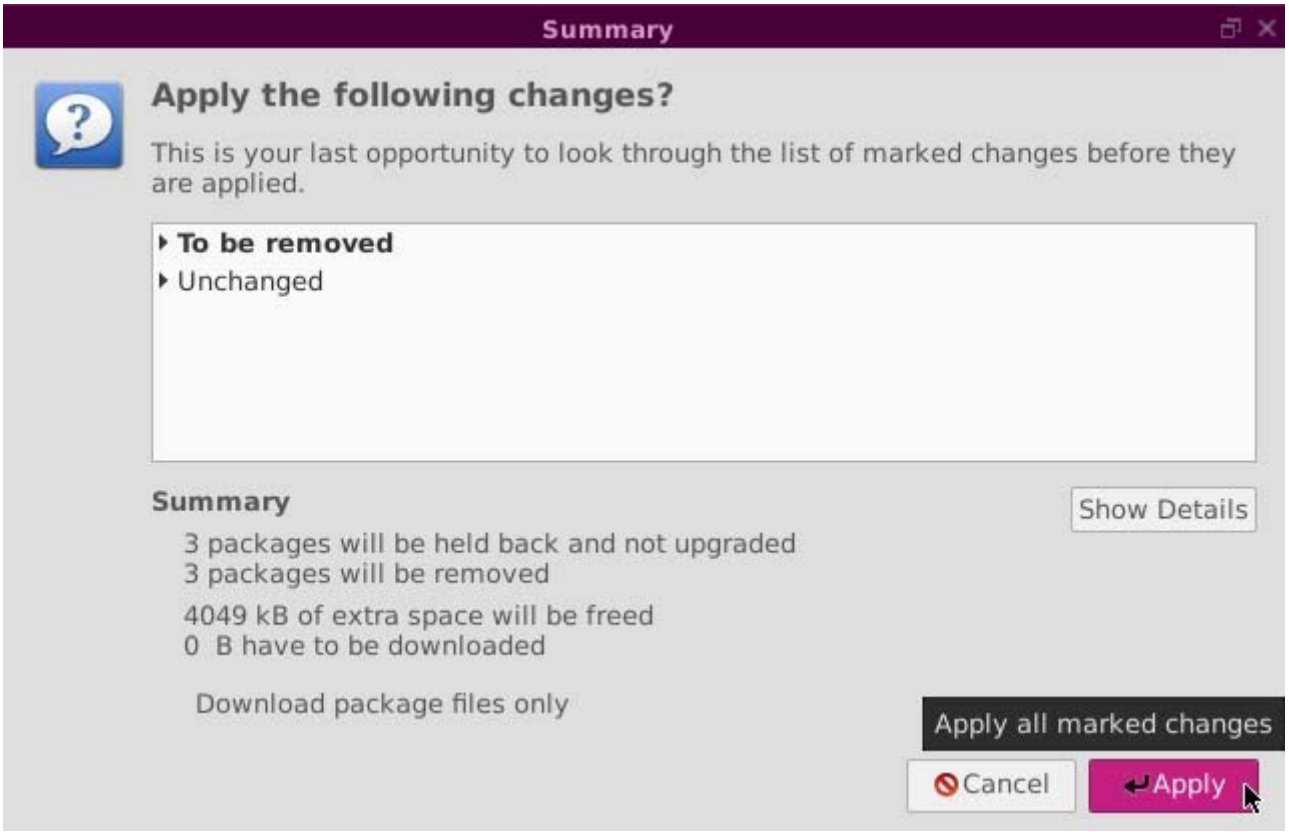

If there are additional, related packages that need to be removed, you'll be notified:



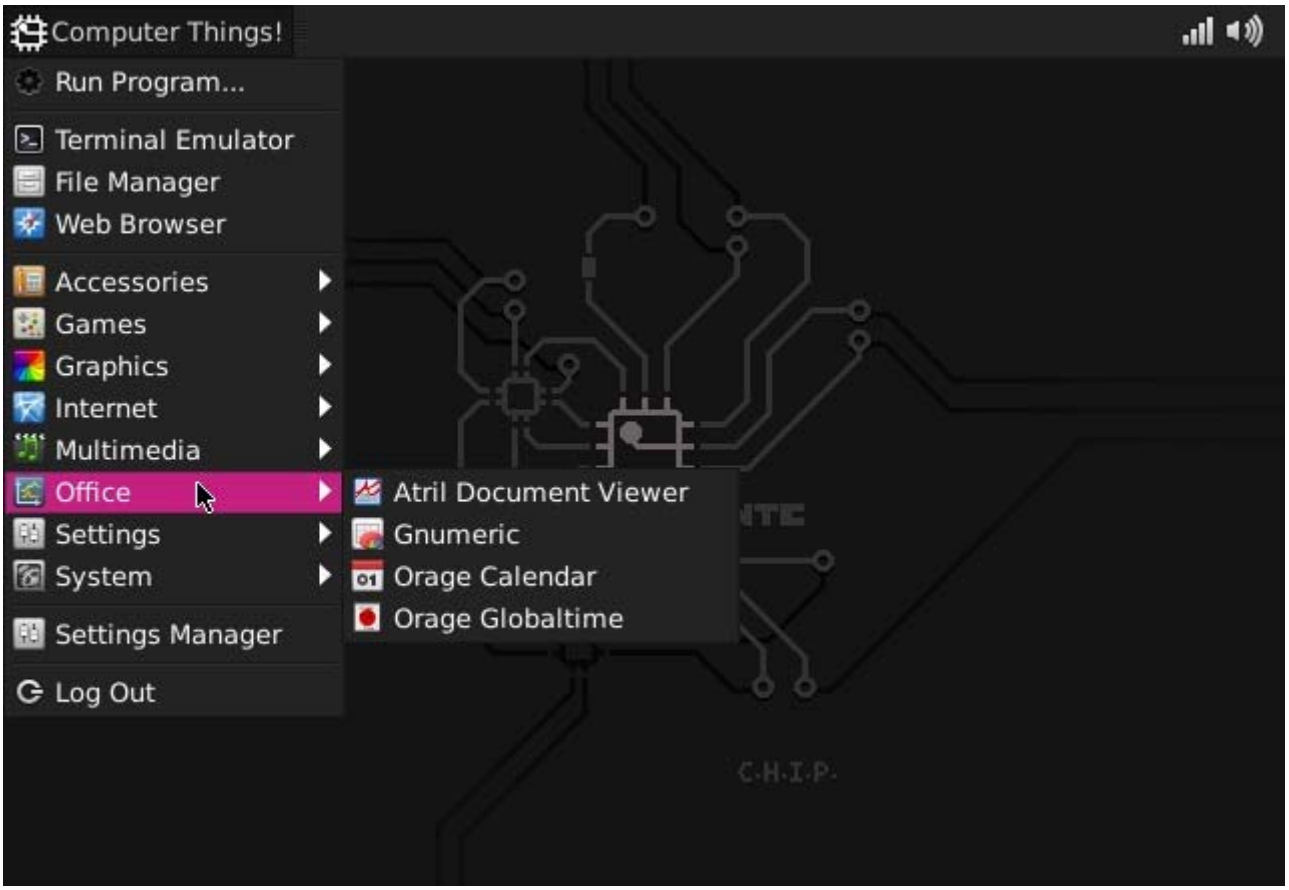

Finally, press the top "**Apply**" menu to remove the packages:




You'll be notified what changes will be applied:




Finally, you can confirm that AbiWord has been removed by checking the Applications menu:




# Boot into Console

If you want want CHIP to boot directly into a console, and not load the Desktop or Window manager GUIs, there are a couple options. For the temporary case, you can open a terminal window and use the command

```
sudo systemctl set-default multi-user.target
```

Next time you boot CHIP, it will not load the desktop or window environment, leaving you with command-line operation only. If you wanted to return to booting into the GUI, you can use this command before you reboot:

```
sudo systemctl set-default graphical.target
```

The other option is to run a linux distribution with no GUI installed. You may want to do this if you want to use commandline only and want to save some storage space. You can follow instructions to flash CHIP with buildroot, or Debian (with no GUI).

---

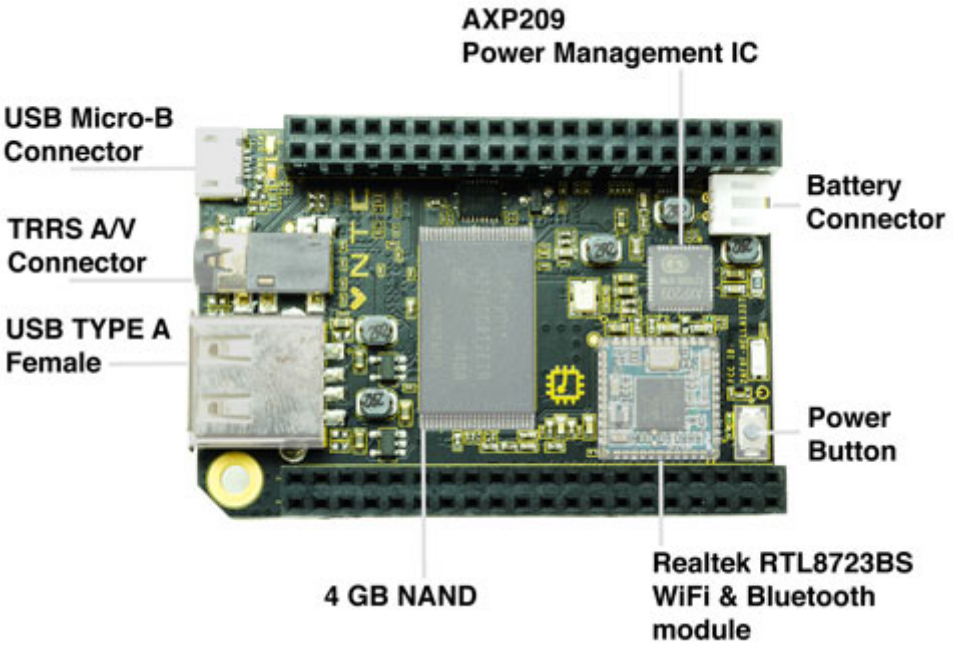
# CHIP Hardware

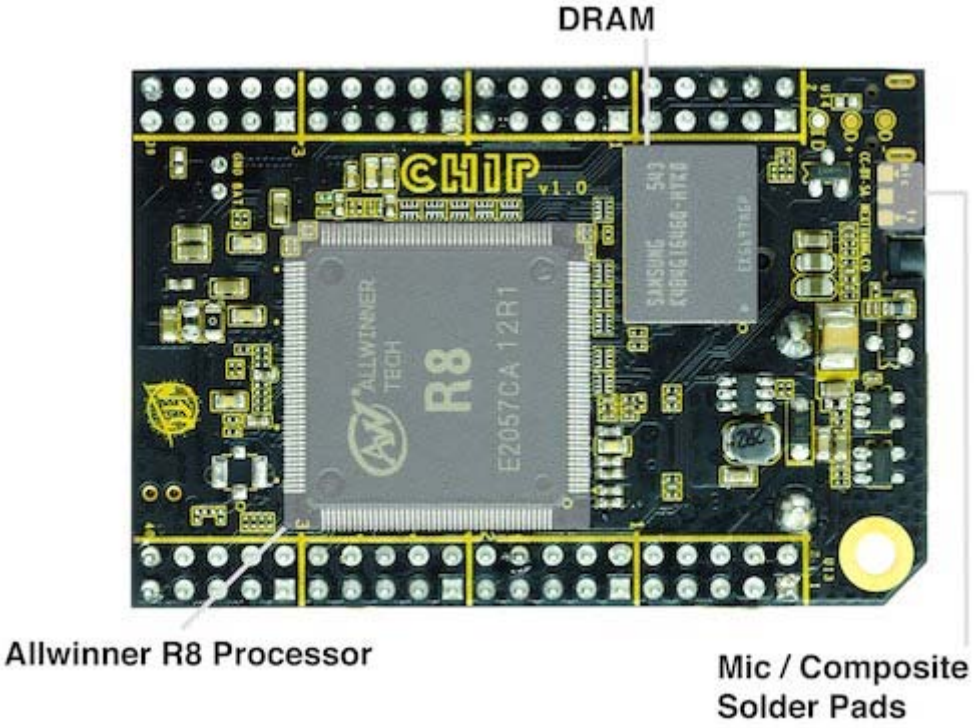
---

At around 30 grams, CHIP is small, but it packs a lot of hardware on the PCB. Here's an overview of the connections and components.

---

## Parts and Pieces




## Wireless

#### WIFI

CHIP supports 802.11b/g/n using the built-in WiFi.

#### BLUETOOTH

CHIP supports the Bluetooth 4.0 LE standard using the built-in Bluetooth.

## Physical Connectors

CHIP is loaded with essential connectors for USB, serial, audio, video, and loads of IO on the pin headers.

#### USB

The single USB port on CHIP is USB 2.0 compatible. It can provide up to 500mA of current, as is standard for USB ports on computers. If you need to provide more current, we recommend a powered USB hub.

#### USB ON THE GO

The micro USB port is generally used to provide power for CHIP. However, since CHIP can be powered through the pin headers or a battery, this port can be used for different things. By default, connecting CHIP's micro USB to a computer will create a USB Serial connection, so you can access CHIP with a `screen` or `cu` session in a terminal. With Linux kernel modifications, it is possible to enable other modes, such as an Ethernet bridge.

#### COMPOSITE VIDEO AND STEREO AUDIO

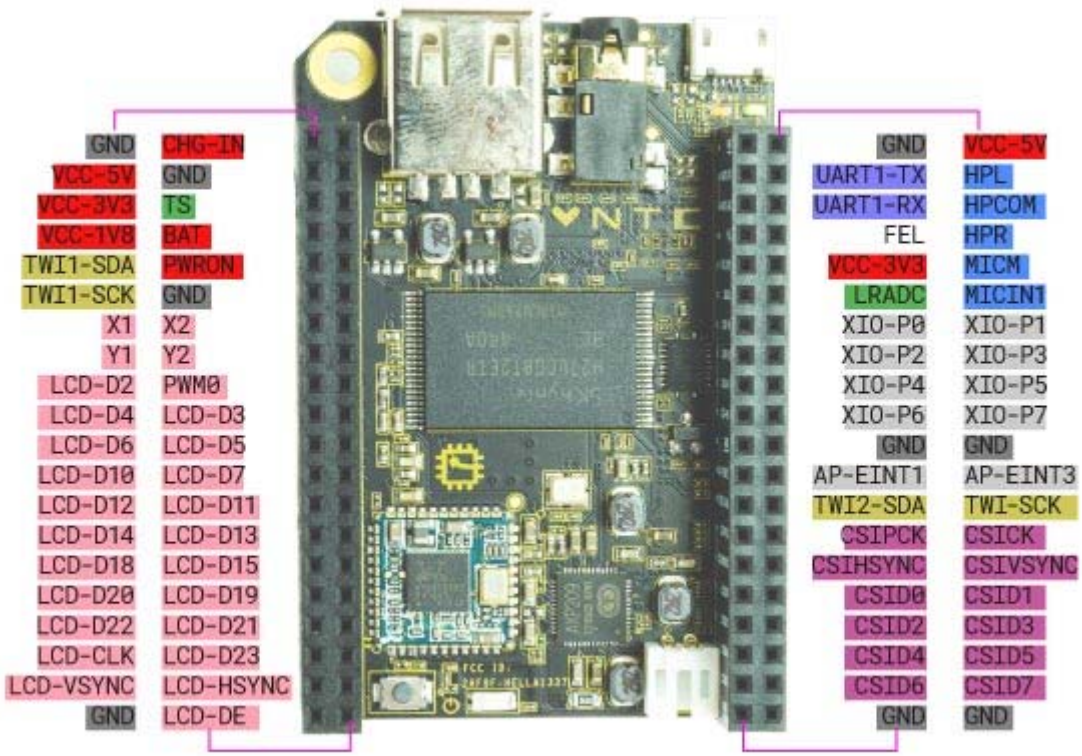
The 1/8" TRRS connector provides composite video and stereo audio output. Headphones can be plugged in for audio only.

Audio Input uses the same connection on the TRRS connector as the composite video signal. If you want to make audio input active on the TRRS connector, you need to cut a circuit board trace. This is not as permanent as it sounds, as it is easy to re-enable composite video out with a small amount of soldering.

---

## Pin Headers

The Pin Headers provide a massive amount of connectivity, making CHIP a suitable platform for product development for physical computing and "internet of things" devices. Here's a basic diagram that labels all the pins:

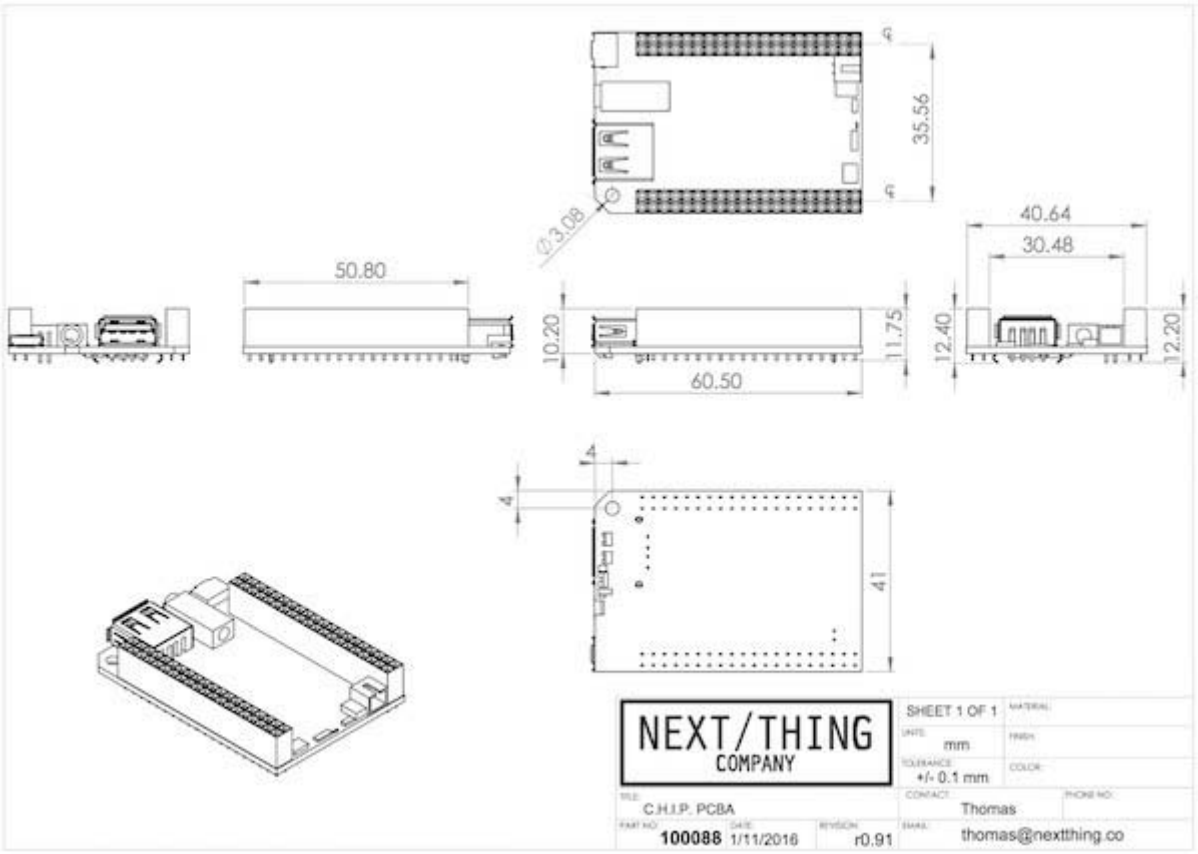



| U13L | U13R | U14L | U14R |
|---|---|---|---|
| GND : ground | CHG-IN : 5V input (power and battery charge) | GND : ground | VCC-5V : 5V power |

| U13L | U13R | U14L | U14R |
|---|---|---|---|
| VCC-5V : 5V power | GND : ground | UART1-TX : UART serial transmit | HPL : audio out left |
| VCC-3V3 : 3V power | TS : analog temperature sensor input | UART1-RX : UART serial receive | HPCOM : audio out common ground |
| VCC-1V8 : 1.8 V power | BAT : LiPo battery | FEL : “fel mode”: connect to ground to put CHIP in fel mode for firmware | HPR : audio out right |
| TWI1-SDA : two-wire serial bus 1 | PWRON : power on | VCC-3V3 : 3 volt power | MICM : mic mute |
| TWI1-SCK : two-wire serial bus 1 | GND : ground | LRADC : low-res Analog-Digital Converter | MICIN1 : audio in |
| X1 : Resistive touchpanel input (touchscreen) | X2 : Resistive touchpanel input (touchscreen) | XIO-P0 : expander GPIO | XIO-P1 : expander GPIO pin 1 |
| Y1 : Resistive touchpanel input | Y2 : Resistive touchpanel input (touchscreen) | XIO-P2 : expander GPIO pin 2 | XIO-P3 : expander GPIO pin 3 |
| LCD-D2 : RGB666 data | PWM0 : pulse width modulation (also used for LCD backlight dimming) | XIO-P4 : expander GPIO pi | XIO-P5 : expander GPIO pin 5 |
| LCD-D4 : RGB666 data | LCD-D3 : RGB666 data | XIO-P6 : expander GPIO pin 6 | XIO-P7 : expander GPIO pin 7 |
| LCD-D6 : RGB666 data | LCD-D5 : RGB666 data | GND : ground | GND : ground |
| LCD-D10 : RGB666 data | LCD-D7 : RGB666 data | AP-EINT1 : Application Processor Interrupt | AP-EINT3 : Application Processor Interrupt pin, necessary for certain kinds of hardware-software interactions (keyboard expander, etc.) |
| LCD-D12 : RGB666 data | LCD-D11 : RGB666 data | TWI2-SDA : two-wire serial bus 2 (I2C) | TWI2-SCK(*) : two-wire serial bus 2 (I2C) |
| LCD-D14 : RGB666 data | LCD-D13 : RGB666 data | CSIPCK : CMOS serial interface | CSICK : CMOS serial interface, can be used for attaching a serial camera sensor |
| LCD-D18 : RGB666 data | LCD-D15 : RGB666 data | CSIHSYNC : CMOS serial interface | CSIVSYNC : CMOS sync |
| LCD-D20 : RGB666 data | LCD-D19 : RGB666 data | CSID0 : CMOS serial interface | CSID1 : CMOS serial interface |
| LCD-D22 : RGB666 data | LCD-D21 : RGB666 data | CSID2 : CMOS serial interface | CSID3 : CMOS serial interface |
| LCD-CLK : RGB666 clock | LCD-D23 : RGB666 data | CSID4 : CMOS serial interface | CSID5 : CMOS serial interface |
| LCD-VSYNC : vertical sync for LCD screen | LCD-HSYNC : horizontal sync for LCD | CSID6 : CMOS serial interface | CSID7 : CMOS serial interface |
| GND : ground | LCD-DE : RGB666 data | GND : ground | GND : ground |

(*)The XIO GPIO pins are provided by an I2C Expander at address 0x38 on the TWI bus 2, as such, this address is not available on bus 2.

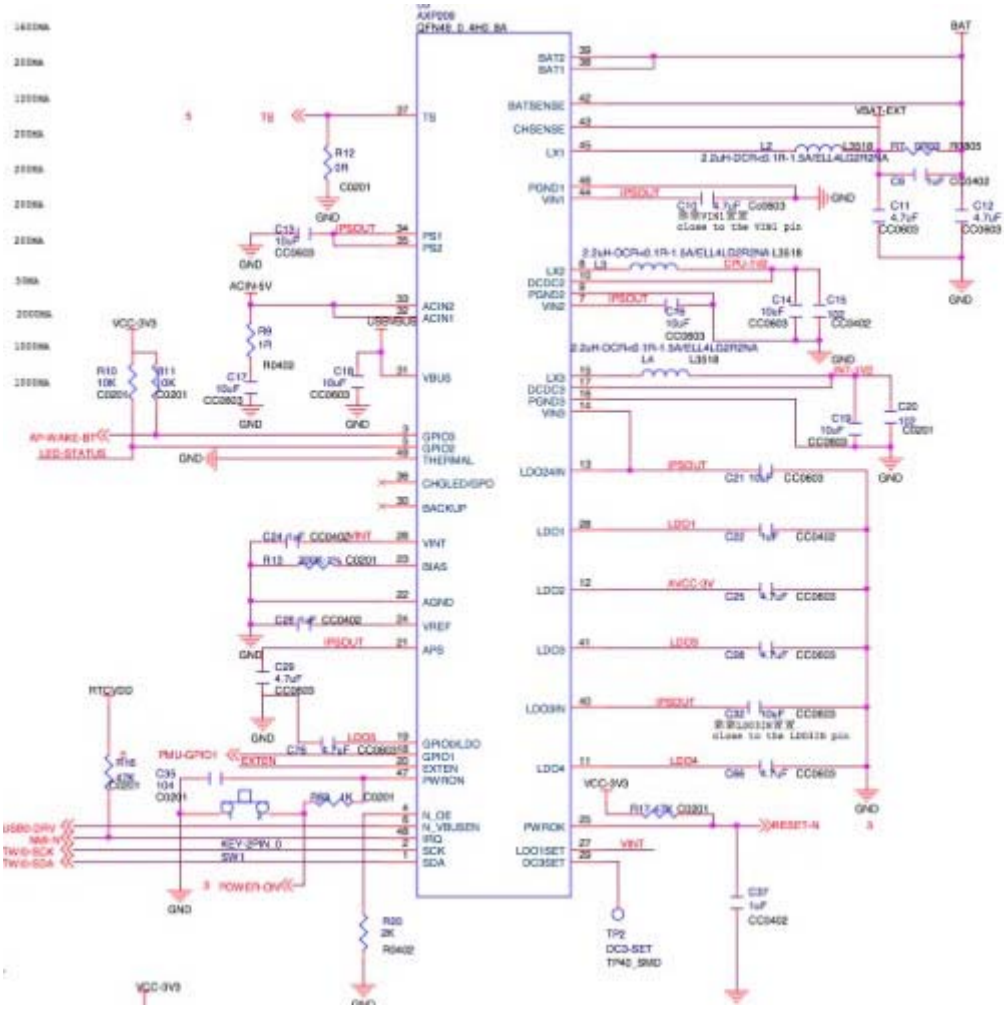
## Mechanical Drawing




Our git repo for CHIP hardware has a mechanical drawing

## Open Source Hardware: Where To Get It

CHIP is open source hardware. Here's where you can get all the data you need to make, modify, or learn about your own CHIP. Visit the CHIP Hardware git repository.



# Making Stuff

CHIP is more than a cool, small, inexpensive computer. It's a complete system for building projects that require remote control, network connectivity, and physical interfacing with people and the environment. CHIP's pin headers have all the connections to make this happen. An annotated diagram of the pin headers can be found in the hardware section of this manual.

## GPIO

GPIO provides basic digital connections to the physical world to create physical products with CHIP. These pins can act as 'reads' or 'writes', for example, to sense switch positions or turn an LED on or off.

CHIP's most easily available IO pins are the "XIO" pins on header U14. This is the "GPIO eXpander" that uses an I2C bus to create eight (8) convenient pins for GPIO. These use address `0x38` on the TWI bus 2. Other pins are available for GPIO if more than eight are needed.

#### READ AND WRITE FROM COMMAND LINE

CHIP has several General Purpose Input/Output (GPIO) pins available for you to build around. If you want to access them in a very primitive way, just to confirm their existence, here's some things to try.

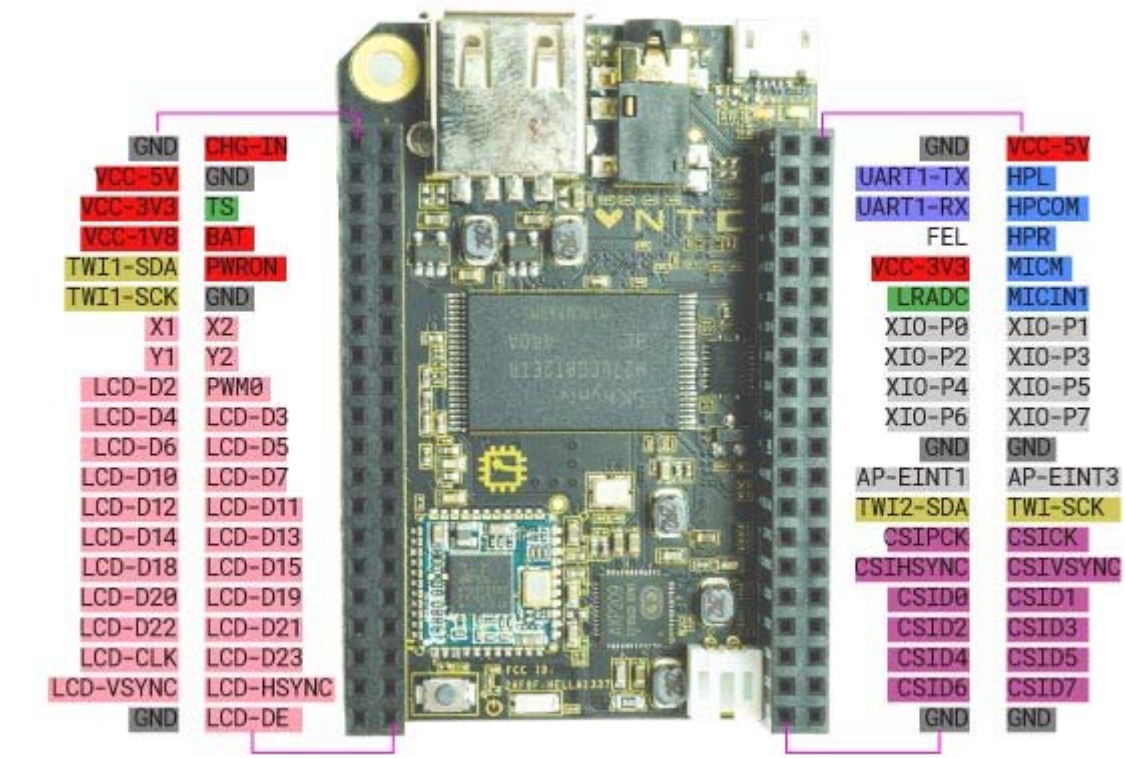
#### REQUIREMENTS

- CHIP
- Jumper Wire
- LED

- SSH or serial connection to CHIP or
- Monitor and keyboard

#### HOW YOU SEE GPIO

There are eight (8) GPIO pins always available for connecting CHIP to the sense-able world. If you orient CHIP with the USB connector pointed up, you'll find the GPIO pins in the middle of the right header, U14, Pins 13-20, labeled XIO-P0 to P7:




#### GPIO LIBRARY

There is an excellent library for working with GPIO and CHIP's IO busses, made available by our wonderful community. Check out the Adafruit_Python_GPIO and the CHIP_IO libraries. These make it very easy to get started with making things with CHIP.

#### KERNEL 4.3 VS 4.4 GPIO - HOW TO TELL THE DIFFERENCE

For various reasons related to the community nature of Linux development, the GPIO expander pin numbers are different between CHIP OS kernels 4.3 and 4.4. What follows is a very technical discussion of the GPIO access. If you just want to start making stuff and don't need low-level information, you might just want to skip this section and go straight to the python library.

If you are developing applications on CHIP that use GPIO pins and you would like consistent behavior between the kernel versions, you need to know how to find out the base value for the GPIO values. It may be enough for you to know that the GPIO expander pins start at *408* on 4.3, *1016* on 4.4.11, and *1013* on 4.4.13-ntc-mlc, **however, it would be ideal to calculate this in your application to truly future-proof for future kernels.**

If you look in the directory `/sys/class/gpio`, you'll find two directories starting with `gpio`: `gpiochip0` and either `gpiochip408` (4.3) or `gpiochip1016` (4.4.11) or `gpiochip1013` (4.4.13-ntc-mlc).

The `408` or `1016` or `1013` are the bases for the expander pins. If you want to definitively find out what the base is using code, you should

```
cat gpiochip*/label
cat gpiochip*/ngpio
cat gpiochip*/base
```

The `label` you are interested in is the value `pcf8574a` which is the device that provides GPIO expansion. This provides the number of GPIO as returned by `ngpio`. The first expander pin starts with the `base` value. If you parse all these values and apply to your code,

you can setup your application to be kernel-agnostic for GPIO access.

Here is a python script that demonstrates this in a gist

Here is a bash script to compute the base (courtesy of bbs user @fordsfords)

```
LABEL_FILE=`grep -l pcf8574a /sys/class/gpio/*/*label` BASE_FILE=`dirname $LABEL_FILE`/base
BASE=`cat $BASE_FILE`
```

Finally, you can view a practical example of calcualting the “xio base” in the CHIP_IO library common.c code.

#### HOW THE SYSTEM SEES GPIO

There is a `sysfs` interface available for the GPIO. This just means you can access the GPIO states in a file-system-like manner. For example, you can reference XIO-P0 using this path:

```
/sys/class/gpio/gpio408/
```

The number is somewhat unfortunate, since the `sysfs` names do not match the labels on our diagram! But is not too hard to translate. Pins XIO-P0 to P7 linearly map to `gpio408` to `gpio415` on kernel 4.3 and `gpio1016` to `gpio1023` on kernel 4.4.11. For kernel 4.4.13-ntc-mlc the range is `gpio1013` to `gpio1019`. See above to learn more about that distinction.

#### SOME GPIO SWITCH ACTION

These lines of code will let us read values on pin XIO-P7. First, we tell the system we want to listen to this pin:

```
  #4.3
sudo sh -c 'echo 415 > /sys/class/gpio/export'
#4.4.11
sudo sh -c 'echo 1023 > /sys/class/gpio/export'
#4.4.13-ntc-mlc
sudo sh -c 'echo 1019 > /sys/class/gpio/export'
```

View the mode of the pin. It should return “in”:

```
  #4.3
cat /sys/class/gpio/gpio415/direction
#4.4.11
cat /sys/class/gpio/gpio1023/direction
#4.4.13-ntc-mlc
cat /sys/class/gpio/gpio1019/direction
```

Connect a jumper wire between Pin 20 (XIO-P7) and Pin 39 (GND). Now use this line of code to read the value:

```
  #4.3
cat /sys/class/gpio/gpio415/value
#4.4.11
cat /sys/class/gpio/gpio1023/value
#4.4.13-ntc-mlc
cat /sys/class/gpio/gpio1019/value
```

#### SOME GPIO OUTPUT

You could also change the mode of a pin from “in” to “out”

```
  #4.3
sudo sh -c 'echo out > /sys/class/gpio/gpio415/direction'
#4.4.11
sudo sh -c 'echo out > /sys/class/gpio/gpio1023/direction'
#4.4.13-ntc-mlc
sudo sh -c 'echo out > /sys/class/gpio/gpio1019/direction'
```

Now that it's in output mode, you can write a value to the pin:

```
  #4.3
sudo sh -c 'echo 1 > /sys/class/gpio/gpio415/value'
#4.4.11
sudo sh -c 'echo 1 > /sys/class/gpio/gpio1023/value'
#4.4.13-ntc-mlc
sudo sh -c 'echo 1 > /sys/class/gpio/gpio1019/value'
```

If you attach an LED to the pin and ground, the LED will illuminate according to your control messages.

#### ENOUGH IO

When you are done experimenting, you can tell the system to stop listening to the gpio pin:

```
  #4.3
sudo sh -c 'echo 415 > /sys/class/gpio/unexport'
#4.4.11
sudo sh -c 'echo 1023 > /sys/class/gpio/unexport'
#4.4.13-ntc-mlc
sudo sh -c 'echo 1019 > /sys/class/gpio/unexport'
```

#### LEARN MORE

You can learn more about GPIO and Linux here:

---

# Python Library

There is a well-maintained python library that works for 4.3 and 4.4 kernels available here. This is analogous to the RPi.GPIO library, but is designed for CHIP. It's an excellent place for quickly working with GPIO and PWM on CHIP.

---

# GPIO Types

There are many types of sensors that can be used with GPIO:

#### SWITCHES

Switches provide on/off state input from the physical world to your computer. You can use the commandline interface to listen to switch values. A python library was created for the ChippyRuxpin project if you need a higher-level example in python.

#### LEDS

LEDs can be illuminated and turned off using the commandline interface. Refer to the ChippyRuxpin project on a good example on how to manipulate the commandline using python.

#### RELAYS

Relays are special hardware bridges used to switch higher voltage electronics, protecting CHIP from the high voltages that would destroy it. Using a relay board is programmatically no different from using switches.

---

# Expanding GPIO

If you don't need to drive an LCD, you can use those pins for more, faster GPIO if you want to. These are the pins numbered 18-40 on U13 and 27-40 on U14 to act as GPIO to increase the number of available GPIO pins.

#### FINDING GPIO PIN NAMES

The process for reading the pins using sysfs are the same as the documentation above. You can calculate the Pin name using the Allwinner R8 Datasheet, starting on page 18.

The letter index is a multiple of 32 (where A=0), and the number is an offset. For example PD4 is `LCD_D4` so

```
D=3
(32*3)+4 = 100
```

Therefore, listening to LCD_D4 in sysfs would begin with

```
sudo sh -c 'echo 100 > /sys/class/gpio/export'
```

---

# Analog to Digital Conversion

Pin 9 on header U14 provides a link for low resolution analog to digital conversion (ADC). There is no driver for this link yet. ADC is used to read continuous sensors (temperature, pots, FSR, photoresistor, etc)

---

# 1 Wire

Only available in CHIP OS 4.4 and above, the 1 Wire serial protocol data is accessible from the sysfs device. Find your one wire devices with

```
ls /sys/bus/w1/devices/2*/eeprom
```

The `*` is there because your eeprom device will register a unique UUID number with C.H.I.P., so the `ls` command will show you all available one wire devices.

---

# UART

UART connections can be made using the UART connections on header U14. It allows serial connection which can be used to:

- Connect from another machine to CHIP via remote serial console
- Use CHIP to connect to a microcontroller or other peripheral which has a serial interface (see below).

#### SERIAL CONNECTION TO A MICROCONTROLLER OR OTHER PERIPHERAL

First stop *Getty* to avoid most shell stdin/stdout to interfere with UART. Yes most, saddly kernel messages will still go though and there is currently no way to stop them (and they may happen from time to time after boot):

$ sudo systemctl stop serial-getty@ttyS0.service

You may even disable completely that service so that it remains off after reboot but then you won't be able to use the serial console:

$ sudo systemctl mask serial-getty@ttyS0.service

You can then use UART as a standard serial port from `/dev/ttyS0`. Below is a little sample experiment to test your UART port:

#### EXAMPLE USAGE

Connect UART Tx to Rx directly via a cable. So all outputs will come as inputs.

Install PySerial (we'll have to run our process as `root` to get access to the port):

$ sudo pip install pyserial

Write this little script and save it for example as `test.py`:

```
import serial
import time
with serial.Serial('/dev/ttyS0') as ser:
for i in range(10):
    ser.write([i])
    print(bytearray(ser.read())[0])
    time.sleep(1)
```

Finally let's run it:

```
$ sudo python test.py
1
2
3
...
99
```

---

# PWM

Pulse Width Modulation can be used to control motors and other devices. It is possible to use GPIO pins to drive motors, but they generally are not fast enough for robust and smooth control. PWM can be accessed through an `sysfs` protocol.

---

# I2C

I2C (Inter-Integrated Circuit) can be accessed through a `sysfs` protocol using the debian i2c-tools. In the terminal, use

```
sudo apt-get install i2c-tools
```

Note that the "XIO GPIO" pins are provided by an I2C expander at address 0x38 on the TWI bus 2, so that address cannot be used on bus 2.

---

# LCD Monitor Support

Using the numerous LCD header pins, a color touchscreen panel can be directly implemented on CHIP.

---

# Project Examples

Projects coming soon!

# Flash CHIP With an OS

You might want (or need) to completely re-flash your CHIP with a different operating system. We've made it really easy to do this by embedding the entire process in a browser-based application. Just hook CHIP up to your computer, fire up a browser, and flash your CHIP

## Things you will need

- C.H.I.P.
- Standard-USB to micro-USB connector
- Thin Paper clip (a jumper wire works too)
- Separate computer with Chrome or Chromium browser

## Instructions

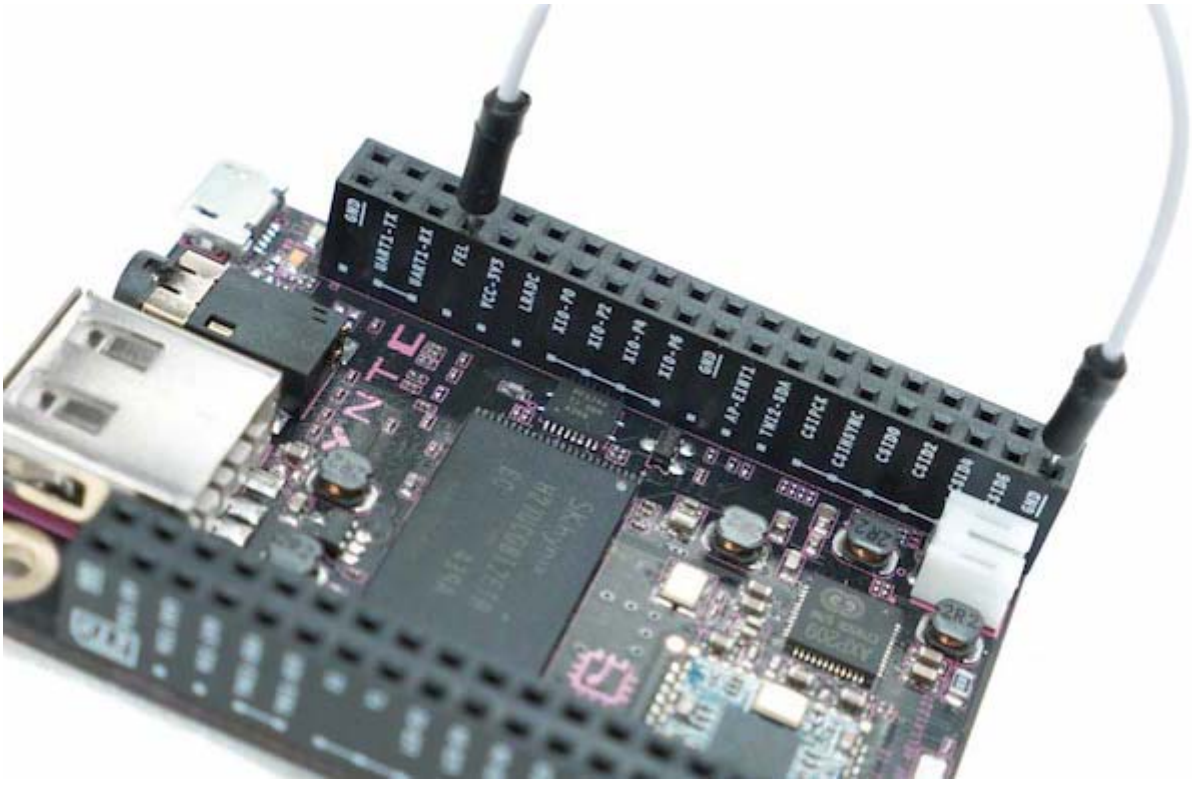
If you don't have the Google Chrome or the open-source Chromium browser on your other computer, install it by following the preceding links.

Ok, good. Now that you have installed the browser, you can visit flash.getchip.com in Chrome or Chromium and follow all the instructions. If you are using a computer with USB3 ports, it's suggested that you attach a USB2-compliant hub and connect your CHIP to the hub, instead of directly to the USB3 port.

It's possible to run the entire operation online. There are also options for downloading the OS image to your computer's harddrive, then flashing your CHIP with no additional need for internet access.

#### FEL MODE

Here is a photo (which may be clearer than the animation in the web flasher) which shows where to place your jumper wire or paper clip:



*Note: this jumper needs to be present only when you connect CHIP to power*. If for some reason the wire becomes disconnected after you have powered CHIP, there is no problem or need to panic.

For more information on OS-specific issues, see here.

---

# The SDK Way

You may not want to use the browser-based flashing procedure. If this is the case, or you need additional tools, you can flash using the CHIP SDK

---

# Web Flasher OS-Specific Issues

Before you try anything else, try using a different USB cable. Many cables are charging-only, or do not support high bandwidth and will cause flashing to fail.

#### WINDOWS-SPECIFIC

- You must install drivers to be able to talk with C.H.I.P.
- Reboot after installing drivers on previous versions (<10) of Windows.

Unfortunately, due to the nature of how Windows manages drivers, the flashing procedure will likely fail the first time you use it. When that happens, try completely closing and reopening your browser. Depending on your version of windows, this might happen twice, once when waiting for FEL, and then again waiting for Fastboot.

#### TROUBLESHOOTING THE WEB FLASHER

- Try using a USB2 port (USB3 ports have issues).
- Try passing through a USB2 hub if using a USB3 port.
- Try a different USB cable. They often are bad.
- Try turning off antivirus software.
- If you get stuck “Waiting for Fastboot” and the above options don’t work, you should be able to install a “headless no fastboot” image. However, it will take quite a bit longer, and the Operating System won’t have a GUI.

#### MACOS SPECIFIC

- There are some times where using USB3 ports will cause the flashing to fail. If you can, try using a USB2 port, not a USB3. Recent Macs have only USB3 ports. If you find yourself with a modern Mac, try using a USB2 hub in your USB3 port and plug C.H.I.P. into that.
- If you get stuck “Waiting for Fastboot” and the above options don’t work, you should be able to install a “headless no fastboot” image. However, it will take quite a bit longer, and the Operating System won’t have a GUI.
- OS X El Capitan has been known to have issue with the flashing process. If a new cable or USB2 hub does not work and you are able to, upgrade to macOS Sierra.

#### LINUX-SPECIFIC

Linux requires permissions to write to C.H.I.P. when its plugged into your computer. Chrome (or Chromium) does not have these permissions, so you need to explicitly create them before you’ll be able to use the web flasher .

#### ON UBUNTU:

You need to paste the following into a terminal:

```
sudo usermod -a -G dialout ${USER}
sudo usermod -a -G plugdev ${USER}

# Create udev rules
echo -e 'SUBSYSTEM=="usb", ATTRS{idVendor}=="1f3a", ATTRS{idProduct}=="efe8", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip"
SUBSYSTEM=="usb", ATTRS{idVendor}=="18d1", ATTRS{idProduct}=="1010", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip-fastboot"
SUBSYSTEM=="usb", ATTRS{idVendor}=="1f3a", ATTRS{idProduct}=="1010", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip-fastboot"
SUBSYSTEM=="usb", ATTRS{idVendor}=="067b", ATTRS{idProduct}=="2303", GROUP="plugdev", MODE="0660" SYMLINK+="usb-serial-adapter"
' | sudo tee /etc/udev/rules.d/99-allwinner.rules
sudo udevadm control --reload-rules
```

Then logout and log back in.

For the curious:

- ${USER}: outputs your username
- dialout: gives non-root access to serial connections
- plugdev: allows non-root mounting with pmount

The udev rules then map the usb device to the groups.

For more information, check the systems group page on debian.org.

**USB3 Issues** * If you have any issues, try using a USB2 port and not a USB3 one, or try using a USB2 hub in your USB3 port and plug C.H.I.P. into that. * If you get stuck “Waiting for Fastboot” and the above options do not work, you should be able to install a “headless no fastboot” image. However, it will take quite a bit longer, and the Operating System won’t have a GUI.

**Caveat** In rare cases, you may have an issue with your computer putting C.H.I.P. into auto-suspend mode. Here is an example on how to fix this problem:

```
apt-get install laptop-mode-tools
#### edit /etc/laptop-mode/conf.d/runtime-pm.conf, uncomment/change AUTOSUSPEND_RUNTIME_DEVID_BLACKLIST
#### add all fel devices to the blacklist:
AUTOSUSPEND_RUNTIME_DEVID_BLACKLIST="1f3a:efe8"
reboot
```

# Advanced

For those interested in building with a stripped-down version of an operating system, or looking to customize CHIP from the command line, we have several tutorials that describe how to setup CHIP with more depth.

## Installing C.H.I.P. SDK

CHIP-SDK has everything needed to develop software for C.H.I.P. Most importantly, if you want to load an operating system onto CHIP, the only supported way is to do this from a virtual machine. Given that the virtual machine runs Ubuntu, it’s pretty safe to say that Ubuntu users can flash without the virtual machine.

#### REQUIREMENTS

- Computer running OS X 10.10+, Ubuntu 14.04+, or Windows 7+
- At least 1 GB free RAM, up to 40 GB of disk space may be used
- Software: VirtualBox, Vagrant, git, terminal

#### SOFTWARE SETUP

There are several required software pieces to get the CHIP SDK virtual machine running.

#### INSTALL VIRTUALBOX AND EXTENSIONS

- Get the installer for Virtual Box
- Install the Oracle VM VirtualBox Extension Pack.
- If you are using Windows, you need to add the VirtualBox installation directory to your PATH.
- In case of an Ubuntu host: add your user to the vboxusers group!

#### INSTALL VAGRANT

Install Vagrant from the Vagrant site. Alternatively, if OS X, you can use the homebrew package manager: brew install caskroom/cask/brew-cask brew cask install vagrant

#### INSTALL GIT

Installation of Git depends on your operating system:

- Windows: direct to download
- Debian Linux: `sudo apt-get install git`
- OS X homebrew: `brew install git`

#### CLONE THE CHIP-SDK REPOSITORY AND BOOT THE VIRTUAL MACHINE

Assuming you have git in your PATH, open up a terminal and type:

```
git clone https://github.com/NextThingCo/CHIP-SDK
```

and start up the virtual machine:

```
cd CHIP-SDK
vagrant up
```

#### LOGIN TO VIRTUAL MACHINE

In the same shell on the host type the following:

```
 vagrant ssh
```

If everything went well you should see the following prompt:

```
vagrant@vagrant-ubuntu-trusty-32:~$
```

#### ALL THE COMMANDS AT ONCE

Here's all the commands in one place:

```
git clone https://github.com/NextThingCo/CHIP-SDK
cd CHIP-SDK
vagrant up
vagrant ssh
```

Congratulations! Now you're ready to Flash a C.H.I.P. from your SDK!

#### TROUBLESHOOTING FLASHING FROM THE SDK

Here are a few possible problems.

#### SHARED FOLDER OUT OF SYNC

In case you run into trouble because the kernel in the VM was updated and the shared vagrant folder can no longer be mounted, update the guest additions by typing the following in the CHIP-SDK directory on the host:

```
vagrant plugin install vagrant-vbguest
```

This blog post has some more tips on keeping additions in sync.

#### INVALID STATE

If you get an error like:

```
error: The guest machine entered an invalid state while waiting for it to boot.
```

This probably means your version of VirtualBox needs updating and/or needs the Extension Pack. Update as necessary and try `vagrant up` again.

#### COULDN'T FIND FILE

If you get the error:

```
error: Couldn't open file /Volumes/Satellite/gitbins/CHIP-SDK/base
```

that means you didn't cd CHIP-SDK. Very basic, perhaps, but late nights sometimes need that bump!

#### UPDATING THE CHIP-SDK VIRTUAL MACHINE

You may have been working with CHIP for a while now, and you want to updated your SDK. It's only slightly more involved than sync'ing with the git repo; you have to update the virtual machine, too.

#### REQUIREMENTS

- Computer running OS X 10.10+, Ubuntu 14.04+, or Windows 7+
- Existing installation of CHIP-SDK

#### HOW TO UPDATE

Just follow these steps:

On your host operating system, pull the latest changes from our Git repository:

```
cd ~/CHIP-SDK
git pull
```

Make sure the virtual machine is shut down and update it:

```
vagrant halt
vagrant provision
```

Now you can boot the virtual machine and ssh into it:

```
vagrant up
vagrant ssh
```

Once you see the trusty prompt, your CHIP SDK virtual machine is ready to use:

```
vagrant@vagrant-ubuntu-trusty-32:~$
```

#### ALL THE COMMANDS AT ONCE

Here's all the commands in one place:

```
cd ~/CHIP-SDK
git pull
vagrant halt
vagrant provision
vagrant up
vagrant ssh
```

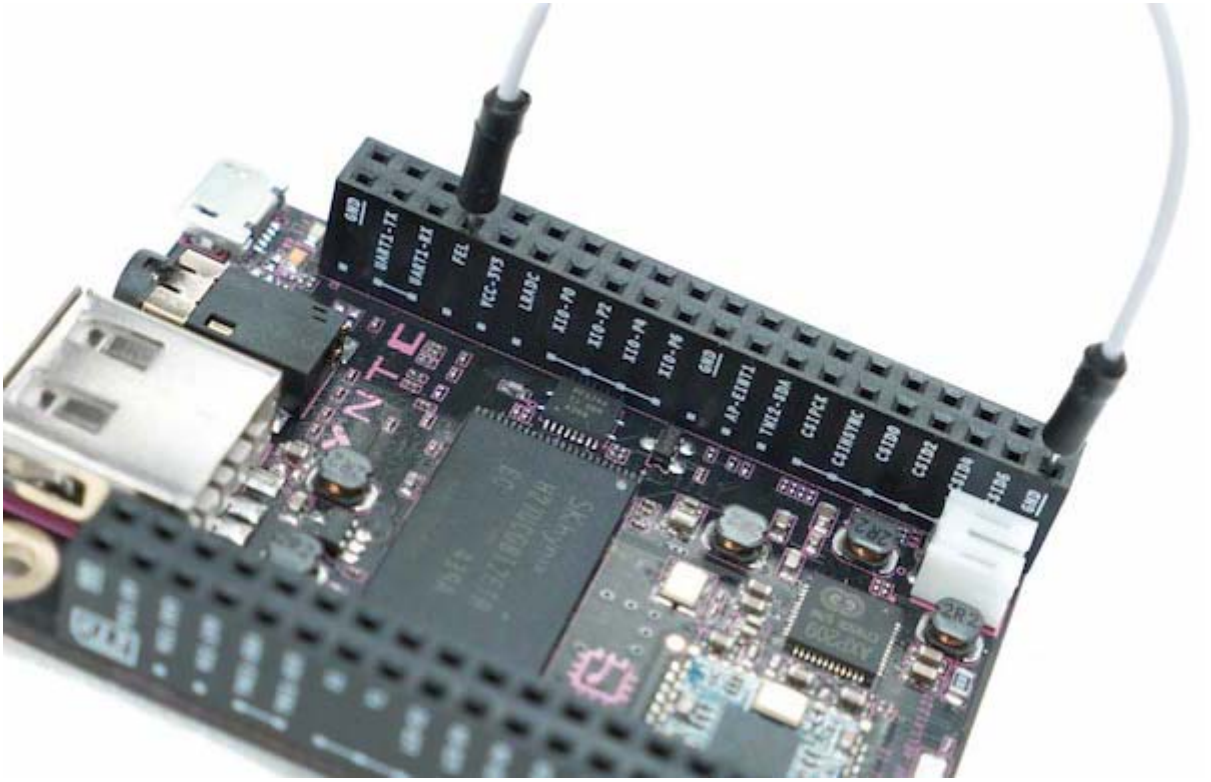
---

# Flash CHIP Firmware

Now that the virtual machine and SDK are running and configured, you can connect CHIP to your computer and give it an operating system. If you want to flash using a native Ubuntu installation, read how to prepare Ubuntu to flash

#### PREPARE CHIP FOR FLASHING

Prepare CHIP with a jumper wire connecting Pin 7 and Pin 39 on header U14 (FEL pin and GND). Here's a reference image that labels the headers and pins:




*Note: this jumper needs to be present only when you connect CHIP to power*. If for some reason the wire becomes disconnected after you have powered CHIP, there is no problem or need to panic.

Now connect CHIP to your computer with a micro-USB->USB-A cable. The power LED will illuminate.

#### OPTION 1: FLASH WITH NTC BUILDROOT OS

Buildroot is a lean operating system, and does not have a package manager to install software. You can add additional software before you flash CHIP by customizing buildroot.

```
cd ~/CHIP-tools
./chip-update-firmware.sh -f
```

The `-f` option means "fastboot." If you have problems flashing, particularly on Windows or OS X, you can run `./chip-update-firmware.sh` to disable fastboot flashing.

During flashing, the terminal will fill with messages. If successful, you'll see C.H.I.P. run through a hardware test, with the answers being 'OK'. If C.H.I.P. is 'OK', you can remove the jumper wire. Here is a sample successful output.

#### OPTION 2: FLASH WITH DEBIAN

If you want to flash CHIP with the debian OS with no window manager or GUI

```
cd ~/CHIP-tools
./chip-update-firmware.sh -d -f
```

The `-f` option means "fastboot." If you have problems flashing, particularly on Windows or OS X, you can disable fastboot by leaving off the -f option: `./chip-update-firmware.sh -d`. Here is a sample successful output.

#### OPTION 3: FLASH WITH CHIP OPERATING SYSTEM

If you want to flash CHIP with the complete CHIP Operating System with a desktop manager and GUI:

```
cd ~/CHIP-tools
./chip-update-firmware.sh -d -b stable-gui -f
```

During flashing, the terminal will fill with messages. If successful, you'll see C.H.I.P. run through a hardware test, with the answers being 'OK'. If C.H.I.P. is 'OK', you can remove the jumper wire. Here is a sample successful output. Because of filesize, the "gui" option must also include the `-f` fastboot option. Windows and OS X are not yet supported as flashing hosts.

#### CONNECT TO CHIP AND DO SOMETHING

If everything went OK, you can now power up your CHIP again and connect via serial as a USB gadget:

```
screen /dev/ttyACM0 115200
```

You can login to CHIP as `chip` or `root` using the password `chip`.

and even test the hardware:

```
sudo hwtest
```

#### CUSTOMIZE BUILDROOT

Buildroot is a tool for building and cross-compiling a linux distribution that only has what you need. Setting up buildroot requires either a virtual machine or a computer running Ubuntu OS, setup for flashing.

#### MODIFY AND BUILD

C.H.I.P.-buildroot is used to build buildroot and the linux kernel. Its Makefile operates on a `.config` file which specifies options to include in the build. The `.config` lives in the repository's root, whereas the one for the linux kernel is: ./board/chip/linux.config/

First, clone the buildroot repot and create the default config file with:

```
git clone https://github.com/NextThingCo/CHIP-buildroot
cd CHIP-buildroot
make chip_defconfig
```

This will copy the the `chippro_defconfig` file as `.config` in the root of the repository. Other default config targets for other hardware can be found in the `config` subdirectory. You can, of course, create your own config files and use them later.

Customize the buildroot using

```
make nconfig
```

For Linux (which will modify the linux.config under board/nextthing/chip/):

```
make linux-nconfig
```

Now

```
make
```

from the buildroot repository root. This will cross-compile linux/buildroot for C.H.I.P. Pro. The targets wind up in the ./output/images directory. If you make changes to your config files, you can just `make` again without a `make clean`.

This will take a while, maybe an hour. When finished, flash CHIP with the script:

```
cd ~/CHIP-tools
BUILDROOT_OUTPUT_DIR=../CHIP-buildroot/output ./chip-fel-flash.sh
```

Unless you changed the users or passwords, you can login to CHIP as `chip` or `root` using the password `chip`.

#### BUILDROOT CHEAT SHEET

Here's a very terse explanation of how the make commands work in CHIP-buildroot:

```
CHIP-buildroot/
├── make chip_defconfig
│   ├── apply pre-existing chip-specific configuration to buildroot
│   └── apply pre-existing chip-specific configuration to kernel
├── make chippro_defconfig
│   ├── apply pre-existing chippro-specific configuration to buildroot
│   └── apply pre-existing chippro-specific configuration to kernel
├── make linux-nconfig
│   └── make realtime changes to currently applied kernel defconfig
└── make nconfig
    └── make realtime changes to currently applied buildroot defconfig
```

The `defconfig` is a sort of macro that loads a suggested starting point for a buildroot OS, for packages (nconfig) and kernel (linux-nconfig).

Use `make nconfig` to add packages for extending the capabilities, like you might with a package manager in debian.

The `make linux_nconfig` command modifies the kernel for specific drivers or hardware additions.

#### APPENDIX

Sample outputs are provided in this appendix so you can more easily troubleshoot or proceed with confidence when flashing CHIP with firmware.

#### BUILDROOT OUTPUT

Sample output from flashing Buildroot to CHIP looks like:

```
ROOTFS_URL=http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images
BUILD=71
BR_URL=http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images
BR_BUILD=71
/home/doge/gits/CHIP-tools/.firmware/images/rootfs.ubi exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/rootfs.ub
MD5: 90315ca1fb8ff95fc6878ce8126bdf02
S3_MD5: 6d59af4a0f673e1d61147e4a06dd7ba8
md5sum differs
--2015-10-21 15:59:16--  http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/rootfs.ubi
Resolving opensource.nextthing.co.s3.amazonaws.com (opensource.nextthing.co.s3.amazonaws.com)... 54.231.176.13
Connecting to opensource.nextthing.co.s3.amazonaws.com (opensource.nextthing.co.s3.amazonaws.com)|54.231.176.13|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 54525952 (52M) [binary/octet-stream]
Saving to: '/home/doge/gits/CHIP-tools/.firmware/images/rootfs.ubi'

100%[======================================>] 54,525,952  1.83MB/s   in 29s

2015-10-21 15:59:45 (1.82 MB/s) - '/home/doge/gits/CHIP-tools/.firmware/images/rootfs.ubi' saved [54525952/54525952]

/home/doge/gits/CHIP-tools/.firmware/images/sun5i-r8-chip.dtb exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/su
MD5: de0beb674eeb382901251febfbf1cf9b
S3_MD5: de0beb674eeb382901251febfbf1cf9b
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/sunxi-spl.bin exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/sunxi
MD5: dd3f9c9c0984a6c1d7cdca2921f6f448
S3_MD5: dd3f9c9c0984a6c1d7cdca2921f6f448
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/uboot-env.bin exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/uboot
MD5: 6f2b79a781f9f490911012ec3aa653e9
S3_MD5: 6f2b79a781f9f490911012ec3aa653e9
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/zImage exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/zImage
MD5: 0d35ad764564a2cee9281715823597a2
S3_MD5: 0d35ad764564a2cee9281715823597a2
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/u-boot-dtb.bin exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/buildroot/stable/71/images/u-bo
MD5: 97340d221bcbcc8f0bf27e26adc26f0a
S3_MD5: 97340d221bcbcc8f0bf27e26adc26f0a
```

```
file already downloaded
BUILDROOT_OUTPUT_DIR = /home/doge/gits/CHIP-tools/.firmware
== preparing images ==
/home/doge/gits/CHIP-tools/spl-image-builder -d -r 3 -u 4096 -o 1664 -p 16384 -c 1024 -s 64 /home/doge/gits/CHIP-tools/.firmware/images/sunxi-spl.bin /tmp/chipflashqV
filesize= 3573504
PADDED_SPL_SIZE=0x000000c6
35+1 records in
36+0 records out
589824 bytes (590 kB) copied, 0.00082507 s, 715 MB/s
12+0 records in
12+0 records out
196608 bytes (197 kB) copied, 0.0176519 s, 11.1 MB/s
Image Name:   flash CHIP
Created:      Wed Oct 21 15:59:46 2015
Image Type:   ARM Linux Script (uncompressed)
Data Size:    736 Bytes = 0.72 kB = 0.00 MB
Load Address: 00000000
Entry Point:  00000000
Contents:
   Image 0: 728 Bytes = 0.71 kB = 0.00 MB
== upload the SPL to SRAM and execute it ==
waiting for fel...OK
== upload spl ==
== upload u-boot ==
== upload u-boot script ==
== upload ubi ==
100% [============================================================]
== execute the main u-boot binary ==
== write ubi ==
flashing.................OK
login... OK
password... OK
poweroff... OK
```

**DEBIAN OUTPUT**

Sample output from a successful Debian output:

```
debian selected
ROOTFS_URL=http://opensource.nextthing.co.s3.amazonaws.com/chip/debian/stable/37
BUILD=37
BR_URL=http://opensource.nextthing.co/chip/buildroot/stable/71/images
BR_BUILD=71
/home/doge/gits/CHIP-tools/.firmware/images/rootfs.ubi exists... comparing to http://opensource.nextthing.co.s3.amazonaws.com/chip/debian/stable/37/rootfs.ubi
MD5: 6d59af4a0f673e1d61147e4a06dd7ba8
S3_MD5: 90315ca1fb8ff95fc6878ce8126bdf02
md5sum differs
--2015-10-21 16:06:36--  http://opensource.nextthing.co.s3.amazonaws.com/chip/debian/stable/37/rootfs.ubi
Resolving opensource.nextthing.co.s3.amazonaws.com (opensource.nextthing.co.s3.amazonaws.com)... 54.231.160.10
Connecting to opensource.nextthing.co.s3.amazonaws.com (opensource.nextthing.co.s3.amazonaws.com)|54.231.160.10|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 245366784 (234M) [binary/octet-stream]
Saving to: ‘/home/doge/gits/CHIP-tools/.firmware/images/rootfs.ubi’

100%[======================================>] 245,366,784 1.27MB/s   in 2m 11s

2015-10-21 16:08:48 (1.78 MB/s) - ‘/home/doge/gits/CHIP-tools/.firmware/images/rootfs.ubi’ saved [245366784/245366784]

/home/doge/gits/CHIP-tools/.firmware/images/sun5i-r8-chip.dtb exists... comparing to http://opensource.nextthing.co/chip/buildroot/stable/71/images/sun5i-r8-chip.dtb
MD5: de0beb674eeb382901251febfbf1cf9b
S3_MD5: de0beb674eeb382901251febfbf1cf9b
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/sunxi-spl.bin exists... comparing to http://opensource.nextthing.co/chip/buildroot/stable/71/images/sunxi-spl.bin
MD5: dd3f9c9c0984a6c1d7cdca2921f6f448
S3_MD5: dd3f9c9c0984a6c1d7cdca2921f6f448
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/uboot-env.bin exists... comparing to http://opensource.nextthing.co/chip/buildroot/stable/71/images/uboot-env.bin
MD5: 6f2b79a781f9f490911012ec3aa653e9
S3_MD5: 6f2b79a781f9f490911012ec3aa653e9
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/zImage exists... comparing to http://opensource.nextthing.co/chip/buildroot/stable/71/images/zImage
```

```
MD5: 0d35ad764564a2cee9281715823597a2
S3_MD5: 0d35ad764564a2cee9281715823597a2
file already downloaded
/home/doge/gits/CHIP-tools/.firmware/images/u-boot-dtb.bin exists... comparing to http://opensource.nextthing.co/chip/buildroot/stable/71/images/u-boot-dtb.bin
MD5: 97340d221bcbcc8f0bf27e26adc26f0a
S3_MD5: 97340d221bcbcc8f0bf27e26adc26f0a
file already downloaded
BUILDROOT_OUTPUT_DIR = /home/doge/gits/CHIP-tools/.firmware
== preparing images ==
/home/doge/gits/CHIP-tools/spl-image-builder -d -r 3 -u 4096 -o 1664 -p 16384 -c 1024 -s 64 /home/doge/gits/CHIP-tools/.firmware/images/sunxi-spl.bin /tmp/chipflashUo
filesize= 3573504
PADDED_SPL_SIZE=0x000000c6
35+1 records in
36+0 records out
589824 bytes (590 kB) copied, 0.00181383 s, 325 MB/s
12+0 records in
12+0 records out
196608 bytes (197 kB) copied, 0.0164913 s, 11.9 MB/s
Image Name:   flash CHIP
Created:      Wed Oct 21 16:08:49 2015
Image Type:   ARM Linux Script (uncompressed)
Data Size:    736 Bytes = 0.72 kB = 0.00 MB
Load Address: 00000000
Entry Point:  00000000
Contents:
   Image 0: 728 Bytes = 0.71 kB = 0.00 MB
== upload the SPL to SRAM and execute it ==
waiting for fel...OK
== upload spl ==
== upload u-boot ==
== upload u-boot script ==
== upload ubi ==
100% [============================================================]
== execute the main u-boot binary ==
== write ubi ==
flashing.........................OK
login... OK
password... OK
poweroff... OK
```

**FAILURE**

There are a couple common errors that occur when flashing.

The first is a that CHIP is not in `fel` mode, ready to receive firmware. There are three possible reasons for this:

- You already successfully flashed CHIP, and haven't disconnected the USB cable from your computer.
- The jumper wire between Pins 7 & 39 is either not present, loose, or the jumper is in the wrong holes.
- There is a problem with the USB cable.

You'll know this is the problem when you see this error in the terminal window:

```
== upload the SPL to SRAM and execute it ==
ERROR: Allwinner USB FEL device not found!
== upload images ==
ERROR: Allwinner USB FEL device not found!
ERROR: Allwinner USB FEL device not found!
ERROR: Allwinner USB FEL device not found!
ERROR: Allwinner USB FEL device not found!
== execute the main u-boot binary ==
ERROR: Allwinner USB FEL device not found!
```

The other common error is that you need to run the **chip-update-firmware.sh** script with **sudo** (or you need to add a rules file as described in the next section). This error looks like this in your terminal window:

```
Image 0: 848 Bytes = 0.83 kB = 0.00 MB
== upload the SPL to SRAM and execute it ==
ERROR: You don't have permission to access Allwinner USB FEL device
== upload images ==
```

```
ERROR: You don't have permission to access Allwinner USB FEL device
ERROR: You don't have permission to access Allwinner USB FEL device
ERROR: You don't have permission to access Allwinner USB FEL device
ERROR: You don't have permission to access Allwinner USB FEL device
== execute the main u-boot binary ==
ERROR: You don't have permission to access Allwinner USB FEL device
```

#### OPTION: FLASH WITHOUT SUDO

As a developer, there's a good chance you'll flash CHIP more than once in your life. You'll probably want to follow these steps. In order to be able to run the **chip-update-firmware.sh** script without sudo, make a rules file:

```
sudo touch /etc/udev/rules.d/99-allwinner.rules
```

and add the content with the tee command:

```
echo 'SUBSYSTEM=="usb", ATTRS{idVendor}=="1f3a", ATTRS{idProduct}=="efe8", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip"' | sudo tee /etc/udev/rules.d/99-allwinner
```

then, to make this rules file work: `shell sudo udevadm control --reload-rules`

---

# Setup Ubuntu For Flashing

If you are running Ubuntu OS on your computer, and don't want to bother with a virtual machine, you can flash CHIP from your real computer. A generous member of our forums created a script that duplicates the below steps in a convenient package. You can get it from github. Please note that this is not supported or maintained by Next Thing - we only link to it here for your potential convenience.

#### REQUIREMENTS

- Computer running Ubuntu 14.04+
- Jumper wire
- CHIP

#### INSTALL DEPENDENCIES

Install some tools:

```
sudo apt-get update
sudo apt-get install u-boot-tools android-tools-fastboot git build-essential curl android-tools-fsutils libusb-1.0-0-dev pkg-config
```

If you get an error that "the repository android-tools-fastboot can't be found", you are probably booting from an Ubuntu Live CD (or USB stick). You'll need to add a repository so you can install the android-tools-fastboot:

```
sudo add-apt-repository universe && sudo apt-get update
sudo apt-get install u-boot-tools android-tools-fastboot git build-essential curl android-tools-fsutils libusb-1.0-0-dev pkg-config
```

If you intend to customize buildroot with additional software, install these packages:

```
sudo apt-get install libncurses5-dev libc6-i386 lib32stdc++6 lib32z1
```

Get and make the fel tools:

```
git clone http://github.com/NextThingCo/sunxi-tools
cd sunxi-tools
make
sudo rm -f /usr/local/bin/fel
sudo ln -s $PWD/fel /usr/local/bin/fel
```

Clone the CHIP-tools repository

```
cd ..
git clone http://github.com/NextThingCo/CHIP-tools
cd CHIP-tools
```

If you have already cloned the CHIP-tools from a previous CHIP flashing, you can, of course, just update your existing repository

```
cd CHIP-tools
git pull
```

You'll also need to add your user to some groups and add a udev rule

```
sudo usermod -a -G dialout $USER &&
sudo usermod -a -G plugdev $USER &&
echo -e 'SUBSYSTEM=="usb", ATTRS{idVendor}=="1f3a", ATTRS{idProduct}=="efe8", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip"
SUBSYSTEM=="usb", ATTRS{idVendor}=="18d1", ATTRS{idProduct}=="1010", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip-fastboot"
SUBSYSTEM=="usb", ATTRS{idVendor}=="1f3a", ATTRS{idProduct}=="1010", GROUP="plugdev", MODE="0660" SYMLINK+="usb-chip-fastboot"
SUBSYSTEM=="usb", ATTRS{idVendor}=="067b", ATTRS{idProduct}=="2303", GROUP="plugdev", MODE="0660" SYMLINK+="usb-serial-adapter"
' | sudo tee /etc/udev/rules.d/99-allwinner.rules
```

Now you are ready to flash CHIP with firmware.

Note, if you are using openSUSE, you have to change the GROUP to 'lp'.

#### ALL THE COMMANDS AT ONCE

Here's all the commands in one place:

```
sudo apt-get update
sudo apt-get install u-boot-tools android-tools-fastboot git build-essential libusb-1.0-0-dev libncurses5-dev libc6-i386 lib32stdc++6 lib32z1 android-tools-fsutils
git clone http://github.com/NextThingCo/sunxi-tools
cd sunxi-tools
make
sudo rm -f /usr/local/bin/fel
sudo ln -s $PWD/fel /usr/local/bin/fel
cd ..
git clone http://github.com/NextThingCo/CHIP-tools
cd CHIP-tools
```

---

# WiFi Connection

Below are detailed instructions for connecting to Wi-Fi networks using two different command line protocols: `nmcli` and `connman`. If you are using the CHIP OS that comes installed on CHIP, or you have flashed with our Debian distribution, you'll want to use the first section about connecting with `nmcli`. If you have flashed CHIP with our buildroot OS, you'll need to use `connman`.

#### CONNECTING C.H.I.P. TO WI-FI WITH NMCLI

There are several tools in Linux for connecting and configuring networks. We will be using the command nmcli (Network Manager Client). You may see other tutorials that reference iw or iwconfig, however, these tools are not recommended for C.H.I.P. You can read more about nmcli on the internet.

#### REQUIREMENTS

You will need one of these scenarios:

- CHIP with monitor and keyboard attached
- SSH or serial connection
- Wireless access to internet

- CHIP loaded with CHIP OS or Debian

#### STEP 1: LIST AVAILABLE WI-FI NETWORKS

In the terminal, type

```
nmcli device wifi list
```

The output will list available access points

```
*  SSID      MODE   CHAN  RATE       SIGNAL  BARS  SECURITY
*  NextThing HQ    Infra  11    54 Mbit/s  100     --
   NextThing Shop  Infra  6     54 Mbit/s  30      WPA1 WPA2
   2WIRE533        Infra  10    54 Mbit/s  44      WPA1 WPA2
```

#### STEP 2: CONNECT TO A NETWORK

You can connect to password -protected or open access points.

#### A: NO PASSWORD

To connect to an open network with no password, use this command:

```
sudo nmcli device wifi connect '(your wifi network name/SSID)' ifname wlan0
```

These commands will respond with information about the connection.

#### B: PASSWORD PROTECTED

To connect to a password protected network, use this command, inserting your own network name and password:

```
sudo nmcli device wifi connect '(your wifi network name/SSID)' password '(your wifi password)' ifname wlan0
```

#### C: HIDDEN SSID AND PASSWORD PROTECTED

To connect to a hidden network, append `hidden yes` to the command, after `ifname wlan0`

#### STEP 3: TEST YOUR CONNECTION

You can verify and test your wireless network connection.

#### VERIFY

You can verify your connection using the command

```
nmcli device status
```

which outputs a list of the various network devices and their connections. For example, a successful connection would look like this:

```
DEVICE   TYPE      STATE         CONNECTION
wlan0    wifi      connected     NextThing HQ
wlan1    wifi      disconnected  --
ip6tnl0  ip6tnl    unmanaged     --
lo       loopback  unmanaged     --
sit0     sit       unmanaged     --
```

Because it is worth knowing that Linux offers many ways of doing things, another command that shows your current active connection is

```
nmcli connection show --active
```

which outputs like so:

```
NAME  UUID                                  TYPE             DEVICE
NTC   59962bac-3441-437b-94ea-bf31dee66e8f  802-11-wireless  wlan0
```

After you have connected once, your C.H.I.P. will automatically connect to this network next time you reboot (or start NetworkManager services).

#### TEST

Finally, you can test your connection to the internet with `ping`. Google's DNS server at the IP address 8.8.8.8 is probably the most reliable computer on the internet, so:

```
ping -c 4 8.8.8.8
```

results in output like:

```
64 bytes from 8.8.8.8: icmp_seq=1 ttl=55 time=297 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=55 time=26.3 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=55 time=24.8 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=55 time=55.7 ms
```

You can stop this command by pressing CTRL-C on your keyboard. The `-c 4` option means it will happen only 4 times.

Congratulations! You are now network with CHIP!

#### STEP 4: DISCONNECTING AND FORGETTING NETWORKS

The command to disconnect from a wireless device needs a few parameters:

```
sudo nmcli dev disconnect wlan0
```

You may want to prevent auto-connection to a network, so you can use this process to "forget" a network. First, get the connection names:

```
nmcli c
```

which outputs something like

```
NAME       UUID                                  TYPE             DEVICE
NTC 2461   d0a6fb32-3ed8-4a95-a631-ee2ae6153761  802-11-wireless  wlan0
```

then, disconnect (using the example above)

```
sudo nmcli connection delete id "NTC 2461"
```

#### TROUBLESHOOTING NETWORKS

Here are a few possible problems with connections.

#### NO NETWORK FOUND

Not much to say about that. If there's no network, you can't connect. Go find a network!

#### INCORRECT PASSWORD

If you type in the wrong password, you'll get some errors like this:

```
[32258.690000] RTL871X: rtw_set_802_11_connect(wlan0) fw_state=0x00000008
[32258.800000] RTL871X: start auth
[32263.720000] RTL871X: rtw_set_802_11_connect(wlan0) fw_state=0x00000008
[32263.820000] RTL871X: start auth
[32264.430000] RTL871X: auth success, start assoc
[32269.850000] RTL871X: rtw_set_802_11_connect(wlan0) fw_state=0x00000008
[32269.970000] RTL871X: start auth
Error: Timeout 90 sec expired.
```

Try connecting again with the correct password.

#### FAILED PING

If you don't have access to the internet, your ping to an outside IP will fail. It is possible that you can connect to a wireless network, but have no access to the internet, so you'd see a connection when you request device status, but have a failed ping. This indicates a problem or restriction with the router or the access point, not a problem with the CHIP.

A failed ping looks something like:

```
From 192.168.2.56 icmp_seq=14 Destination Host Unreachable
From 192.168.2.56 icmp_seq=15 Destination Host Unreachable
From 192.168.2.56 icmp_seq=16 Destination Host Unreachable
18 packets transmitted, 0 received, +9 errors, 100% packet loss, time 17013ms
pipe 4
```

#### LOSS OF WIRELESS NETWORK

A sudden, unplanned disconnection will post an error in the terminal window, for example:

```
[30863.880000] RTL871X: linked_status_chk(wlan0) disconnect or roaming
```

The Network Manager will periodically try to reconnect. If the access point is restored, you'll get something like this in your terminal window:

```
[31798.970000] RTL871X: rtw_set_802_11_connect(wlan0)
[31799.030000] RTL871X: start auth
[31799.040000] RTL871X: auth success, start assoc
[31799.050000] RTL871X: rtw_cfg80211_indicate_connect(wlan0) BSS not found !!
[31799.060000] RTL871X: assoc success
```

#### NMCLI NOT INSTALLED ERROR

If you try to use `nmcli` and you get an error that it is not found or is not a command, chances are that you are using the CHIP buildroot image. The `nmcli` commands only apply to CHIPs running CHIP OS or Debian linux.

#### CONNECTING C.H.I.P. TO A WIRELESS NETWORK WITH CONNMAN

The buildroot operating system uses the `connman` command-line network manager to connect and manage your network connections. If you are using CHIP OS (or Debian), you will find that `connman` is not installed - you'll need to use nmcli.

If you want all the details of `connman` visit the ArchLinux wiki.

#### REQUIREMENTS

- CHIP running buildroot OS
- One of the following:
  - Keyboard and monitor for CHIP
  - Serial connection to CHIP

#### STEP 1: ENABLE WIFI AND FIND A NETWORK

These three commands will, in turn, enable wifi, scan for access points, and see what networks are available:

```
connmanctl enable wifi
connmanctl scan wifi
connmanctl services
```

The `services` command has output similar to:

```
*AO
    NTC                 wifi_7cc70905cd77_4e5443_managed_psk
                        wifi_7cc70905cd77_hidden_managed_psk
    NTC Guest           wifi_7cc70905cd77_4e5443204775657374_managed_psk
                        wifi_7cc70905cd77_hidden_managed_none
    ATT312              wifi_7cc70905cd77_415454333132_managed_psk
    HP-Print-99-LaserJet 1102 wifi_7cc70905cd77_48502d5072696e742d39392d4c617365724a65742031313032_managed_none
    ATT344              wifi_7cc70905cd77_415454333434_managed_psk
    CBCI-1B57-2.4       wifi_7cc70905cd77_434243492d314235372d322e34_managed_psk
    mi-fi               wifi_7cc70905cd77_6d692d6669_managed_none
    0024A5D8CF33        wifi_7cc70905cd77_303032344135443843463333_managed_psk
    Twirl-Eco-Events-2.4 wifi_7cc70905cd77_547769726c2d45636f2d4576656e74732d322e34_managed_psk
    xfinitywifi         wifi_7cc70905cd77_7866696e69747977696669_managed_none
```

#### STEP 2: CONNECT TO AN ACCESS POINT

Unfortunately, connman doesn't use the nice name on the left of the services list. It wants the unfriendly string on the right, so you'll want to get copy and paste ready.

#### A: NO PASSWORD

For example, to connect to NTC Guest, which has no password, `services` shows two choices. We want the one without "hidden" in the string. Use the connect command to connect:

```
connmanctl connect wifi_7cc70905cd77_4e5443204775657374_managed_psk
```

If your network is not password protected, you'll get some output that will indicate a successful connection, such as:

```
[  961.780000] RTL871X: rtw_set_802_11_connect(wlan0)  fw_state=0x00000008
[  962.070000] RTL871X: start auth
[  962.080000] RTL871X: auth success, start assoc
[  962.090000] RTL871X: rtw_cfg80211_indicate_connect(wlan0) BSS not found !!
[  962.100000] RTL871X: assoc success
[  962.110000] RTL871X: send eapol packet
[  962.290000] RTL871X: send eapol packet
[  962.300000] RTL871X: set pairwise key camid:4, addr:0a:18:d6:97:2d:26, kid:0, type:AES
[  962.320000] RTL871X: set group key camid:5, addr:0a:18:d6:97:2d:26, kid:1, type:AES
```

If your network is password protected, you'll get an error.

#### B: PASSWORD-PROTECTED

To deal with passwords, you'll need to put `connman` into interactive mode:

```
connmanctl
```

which gives a connmanctl prompt:

```
connmanctl>
```

In the shell, turn the 'agent' on so it can process password requests:

```
agent on
```

and now use the connect command (your network name will be different than what's below of course)

```
connect wifi_7cc70905cd77_4e5443_managed_psk
```

and enter your password when prompted:

```
Agent RequestInput wifi_7cc70905cd77_4e5443_managed_psk
Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase?
```

Now that you are connected to a wireless network, you can exit connmanctl interactive mode by typing

```
quit
```

#### ALL THE COMMANDS IN ONE PLACE

Here's all the commands in one place:

```
connmanctl
agent on
connect wifi_7cc70905cd77_4e5443_managed_psk
quit
```

#### STEP 3: TEST CONNECTION

In CHIP's command line, you can ping Google four times:

```
ping -c 4 8.8.8.8
```

and expect ping to output some timing messages like:

```
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: seq=0 ttl=55 time=209.147 ms
64 bytes from 8.8.8.8: seq=1 ttl=55 time=111.125 ms
64 bytes from 8.8.8.8: seq=2 ttl=55 time=183.627 ms
64 bytes from 8.8.8.8: seq=3 ttl=55 time=147.398 ms
--- 8.8.8.8 ping statistics ---
4 packets transmitted, 4 packets received, 0% packet loss
round-trip min/avg/max = 111.125/162.824/209.147 ms
```

If your connection is not successful, then ping will tell you your network is down:

```
PING 8.8.8.8 (8.8.8.8): 56 data bytes
ping: sendto: Network is unreachable
```

#### TROUBLESHOOTING CONNECTION PROBLEMS

- You'll need to make sure you used the right network when you used the connect commnand.
- Review any messages that the connect commnand gave you. Did they look like the examples of a successful connection?
- If everything checked out until you got to `ping`, there's a good chance the problem is with your router or connection to the internet.

#### CONNMAN NOT INSTALLED ERROR

If you try to use `connman` and you get an error that it is not found or is not a command, chances are that you are using the CHIP OS or Debian image. The `connman` commands only apply to CHIPs running the simple buildroot OS.

#### STEP 4: DISCONNECTING AND FORGETTING NETWORKS

To disconnect from your network, you might first want a reminder of what unfriendly string is used to describe your access point, so type:

```
connmanctl services
```

which will output information about your current link:

```
*AO NTC                wifi_7cc70905cd77_4e5443_managed_psk
```

Use the ID to disconnect:

```
connmanctl disconnect wifi_7cc70905cd77_4e5443_managed_psk
```

and you'll get some status like this:

```
[  301.890000] RTL871X: clear key for addr:0a:18:d6:97:2d:26, camid:4
[  301.900000] RTL871X: clear key for addr:0a:18:d6:97:2d:26, camid:5
[  301.920000] IPv6: ADDRCONF(NETDEV_UP): wlan0: link is not ready
Disconnected wifi_7cc70905cd77_4e5443_managed_psk
```

Generally, `conman` will remember and cache setup information - if you reboot in the vicinity of a known network, it will attempt to connect. However, if you need to forget a network setup, these setups can be found by navigating:

```
cd /var/lib/connman/
```

You can delete a single connection by seeing what connections are stored

```
ls /var/lib/connman/
```

and then delete a setup that you find, for example

```
rm -r wifi_7cc70905cd77_4e5443_managed_psk
```

You can delete all the "wifi" directories with

```
rm -r wifi*
```

(the `-r` is needed because these are directories you are deleting, and the star at the end of `wifi*` assumes your configurations all start with the string "wifi")

#### FOR ADVANCED USERS

It's worth noting that you'll see two wireless networking interfaces if you list them with

```
ifconfig
```

`connman` is configured to see only the physical interface wlan0 which simplifies setup. We do this with a blacklist, which can be modified at `/etc/connman/main.conf`

---

# Configure Sound Output on Debian

Getting simple audio playback working on CHIP is pretty easy, once you install the correct packages and enable audio output. In the code examples below, we've inserted the && characters at the end of lines so you can copy and paste the entire block into a terminal window and execute each line in series. If you are using CHIP OS, sound output is already configured and working. However, you may be running a simple version of Debian or buildroot, so these instructions will help you get sound working on CHIP.

#### REQUIREMENTS

- CHIP
- SSH or serial connection to CHIP or
- Monitor and keyboard
- Headphones or powered speakers connected to CHIP a/v jack
- Connection to a network

#### SETUP CHIP

Update your apt repository list if you haven't done so recently:

```
sudo apt-get update
```

Then install ALSA:

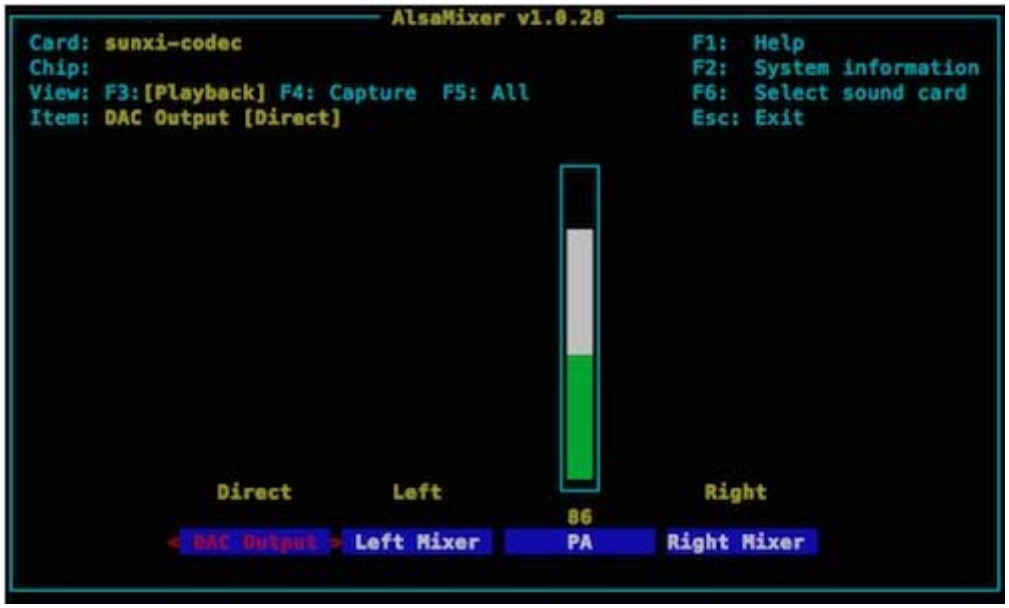
```
sudo apt-get install libasound2 alsa-utils
```

This will install alsa and some utilities for playing sound from the command line. Once those have installed, you'll need to make the outputs active for sound

```
alsamixer
```

will open up a simple interface. Use the left and right arrow keys on your keyboard to select among the items, and use the up/down keys to change the options:

- DAC Output - set to Direct
- Left Mixer - set to Left
- PA - set to desired volume
- Right Mixer - set to Right




#### PLAY A SOUND

Change to the root media directory:

```
cd /media
```

Alternatively, you could download a sound into chip's home directory:

```
mkdir /home/chip/Media && cd /home/chip/Media
```

Use `wget` to download a sound of piano chords to the file test.wav:

```
wget -O test.wav https://upload.wikimedia.org/wikipedia/commons/d/db/Descending_thirds.wav
```

If wget returns command not found you can install it:

```
sudo apt-get install wget
```

We can finally play the sound and hear it over CHIP's headphone jack:

```
aplay test.wav
```

If you want to play mp3 or ogg files, you can install mplayer:

```
sudo apt-get install mplayer
```

Then try an ogg file:

```
wget -O test.ogg https://upload.wikimedia.org/wikipedia/commons/e/e7/Agogo.ogg &&
mplayer test.ogg
```

And mp3 file:

```
wget -O test.mp3 http://www.freesound.org/data/previews/315/315618_2050105-lq.mp3 &&
mplayer test.mp3
```

#### RECORD A SOUND

If you want to try the audio input, you need to connect audio input to header U14, pins 06 & 12 or modify CHIP to use audio in on the TRRS connector. Once you have an audio signal going into CHIP, you can test it out by recording a three second (`-d 3`) WAV file with arecord:

```
arecord -f cd -d 3 -D hw:0,0 chipaudioin.wav
```

#### MORE PACKAGES

Developers that want to use sound will probably want to download these packages:

```
sudo apt-get install portaudio19-dev &&
sudo apt-get install swig &&
sudo apt-get install python-setup-tools &&
sudo apt-get install python-dev
```

---

# USB Storage Devices

In this tutorial, we'll describe how you can use the USB port to add more storage with a thumb drive, hard drive, card reader, or whatever else. You can then copy, store, and edit files on the storage device, extending the capability of CHIP.

This tutorial is suitable for the buildroot image. If you are following this for other Linux distributions, there are some adjustments that you'll need to make for paths, permissions, and enabling 'sudo.' With buildroot, you work as the root user, so this tutorial is appropriately terse.

#### REQUIREMENTS

- USB thumb drive or hard drive
- Computer running OS X 10.10+, Ubuntu 14.04+, or Windows 7+ (to format USB device, if needed)

#### STEP 1: FORMAT THE DRIVE

First, you'll want to format the drive as an MS-DOS (FAT), NTFS, or ext3 volume. You can do this on another computer.

Once formatted, insert the drive into CHIP's USB port. Enter the command

```
dmesg
```

You'll get output like:

```
[ 4953.430000] usb 1-1: new high-speed USB device number 2 using ehci-platform
[ 4953.580000] usb-storage 1-1:1.0: USB Mass Storage device detected
[ 4953.590000] scsi host0: usb-storage 1-1:1.0
[ 4954.590000] scsi 0:0:0:0: Direct-Access USB Flash Memory 1.00 PQ: 0 ANSI: 2
[ 4954.600000] sd 0:0:0:0: [sda] 3911616 512-byte logical blocks: (2.00 GB/1.86 GiB)
[ 4954.610000] sd 0:0:0:0: [sda] Write Protect is off
[ 4954.620000] sd 0:0:0:0: [sda] Mode Sense: 65 44 09 30
[ 4954.630000] sd 0:0:0:0: [sda] No Caching mode page found
[ 4954.630000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 4954.650000] sda: sda1
[ 4954.650000] sd 0:0:0:0: [sda] Attached SCSI removable disk
```

Notice the second to last line. This tells you the device location for the drive. Storage devices generally have device names that start with "sd". If you want to see all the storage devices attached to CHIP, you can use a wildcard to display all devices that start with "sd":

```
ls /dev/sd*
```

and you'll get something like:

```
/dev/sda /dev/sda1
```

With one thumb drive attached, it appears as two devices: the device itself (sda), and the storage partitions (sda1). There is only one partition on this drive.

Another way to find storage devices is the command

```
blkid
```

which lists them, along with the names you might have initialized them with:

```
/dev/sda1: LABEL="TEST" UUID="6668-11E9"
```

#### STEP 2: MOUNT THE DRIVE DEVICE TO YOUR FILESYSTEM

Now that you know where your partition is, it's time to mount the partition so you can access the files.

First, make a directory where your drive can mount:

```
sudo mkdir /drives
```

Mount the drive device to your /drives directory:

```
sudo mount /dev/sda1 /drives
```

Now you can navigate to the `drives` directory and see all the files in the drive:

```
cd /drives
ls
```

#### STEP 3: UNMOUNT THE DRIVE FROM FILESYSTEM

If you want to remove the drive from the USB port on CHIP, it's best to unmount it:

```
sudo umount /dev/sda1
```

#### STEP 4: AUTOMATIC MOUNTING ON BOOT

You'll probably want to mount this drive automatically next time you use it, though. We can set that up with a quick modification to the `fstab` (file system table) document:

```
vi /etc/fstab
```

Getting around vi is not very intuitive. If you are new to it, here's a quick guide on getting this text into the fstab document:

- 'arrow' key to the end of the file,
- press the 'i' key to insert text
- type (or copy-paste) this:

```
/dev/sda1 /drives vfat defaults 0 0
```

To exit vi,

- press the 'esc' key,
- type ':' (colon),
- type 'wq' to write and quit vi.

You can test your work with:

```
mount -a
```

If there's an error, double check the `fstab` file and make sure it has the line `/dev/sda1 /drives vfat defaults 0 0` at the end. If it's successful, you'll be able to view, modify and copy the files on the disk:

```
ls /drives
```

Now, if you reboot , the drive will mount automatically. If you remove the drive, then insert it again, you'll need the command

```
mount -a
```

---

# Connecting Bluetooth Devices

CHIP has built-in Bluetooth and uses the bluez 5 stack for implementing connections and devices. This tutorial instructs how to use a Bluetooth keyboard, since it is a simple and obvious example. There are, of course, several types of Bluetooth devices, such as

earpieces, audio connectors, vacuum cleaners, and more. Future tutorials (search our bbs will cover those devices, but the keyboard is a good introduction to the commands and an easy way to test your system.

#### REQUIREMENTS

- CHIP
- SSH or serial connection to CHIP or
- Monitor and keyboard
- Bluetooth device, preferably keyboard

#### IMPORTANT!

Start with a CHIP completely unplugged and powered down. Add power and boot up. A known limitation is that after `reboot`, CHIP's Bluetooth controller may not work until you `power` and physically disconnect from a power source.

#### ABOUT `BLUETOOTHCTL`

We'll be using the command `bluetoothctl` to find, pair with, and connect to devices.

In the terminal, type

```
bluetoothctl
```

This starts up `bluetoothctl` in interactive mode. You should see output like

```
[NEW] Controller 7C:C7:08:05:CD:77 BlueZ 5.27 [default]
[NEW] Device 60:33:4B:13:A7:45 nyb
[NEW] Device 15:03:26:A0:26:26 SK032B02-2626
```

which is a list of MAC addresses of CHIP's Bluetooth controller chip (the first line) and any other devices that have been paired with CHIP in the past. Use the `help` command - it lists all the very useful commands in the `bluetoothctl` interactive mode.

In Bluetooth interactive mode, use the command

```
power on
```

which outputs

```
Changing power on succeeded
[CHG] Controller 7C:C7:08:05:CD:77 Powered: yes
```

#### FIND A BLUETOOTH DEVICE

If you need to discover a device, start the scan process:

```
scan on
```

which will start printing MAC addresses and names (if available) of Bluetooth devices in your vicinity.

```
[NEW] Device 15:03:26:A0:26:26 SK032B02-2626
[NEW] Device 1C:1A:C0:85:5E:2C 1C-1A-C0-85-5E-2C
[NEW] Device 60:33:4B:13:A7:45 nyb
```

#### PAIR WITH A BLUETOOTH DEVICE

Pair to a device with the MAC address and the `pair` command:

```
pair 1C:1A:C0:85:5E:2C
```

This may fail if the device is powered off, goes out of range, or your toddler spills water on it. Here's what failure looks like:

```
Attempting to pair with 1C:1A:C0:85:5E:2C
[CHG] Device 1C:1A:C0:85:5E:2C Connected: yes
[CHG] Device 1C:1A:C0:85:5E:2C Connected: no
Failed to pair: org.bluez.Error.AuthenticationCanceled
```

As the scan continues, you'll eventually see the device you are interested in, so copy that MAC address and type:

```
pair 15:03:26:A0:26:26
```

with output like:

```
[CHG] Device 15:03:26:A0:26:26 Connected: yes
[CHG] Device 15:03:26:A0:26:26 Modalias: usb:v05ACp3232d0001
[CHG] Device 15:03:26:A0:26:26 UUIDs:
 00001124-0000-1000-8000-00805f9b34fb
 00001200-0000-1000-8000-00805f9b34fb
[CHG] Device 15:03:26:A0:26:26 Paired: yes
Pairing successful
[CHG] Device 15:03:26:A0:26:26 Connected: no
Pair with a Bluetooth Device with Password (keyboard)
```

Some Bluetooth devices need user input to pair. In that case, you'll need to turn the agent 'on' so the device can post a password, and you can enter it:

```
agent on
```

will output

```
Agent registered
```

now you can pair it:

```
pair DC:2C:26:D7:B6:8F
```

will output

```
Attempting to pair with DC:2C:26:D7:B6:8F
[CHG] Device DC:2C:26:D7:B6:8F Connected: yes
[agent] PIN code: 245261
```

Now you can use the Bluetooth device to enter the PIN code, then hit enter. The terminal will give some status about the pairing:

```
[CHG] Device DC:2C:26:D7:B6:8F Modalias: usb:v05ACp022Cd011B
[CHG] Device DC:2C:26:D7:B6:8F UUIDs:
        00001000-0000-1000-8000-00805f9b34fb
        00001124-0000-1000-8000-00805f9b34fb
        00001200-0000-1000-8000-00805f9b34fb
[CHG] Device DC:2C:26:D7:B6:8F Paired: yes
Pairing successful
[CHG] Device DC:2C:26:D7:B6:8F Connected: no
```

Now that you are paired, you will have to connect.

#### CONNECT WITH A BLUETOOTH DEVICE

Now that you have paired the Bluetooth device, you won't have to do that again. However, the device still needs to be connected:

```
connect 15:03:26:A0:26:26
```

will output, when successful:

```
Attempting to connect to 15:03:26:A0:26:26
[CHG] Device 15:03:26:A0:26:26 Connected: yes
Connection successful
[bluetooth]## [ 1405.340000] hid-generic 0005:05AC:3232.0001: unknown main item tag 0x0
[ 1405.360000] input: SK032B02-2626 as /devices/platform/soc@01c00000/1c28c00.serial/tty/ttyS1/hci0/hci0:4/0005:05AC:3232.0001/input/input1
[ 1405.380000] hid-generic 0005:05AC:3232.0001: input: BLUETOOTH HID v0.01 Mouse [SK032B02-2626] on 7c:c7:08:05:cd:77
```

or, if the device is not available, it will fail:

```
Attempting to connect to 15:03:26:A0:26:26
[bluetooth]## [ 1304.470000] Bluetooth: HIDP (Human Interface Emulation) ver 1.2
[ 1304.480000] Bluetooth: HIDP socket layer initialized
Failed to connect: org.bluez.Error.Failed
```

#### TRUSTING A BLUETOOTH DEVICE

Trust between people leads to understanding and perhaps even harmonious living. Trust between bluetooth devices means that you won't have to connect the device every time it's near. Which is a sort of harmony, I suppose. Once you have connected a bluetooth device to CHIP, if you intend to use it again, you can trust it:

```
trust 15:03:26:A0:26:26
```

#### REMOVE A BLUETOOTH DEVICE

You may want CHIP to not pair or connect to a device - perhaps the conveniently trusted device needs to be freed for another connection. Whatever the reason, if you want to remove your Bluetooth device,

```
remove 15:03:26:A0:26:26
```

#### TROUBLESHOOTING BLUETOOTH

If your Bluetooth controller module on CHIP is not functioning, you can easily find the problem. Type

```
bluetoothctl
```

to get into the interactive mode, then type

```
power on
```

If you get the response

```
No default controller available
```

Then there's a problem with CHIP recognizing the Bluetooth module. Read the very first instructions at the top of this tutorial.

---

# Install X-windows

If you want a windowed desktop on C.H.I.P., you can install X-Windows.

#### REQUIREMENTS

- CHIP connected to WiFi

- Monitor attached to CHIP
- Keyboard or Serial or SSH Connection to CHIP

#### INSTALLATION (XFCE4)

CHIP is a lightweight computer, so we'll install the lightweight xfce4:

```
sudo apt-get install xfce4
```

It might take some time to download and install all the packages, since there are a lot of dependencies and libraries involved. Once installed, start the windowing system with the command

```
startx&
```

(the `&` runs Xwindows in the background, so you can still use your terminal). After a minute or so, you'll get an image on the monitor:


Now you can use a mouse and keyboard to explore CHIP and launch programs.

#### TROUBLESHOOTING APT-GET

If you get errors from apt that report "unmet dependencies," you can run the command

```
sudo apt-get install -f
```

which will force installation of any alternate or missing dependencies of any installed packages.

---

# Install the latest PureData

The latest versions of PureData can be installed via apt-get. Use these commands (or put them in a script). This adds a repository source to your apt sources, updates apt-get, then installs puredata and all the dependencies.

```
#!/bin/bash
echo "deb http://ftp.de.debian.org/debian stretch main" | sudo tee --append /etc/apt/sources.list
sudo apt-get update
sudo apt-get install -y puredata
echo "@audio - rtprio 99" | sudo tee --append /etc/security/limits.conf
echo "@audio - memlock unlimited" | sudo tee --append /etc/security/limits.conf
WHO=$USER
sudo adduser $WHO audio
```

---

# Building and Installing PureData (PD) on CHIP

If you want to build from source, these instructions will take you there. PureData is a graphical programming environment, primarily for making audio and multimedia applications. This tutorial describes how to build the “vanilla” version of PD. This is a very rudimentary version of PD - it does not compile or build the extras objects, such as “bob~” or “expr~”.

#### GET SOURCE

First, download and un-archive the source from Miller Puckette’s website:

```
wget http://msp.ucsd.edu/Software/pd-0.46-7.src.tar.gz
gzip -d pd-0.46-7.src.tar.gz
tar -xvf pd-0.46-7.src.tar
```

#### INSTALL DEPENDENCIES

Now, you’ll need to install all the dependencies and make a symbolic link to wish:

```
sudo apt-get update
sudo apt-get install libasound2 alsa-utils mplayer software-properties-common git autoconf libtool make  build-essential gettext portaudio19-dev  jack libasound-dev q
sudo apt-get build-dep puredata
sudo ln -s /usr/bin/wish8.6 /usr/bin/wish
```

Navigate to the pd directory the archive created:

```
cd pd-0.46-7
```

#### BUILD IT

You’re ready to go ahead and build, running some scripts, then making the install:

```
cd ~/pd-0.46-7/
./autogen.sh
./configure --disable-portaudio --disable-portmidi --no-recursion
make
sudo make install
```

You’ll probably also want the “extra” objects such as expr, expr~, clone, fiddle~, bonk~, bob~, sigmund~, et al. These require an extra build step. The “extra” folder is in `pd-0.46-7/extra`, so if you are still in `src/` you can

```
cd ../extra
make install
```

You’ll probably also want to install the deken plugin so you can add more externals to your bag of tricks: https://github.com/pure-data/deken

I've also found this kiosk plugin to be very handy for making a pure data widow take up the entire screen: https://puredata.info/downloads/kiosk-plugin

#### SET UP PRIORITY

Now set up pd so it can run in real-time priority mode for low latency (launching with `pd -rt`). This is mostly about giving audio the necessary thread priority and giving the chip user access:

```
sudo nano /etc/security/limits.conf
```

Navigate to the end of the file (CTL-V) and add the lines

```
@audio - rtprio 99
@audio - memlock unlimited
```

and save (CTL-X to exit, you'll be prompted to save) You'll want to double check that the `chip` user is in the audio group:

```
sudo adduser username audio
```

Then reboot CHIP:

```
sudo reboot
```

#### TEST PD

Now test pd with a test patch. Open a terminal and use this command, which should result in a sine wave:

```
wget http://log.liminastudio.com/wp-content/uploads/2012/06/testPatch.pd_.zip
unzip testPatch.pd_.zip
pd -rt -nogui -noadc -alsa testPatch.pd
```

#### TEST MIDI CONTROLLER

If you need to test out a midi controller to make sure data is coming into CHIP, you can do this from the terminal. You'll want to list the connected devices, if not just to get the port name as ALSA sees it.

```
amidi -l
```

Example output might look like `shell Dir Device Name IO hw:1,0,0 DS1 MIDI 1`

You can then use the command to display MIDI data bytes (in hex) in the terminal window:

```
amidi -p hw:1,0,0 -d
```

Moving a fader might provide output like:

```
B0 29 1D
B0 29 20
B0 29 24
B0 29 29
B0 29 2E
B0 29 32
B0 29 37
B0 29 3A
B0 29 3C
```

#### UNINSTALL

If you need to remove pd, it takes a few steps:

```
sudo apt-get remove puredata-core
sudo apt-get remove puredata-dev puredata-import puredata-utils
sudo apt-get purge puredata-core
sudo apt-get install aptitude wget unzip
sudo apt-get autoremove
```

#### RUN PD

Start PD from the terminal with the command

```
pd -rt &
```

You can then use the mouse and keyboard to go through the Browser and learn more about PD.

#### REFERENCES

Here are some reference links

- real time priority mode
- low latency alsa
- pure data on sourceforge
- pd extended on RPi

---

# Headless CHIP

One of the most amazing features of CHIP is that it's insanely simple to use it as small, wireless computer. Low power requirements, battery-powered with charge management, and both WiFi and Bluetooth connectivity makes CHIP easy to run as a headless, autonomous machine. Of course, you'll still want to access it and control it without a monitor or keyboard. You can control CHIP with another computer and a serial or network connection. Here's how you do this.

#### BEGIN

If you want to use CHIP without a monitor or keyboard attached, there's a few ways to do this:

- Serial connection between a computer and CHIP with a micro-USB cable (USB OTG)
- Serial connection between a computer and CHIP with USB to UART cable
- Secure Shell (SSH) over wireless or wired ethernet

#### REQUIREMENTS

- Computer running OS X 10.10+, Ubuntu 14.04+, or Windows 7+
- CHIP
- Micro-USB cable for USB OTG
- USB-UART cable for USB serial
- A network connection for SSH

#### USB ON-THE-GO SERIAL CONNECTION

Possibly the simplest method to connect to a CHIP is with USB OTG (On-The-Go) Serial. You can connect to CHIP with a micro-USB cable to your computer. Your computer will see CHIP as a serial device as well as provide power to the CHIP. Once you've connected the USB cable to CHIP and your computer, you can read how to control CHIP using a serial terminal

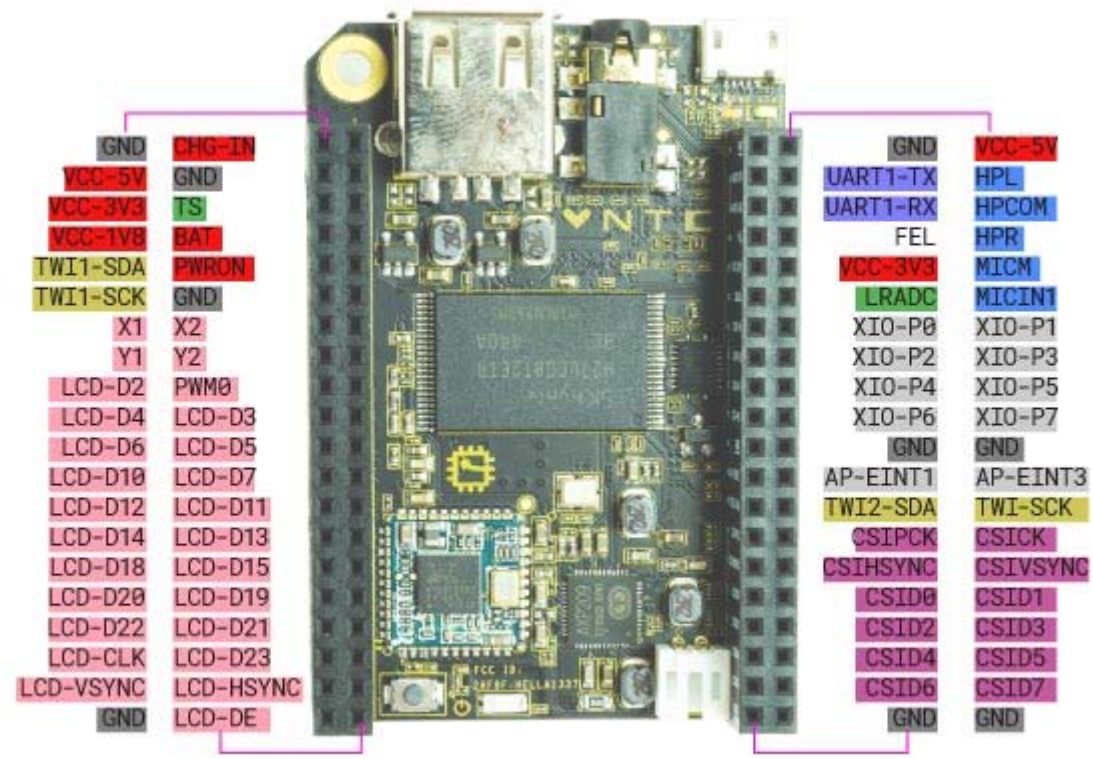
#### USB TO UART SERIAL CONNECTION

There are a few reasons you'd want to use a serial connection:

- No wireless network
- No USB-ethernet cable
- Don't know the IP or network name of CHIP
- You're old-school and like it
- You need to see terminal output from the beginning of boot

Connect a USB to UART cable to the Ground (GND), Transmit (TX), and Recieve (RX) pins on CHIP

We'll find those on header U14, pin outs 1,3 and 5. See the following diagram, which assumes CHIP's USB ports are pointed up…




#### ABOUT THE CABLE

If you need a connector, search your favorite shop for 'USB to UART cable' - any will do.

Here's the one we bought. Most of them will have a USB A plug for your computer on one end and four wires (red, green, black, and white) with female header pins on the other.

You may find other USB-UART cables that have more wires. There will be some labels that will help you connect to the correct pins (GND, TX, RX) on terminal U14. Just be sure to check your datasheets to make sure you're using the correct pins.

#### INSTALL THE DRIVER

For this tutorial, we are using a PL2303 USB to Serial cable. If you are using this one too, you'll probably need to install the PL2303 driver for your computer.

#### CONNECT THE CABLE

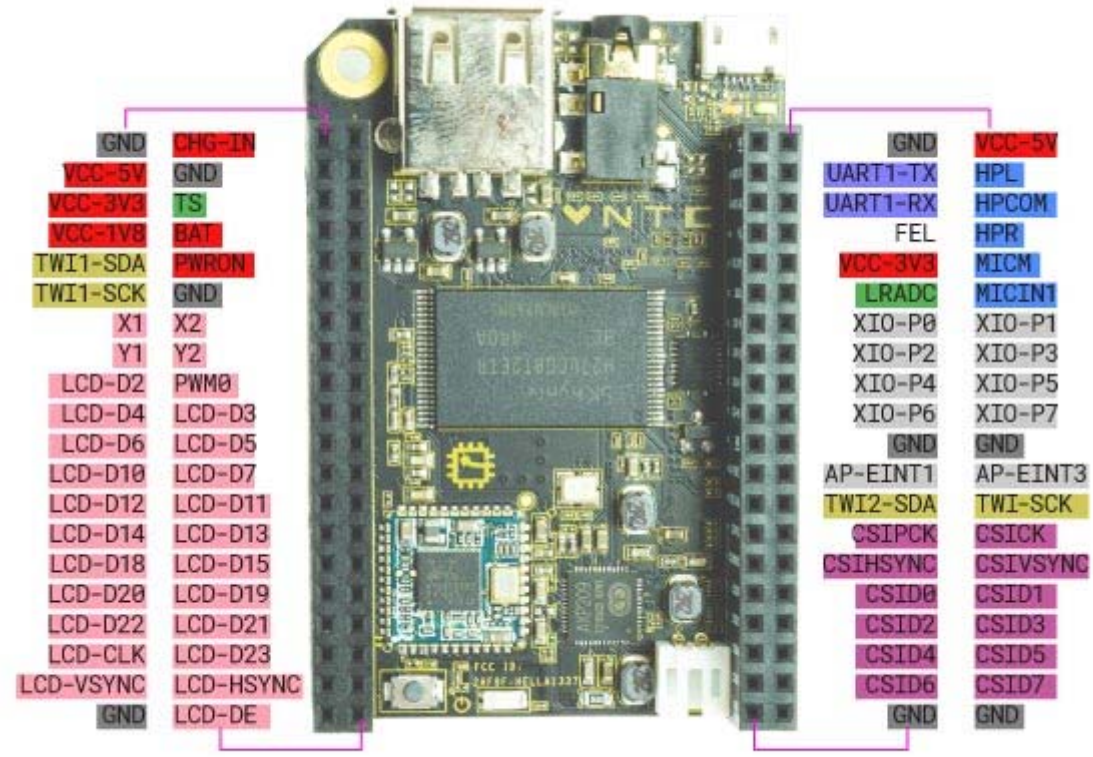
You only need to worry about three of the wires:

- Black = Ground (GND)
- White = Transmit (TX)
- Green = Receive (RX)

The red wire carries voltage (+5 V). DO NOT USE THE RED ONE. Plugging in a +5 V pin could damage your CHIP

Again, there is a chance your USB to UART cable may be different. Please check your data sheets!

The correct pins are on U14 at 1, 3, and 5.




Here's a photo of the cable properly plugged in:

#### SSH

SSH (or "Secure Shell") is a common way to control a computer remotely over a network. You'll need to first get your computer's network name or IP address before you can connect.

#### CONNECT TO CHIP OVER A NETWORK

CHIP comes with `avahi` installed, meaning you can simply refer to it with a name, rather than an IP address

```
ssh chip@chip.local
```

In some situations, you'll need to use CHIP's IP address to connect, in which case the command would look like:

```
ssh chip@10.1.1.99
```

You'll be asked for CHIP's password. The default password is `chip`. This process is the same if CHIP is connected to the network using built-in wireless or a USB-Ethernet adapter.

#### HOW TO GET YOUR IP ADDRESS

The easiest way to get CHIPs IP address is to hook up a monitor and keyboard. Bootup, log in, connect to the network if you need to, and use the command

```
hostname -i
```

which results in your IP address, which might look like this:

```
10.1.1.99
```

If the `hostname -i` command doesn't work you can use

```
ip addr show dev wlan0
```

(You can use the abbreviated `ip a` for an easy to remember command).

which will output a lot of data. Look for the line `wlan0` and the entry `inet`, something like:

```
inet 10.1.1.99
```

#### MAKE CONNECTIONS TO CHIP EASY

You may want to setup your network so it will always provide the same (static) IP address to CHIP. You can then rely on CHIP always having the same IP address.

Alternatively, you can setup zero configuration networking to give your CHIP an easily remembered name.

You are now free to do whatever it is you do with Linux command line on CHIP.

#### CONTROL CHIP USING A SERIAL TERMINAL

Once you've connected CHIP to your computer with the UART or USB cable, open up a terminal. There's lots out there. Here's a few:

- OS X: Zterm, `screen` (built-in to OS X terminal)
- Windows: PuTTy or cygwin
- Linux: `screen`, `cu`

No matter the software, you'll need to set some settings for the port (aka connection). You'll probably only need to set the baud rate, as the others will be defaults:

- Baud Rate (Data Rate): 115200
- Data Bits: 8
- Parity: none
- Stop bits: 1
- Flow control: none

#### USING SCREEN

If you are using screen, the command will look something like this:

```
screen /dev/tty.usbserial 115200 # on macOS
screen /dev/ttyUSB0 115200 # on linux
```

Here's a clever way that work on any system to just connect to the most recent serial device you plugged in:

```
screen $(ls -tw 1 /dev/tty* | head -1) 115200
```

What comes after the '/dev/' may vary among different systems and connections. You can narrow down the choices by using one of the commands

```
ls /dev/tty* # everything
ls -t /dev/tty* | head -5 # the five most recent
```

to list the serial devices.

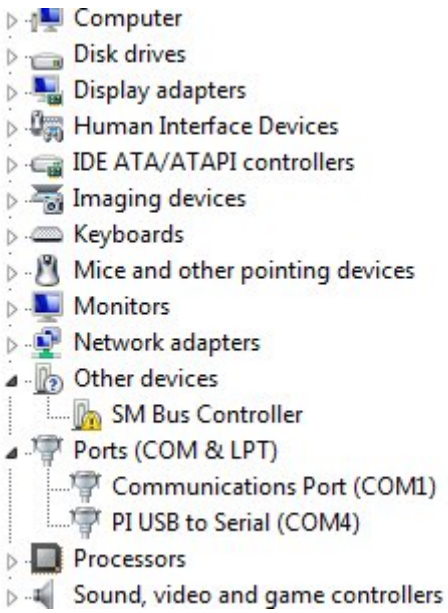
Now power up CHIP. You could do this at anytime, but you'll have the most reliable experience powering CHIP after connecting the USB-UART wires. If you make the serial connection after booting chip, you'll probably need to hit 'return' on your keyboard a few times to get CHIP to send some data to you and print in your terminal.

You'll then be prompted for login. Defaults are username `chip` and password `chip`.

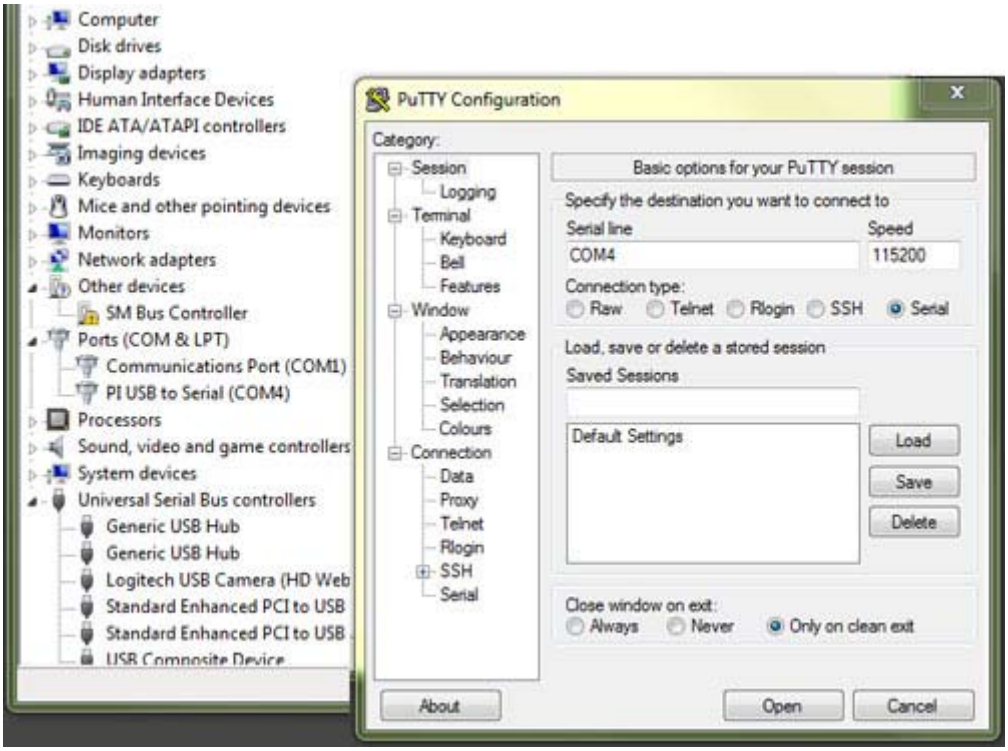
You are now free to do whatever it is you do with Linux command line on CHIP.

#### USING PUTTY

If you are on Windows using PuTTy, you'll probably want to open the windows Device Manager to get the COM name for the serial port. The device won't show up in the Ports list until after the kernel loads and presents the device, so it may take a minute or so before Windows actually detects it.




In the PuTTy configuration panel, you can now use the COM name to set it up. In this case, it's "COM4":




Press “Open” to open a terminal window ,where you can log in to CHIP with username and password `chip`.

You are now free to do whatever it is you do with Linux command line on CHIP.

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# Zero Configuration Networking

You can make working with CHIP on a local network much more convenient by installing zero-conf networking. OS X users may know this as “Bonjour”.

With zero-conf properly configured, your CHIP can be contacted using a name, such as `chip.local`, rather than an IP. This is especially convenient, if you are moving CHIP to different networks that might assign different IP addresses. The key technology for this in Linux is the `avahi` set of tools. There are a few related packages, but this tutorial is a minimal installation to get it up and running.

#### REQUIREMENTS

- CHIP
- SSH or serial connection to CHIP or
- Monitor and keyboard
- Connection to a network

#### INSTALL AVAHI

Getting avahi running is extremely simple. First, install the avahi-daemon:

```
sudo apt-get install avahi-daemon
```

to install the necessary libraries. You may want to configure the daemon with this service file so you can find Apple Bonjour devices from CHIP :

```
sudo nano /etc/avahi/services/afpd.service
```

Then just copy and paste this XML into it:

```
<?xml version="1.0" standalone='no'?><!--*-nxml-*-->
<!DOCTYPE service-group SYSTEM "avahi-service.dtd">
<service-group>
<name replace-wildcards="yes">%h</name>
<service>
<type>_afpovertcp._tcp</type>
<port>548</port>
</service>
</service-group>
```

Then restart avahi-daemon:

```
sudo /etc/init.d/avahi-daemon restart
```

You can now find the hostname that you can use to reach CHIP:

```
hostname
```

which will probably return “chip” as the hostname.

#### USE ZERO-CONF

From a terminal on another computer you can try accessing CHIP with the network name `chip.local`

```
ssh chip@chip.local
```

and enter the password (default is `chip`). That’s it. You can now reach CHIP without knowing the IP.

#### CHANGE THE HOSTNAME

If you have more than one CHIP on the network, or you just want to change the name from “chip” to fit into your network name scheme, you can modify the hostnames file. Open the file in an editor:

```
sudo nano /etc/hostname
```

where you’ll see a single word “chip.” Just modify that line (for example, change it to “bobofettywap”) and save the file. You’ll also need to modify the hosts file where you’ll need to change the first line `127.0.0.1 chip` where you replace “chip” with your new hostname.

```
sudo nano /etc/hosts
```

Finally, to get this new name to broadcast over the network restart avahi-daemon:

```
sudo /etc/init.d/avahi-daemon restart
```

You can now access chip with the new name:

```
ssh chip@bobofettywap.local
```

#### OTHER PACKAGES

You may want to explore some of the other features of avahi, such as browsing a network for other zero-configure enabled computers. There’s a package you can install:

```
sudo apt-get update &
sudo apt-get install avahi-utils
```