

IoT Security, Digital Data Privacy, the Linux Dirty COW and related matters

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BLU, April 19, 2017++
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A Talk in Three Parts

1. IoT Security and Digital Data Privacy
2. Intro to IoT Device “platforms”
3. Deep Dive into RPi-land

Public Service Announcement

*“Principles, Practices and a Prescription for Responsible IoT
and Embedded Systems Development”*

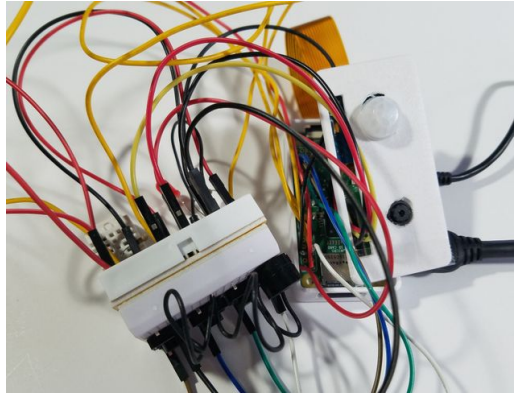
-- <https://www.iotiap.com/principles.html> and <https://www.iotiap.com/principles.pdf> --

This working paper suggests approaches to improve the situation security challenges related to the Internet of Things (IoT).

Please send any comments or questions to IoTiapEmail@gmail.com

1. IoT Security and Digital Data Privacy

What is IoT?



Integration of hardware, software, sensors, and networks to:

1. Collect data / information (via passive or active input)
2. Control devices (algorithmically, adaptively, or via human)
3. Compute actions (this is the algorithmic part ...)
4. Communicate (via LAN or WAN, this is the networking part ...)
5. Customize the user experience (this is a bit of the AI story ...)

BrickerBot and The IoT Vigilante

What is a PDoS (Permanent Denial of Service) attack?

“The BrickerBot PDoS attack used Telnet brute force – the same exploit vector used by Mirai – to breach a victim’s devices. Bricker does not try to download a binary, so Radware does not have a complete list of credentials that were used for the brute force attempt, but were able to record that the first attempted username/password pair was consistently ‘root’/’vizxv’.”

-- Ron Winward, Radware security evangelist at the Data Center World conference April 2017

The Internet of Poorly Secured Things (IoT-ps)

1. “Hajime has infected at least 10,000 home routers, network-connected cameras, and other so-called Internet of Things devices.”
2. “Hajime uses a decentralized peer-to-peer network to issue commands and updates to infected devices.”
3. “Hajime appears to be the brainchild of a grayhat hacker, as evidenced by a cryptographically signed message it displays every 10 minutes or so on terminals.”
4. “Another sign Hajime is a vigilante-style project intended to disrupt Mirai and similar IoT botnets: It blocks access to four ports known to be vectors used to attack many IoT device. Hajime also lacks distributed denial-of-service capabilities or any other attacking code”



Seth Anderson, Vigilante Man is the image source
at
<https://www.flickr.com/photos/swanksalot/6018217883>

<https://arstechnica.com/security/2017/04/vigilante-botnet-infests-iot-devices-before-blackhats-can-hijack-them/> is the text source

18 InterContinental Hotel Chain Breach Expands

APR 17

In December 2016, KrebsOnSecurity [broke the news](#) that fraud experts at various banks were seeing a pattern suggesting a widespread credit card breach across some 5,000 hotels worldwide owned by **InterContinental Hotels Group (IHG)**. In February, IHG acknowledged a breach but said it appeared to involve **only a dozen properties**. Now, IHG has released data showing that cash registers at more than 1,000 of its properties were compromised with malicious software designed to siphon customer debit and credit card data.



An Intercontinental hotel in New York City.

11 Fake News at Work in Spam Kingpin's Arrest?

APR 17

Over the past several days, many Western news media outlets have predictably devoured thinly-sourced reporting from a Russian publication that the arrest last week of a Russian spam kingpin in Spain was related to hacking attacks linked to last year's U.S. election. While there is scant evidence that the spammer's arrest had anything to do with the election, the success of that narrative is a sterling example of how the Kremlin's propaganda machine is adept at manufacturing fake news, undermining public trust in the media, and distracting attention away from the real story.

04 Dual-Use Software Criminal Case Not So Novel

APR 17

"He built a piece of software. That tool was pirated and abused by hackers. Now the feds want him to pay for the computer crooks' crimes."

The above snippet is the subhead of a story published last month by the *The Daily Beast* titled, "FBI Arrests Hacker Who Hacked No One." The subject of that piece — a 26-year-old American named **Taylor Huddleston** — faces felony hacking charges connected to two computer programs he authored and sold: An anti-piracy product called **Net Seal**, and a **Remote Administration Tool (RAT)** called **NanoCore** that he says was a benign program designed to help users remotely administer their computers.

The author of the Daily Beast story, former **black hat** hacker and *Wired.com* editor **Kevin Poulsen**, argues that Huddleston's case raises a novel question: When is a programmer criminally responsible for the actions of his users?

"Some experts say [the case] could have far reaching implications for developers, particularly those working on new



© Lucien/The Daily Beast

"I've been interested in malware since I [was] a child, and I wanted to have a challenge," Inzirillo said. "I was excited about this, and having nobody to share this with, I distributed the code to 'friends' who tried to profit off my work." — 18-year-old malware author Augustin Inzirill

07 Gamestop.com Investigating Possible Breach

APR 17

Video game giant **GameStop Corp.** [NYSE: **GME**] says it is investigating reports that hackers may have siphoned credit card and customer data from its website — **gamestop.com**. The company acknowledged the investigation after being contacted by KrebsOnSecurity.

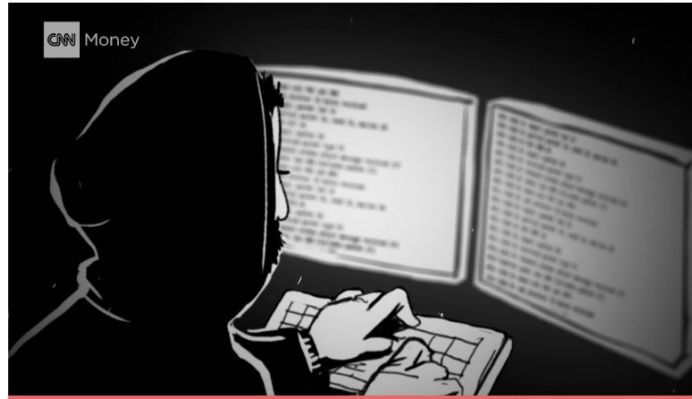
"GameStop recently received notification from a third party that it believed payment card data from cards used on the GameStop.com website was being offered for sale on a website," a company spokesman wrote in response to questions from this author.

"That day a leading security firm was engaged to investigate these claims. Gamestop has and will continue to work non-stop to address this report and take appropriate measures to eradicate any issue that may be identified," the company's statement continued.

GameStop
POWER TO THE PLAYERS™



My hack stole your credit card



My hack stole your credit card



My hack stole your credit card

Someday, passwords will likely be a distant memory.

“The farther you go, the weirder it gets.”
-- CNN Money Interview

Future Tense

Facebook wants to kill the password

by Selena Larson @selenalarson

<http://money.cnn.com/2017/04/19/technology/future/facebook-no-password/index.html>

Are Your Headphones Listening to You?

TECHNOLOGY NEWS | Wed Apr 19, 2017 | 1:26pm EDT

Bose headphones spy on listeners: lawsuit



"People should be uncomfortable with it," Christopher Dore, a lawyer representing Zak, said in an interview. "People put headphones on their head because they think it's private, but they can be giving out information they don't want to share."

See <http://www.reuters.com/article/us-bose-lawsuit-idUSKBN17L2BT>

<https://en.wikipedia.org/wiki/Headphones>

Image Source <http://muzyczny.pl>

Schneier on Security



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Covert Channel via Two VMs

Researchers build a [covert channel](#) between two virtual machines using a shared cache.

Tags: [Amazon](#), [side-channel attacks](#), [SSH](#)

[Posted on April 18, 2017 at 5:58 AM](#) • [18 Comments](#)

“Since Edward Snowden revealed to the world the extent of the NSA's global surveillance network, there has been a vigorous debate in the technological community about what its limits should be.

Less discussed is how many of these same surveillance techniques are used by other -- smaller and poorer -- more totalitarian countries to spy on political opponents, dissidents, human rights defenders ... That these countries can use network surveillance technologies to violate human rights is a shame on the world, and there's a lot of blame to go around.”

“I regularly say that, on the Internet, attack is easier than defense. There are a bunch of reasons for this, but primarily it's 1) the complexity of modern networked computer systems and 2) the attacker's ability to choose the time and method of the attack versus the defender's necessity to secure against every type of attack. This is true, but how this translates to military cyber-operations is less straightforward. Contrary to popular belief, government cyberattacks are not bolts out of the blue, and the attack/defense balance is more...well...balanced.

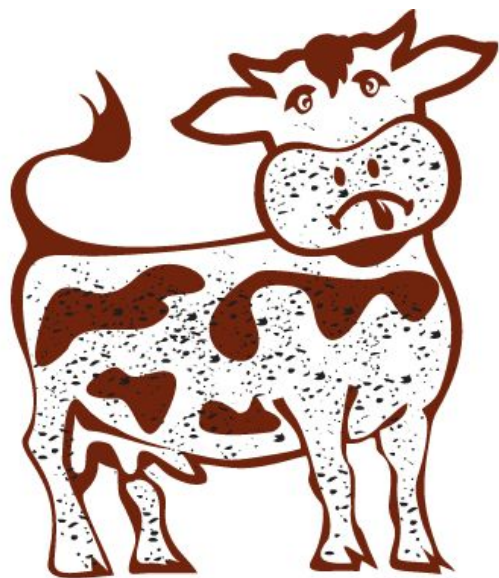
Rebecca Slayton has a good article in *International Security* that tries to make sense of this...”

See <https://www.schneier.com/>

Protecting Customers and Evaluating Risk

“When a potential vulnerability is reported to Microsoft, either from an internal or external source, the Microsoft Security Response Center (MSRC) kicks off an immediate and thorough investigation. We work to swiftly validate the claim and make sure legitimate, unresolved vulnerabilities that put customers at risk are fixed. Once validated, engineering teams prioritize fixing the reported issue as soon as possible, taking into consideration the time to fix it across any impacted product or service, as well as versions, the potential threat to customers, and the likelihood of exploitation.” Keeping in mind: “Customers still running prior versions of these products are encouraged to upgrade to a supported offering.”

Is this a Dirty Cow?



DIRTY COW

“**Dirty COW** (*Dirty copy-on-write*) is a [computer security vulnerability](#) for the [Linux kernel](#) that affects all Linux-based operating systems including [Android](#). It is a local [privilege escalation](#) bug that exploits a [race condition](#) in the implementation of the [copy-on-write](#) mechanism in the kernel's memory-management subsystem.

The bug has been lurking in the Linux kernel since version 2.6.22 released in September 2007, and there is information about been actively exploited at least since October 2016.^[2]The bug has been patched in Linux kernel versions 4.8.3, 4.7.9, 4.4.26 and newer.”
https://en.wikipedia.org/wiki/Dirty_COW

By dirtycow on Github -
<https://github.com/dirtycow/dirtycow.github.io>, CC0,
<https://commons.wikimedia.org/w/index.php?curid=52403593>

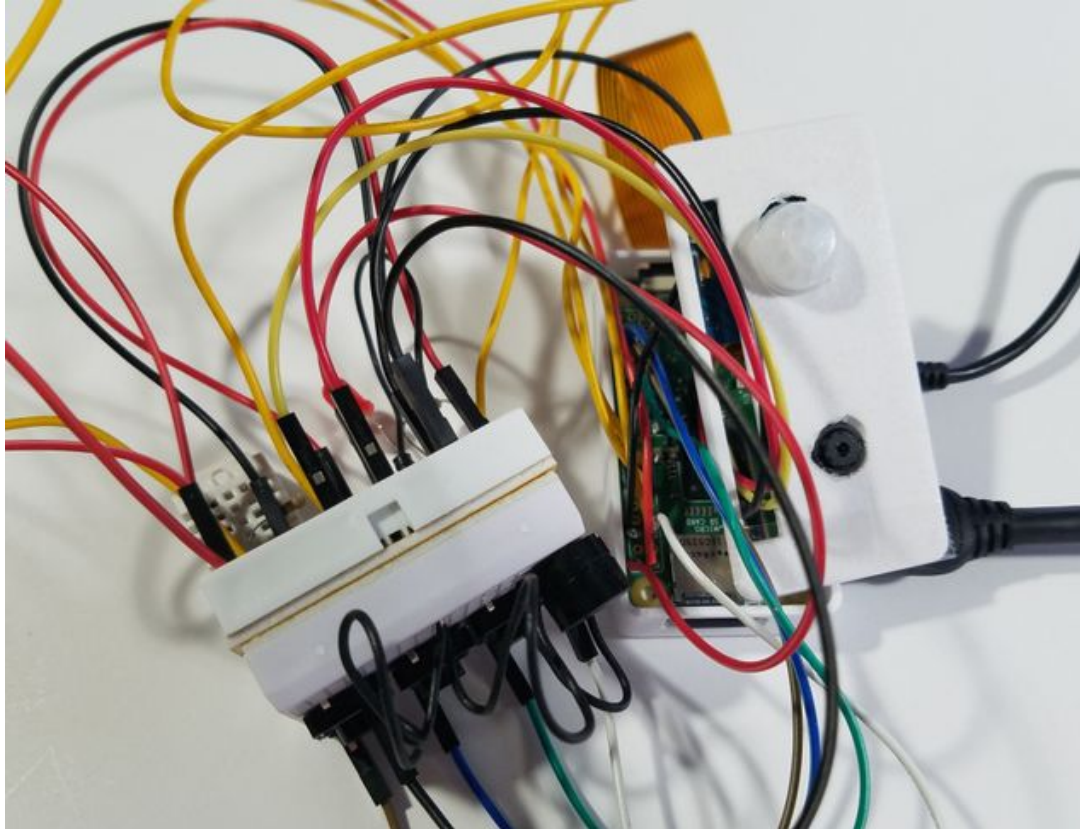
Notes on the Dirty COW - Race during Copy-on-Write - "if a local user can read a file, they can also write to it"

A 9-year old bug, where the original fix was reverted because s390 impact.
Industry observations, starting with the National Vulnerability Database

- <https://nvd.nist.gov/vuln/detail/CVE-2016-5195>
- <https://www.linux.com/blog/how-bad-dirty-cow> (serious, for a decade)
- <https://dirtycow.ninja> (the COW in a nutshell)
- <https://access.redhat.com/security/cve/CVE-2016-5195>
- <https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/commit/?id=19be0eaffa3ac7d8eb6784ad9bdbbc7d67ed8e619>
- <https://github.com/timwr/CVE-2016-5195> (Android Proof of Concept)

Thanks to Bill Ricker for these notes on Dirty COW

If that's a Dirty COW, what's this?



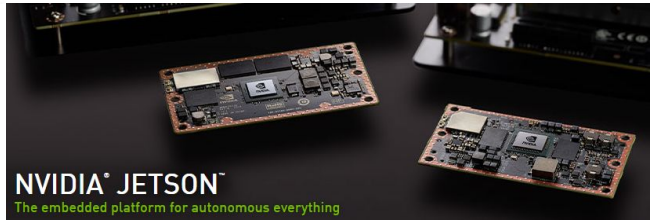
2. Intro to IoT Device Platforms



ESPRESSIF Products / Hardware / ESP8266 / ESP8285 SoC

ESP8266

Low-power, highly integrated Wi-Fi solution
 A minimal of 7 external components
 Wide temperature range: -40°C to +125°C
 ESP8285 - ESP8266 embedded with 8 Mbit flash

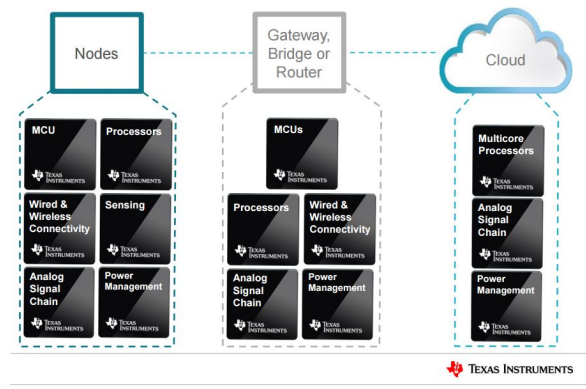


NVIDIA JETSON
 The embedded platform for autonomous everything

Write code, make IoT projects,
 and access cool tutorials!



Only TI has all the IoT building blocks



Google's Internet of Things Solutions



Weave



INTEL EDISON COMPUTE MODULE

Create prototypes and get to market faster. Bring your ideas to life with this cutting edge, adaptive technology made for a range of prototyping projects and commercial ventures.

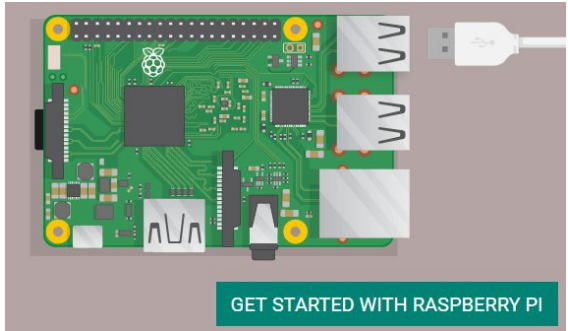
[Get Started](#) [Buy the Module](#)



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The latest and greatest in tech. All in one place.



GET STARTED WITH RASPBERRY PI

OrangePi Sales

“Another recent board released was the \$9.90 Orange Pi 2G-IoT, a small development board for IoT devices, similar to the Raspberry Pi Zero W. But the Orange Pi 2G-IoT includes a twist with a 2G modem, useful for short bursts of data transfers over long distances. With shipping, the board will cost \$13.68.”

Sales contact:

zhao_stevenAT263.net (Consulting service)

Attention Twitter:orangepixunlong

skype: zhaoyifan_steven

Facebook: +8613632793025

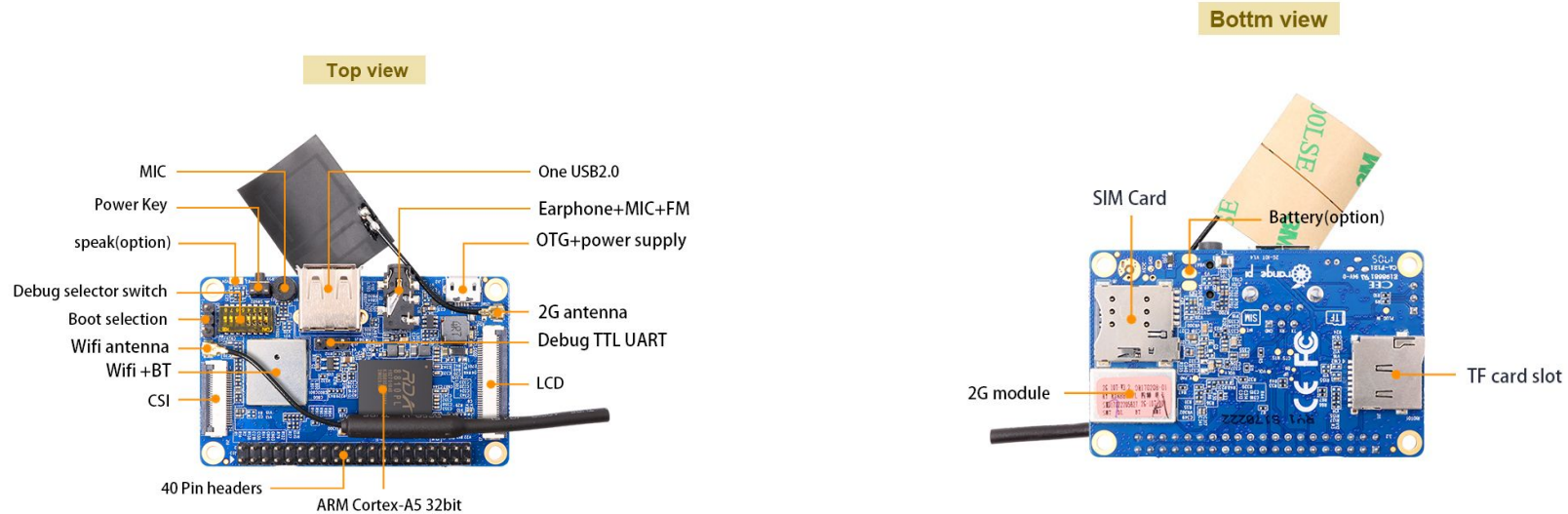
Google+:steven.zhaoyifanATgmail.com

Hardware specification	
CPU	ARM Cortex-A5 32bit
GPU	<ul style="list-style-type: none">• Separate graphic processor, Vivante's GC860• support OpenGL ES1.1/2.0• support OpenVG1.4• support DirectFB• support GDI/DirectShow• 30M Triangle/s, 250M Pixel/s
Memory (SDRAM)	Integrated 256MB LPDDR2 SDRAM
Onboard Storage	TF card / Integrated 500MB 8Bit 1.8V 4K SLC Nand Flash
Onboard WIFI+BT	RD5991, WIFI+BT
Video Input	<p>A CSI input connector Camera:</p> <p>Supports 8-bit YUV422 CMOS sensor interface</p> <p>Supports CCIR656 protocol for NTSC and PAL</p> <p>Supports SM pixel camera sensor</p> <p>Supports video capture solution up to 1080p@30fps</p>
Audio Input	MIC, 3.5 mm Jack
Video Outputs	LCD
Audio Output	3.5 mm Jack, FM, SPEAK (Optional)
2G mode	<p>The four frequency single card</p> <p>GSM/GPRS Dedicated accelerators</p> <p>SIM card</p>
USB 2.0 Ports	One USB 2.0 HOST, One USB 2.0 OTG
Power Source	<p>USB OTG input can supply power</p> <p>Battery input can supply power (Optional)</p>
Buttons	Power Button(SW602)
Low-level peripherals	40 Pins Header, compatible with Raspberry Pi B+
GPIO(1x3) pin	UART, ground.
LED	Power led
Supported OS	Android, Ubuntu, Debian, Rasberry Pi Image
Interface definition	
Product size	68mm × 42mm
Weight	21g

Orange Pi - a \$9.90 alternative

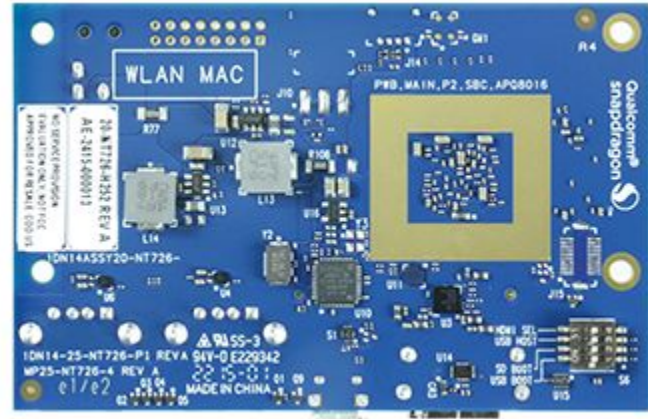
What's Orange Pi 2G-IOT?

It's an open-source single-board computer. It can run Android 4.4, Ubuntu, Debian, Rasberry Pi Image.
It uses the ARM Cortex-A5 32bit SoC, and has Integrated 256MB LPDDR2 SDRAM



DragonBoard (Qualcomm)

\$75



Source: <https://developer.qualcomm.com/hardware/dragonboard-410c>

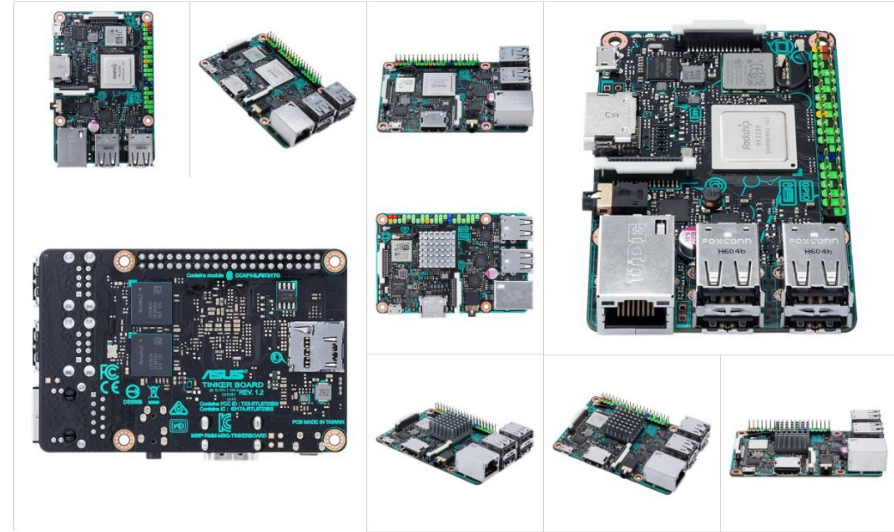
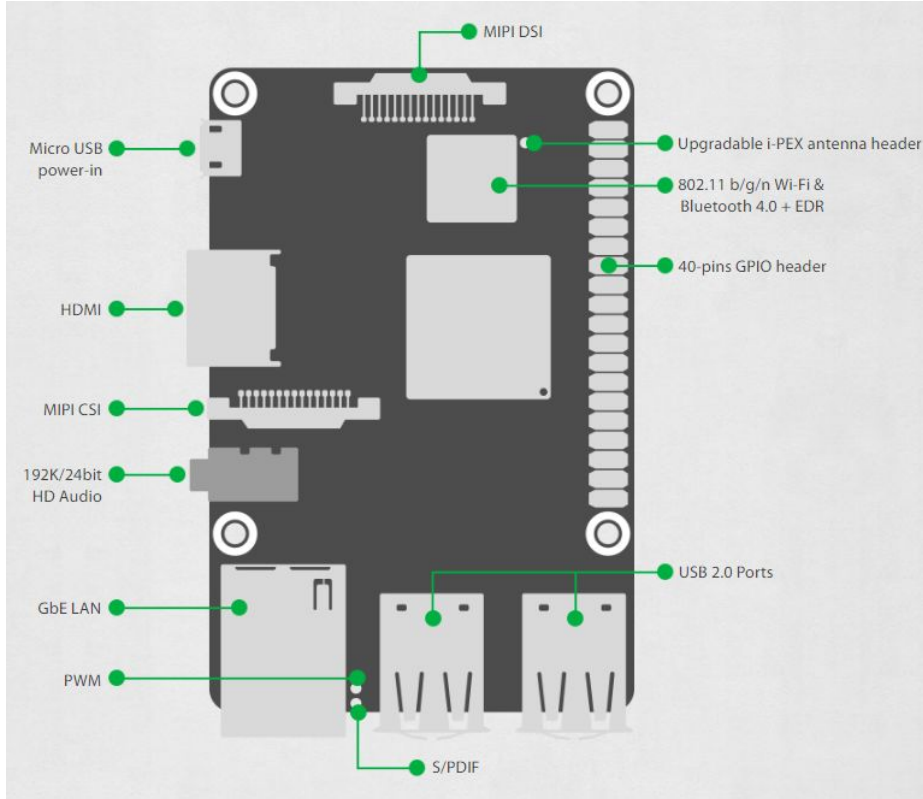
DragonBoard Features

- OS Support: Android 5.1 (Lollipop) on Linux Kernel 3.10, Linux based on Debian 8.0, and Windows 10 IoT Core
- CPU: Quad-core ARM® Cortex® A53 at up to 1.2 GHz per core
- Memory/storages: 1GB LPDDR3 533MHz / 8GB eMMC 4.5 / SD 3.0 (UHS-I)
- Graphics: Qualcomm Adreno 306 GPU with support for advanced APIs
 - OpenGL ES 3.0, OpenCL, DirectX, and content security
- Video: 1080p@30fps HD video playback and capture with H.264 (AVC)
- Camera Support: Integrated ISP with support for image sensors up to 13MP
- Wi-Fi 802.11 b/g/n 2.4GHz, integrated digital core
- Bluetooth 4.1, integrated digital core
- I/O Interfaces: HDMI Full-size Type A connector, one micro USB (device mode only), two USB 2.0 (host mode only), micro SD card slot
- And more

Source: <https://developer.qualcomm.com/hardware/dragonboard-410c>

ASUS Tinker Board

\$60



<http://www.tomshardware.com/news/asus-tinker-board-diy-iot,34190.html>

<https://www.asus.com/us/Motherboards/Tinker-Board/>




<https://www.asus.com/us/Motherboards/Tinker-Board/gallery/>

Comparing SBC Systems

Source and more at:
<https://www.board-db.org/compare/98,57,88/>

Raspberry Pi Zero vs. CHIP vs. Orange Pi PC

[Add another board](#)

	Raspberry Pi Zero <i>Raspberry Pi Foundation</i>	CHIP <i>Next Thing Co.</i>	Orange Pi PC <i>XunLong Software</i>
			
SoC	Broadcom BCM2835	AllWinner R8	AllWinner H3
CPU	ARM11 (32-bit) 1000MHz single core	ARM Cortex-A8 (32-bit) 1000MHz single core	ARM Cortex-A7 (32-bit) 1.6GHz quad core
GPU	VideoCore IV	Mali-400	Mali-400 MP2
RAM size	512MB	512MB	1GB
Built-in RAM	✓	✓	✓
Internal storage	✗	4GB	✗
SD card	MicroSD card slot Max. size: 128GB	✗	MicroSD card slot Max. size: 64GB
USB host	1	1	3
USB OTG	✓	✓	✓

Change in the Air?

Announcement: IDF17 San Francisco

Intel has evolved its event portfolio and decided to retire the IDF program moving forward. Thank you for nearly 20 great years with the Intel Developer Forum!

<https://www-ssl.intel.com/content/www/us/en/intel-developer-forum-idf/san-francisco/2017/idf-2017-san-francisco.html>

3. Deep Dive into RPi-land: The RPi Zero W



Navigation Menu of <https://www.raspberrypi.org/>

History and the RPi

“February 29, 2012 marked a day when computing was changed irrevocably. The first generation of the credit-card-sized Raspberry Pi went on sale and shifted 100,000 units within its first 24-hours.” -- <http://www.wired.co.uk/article/raspberry-pi-future>

On 9/8/16 the ten millionth sale was reported - <https://www.raspberrypi.org/blog/ten-millionth-raspberry-pi-new-kit/>

"Engineering is a wonderful tool for social mobility. Engineering doesn't care who your Dad is. Maybe your Dad can get you a nice job in some field and then you can muddle through. But engineering doesn't care: bridges stand-up or they fall down."

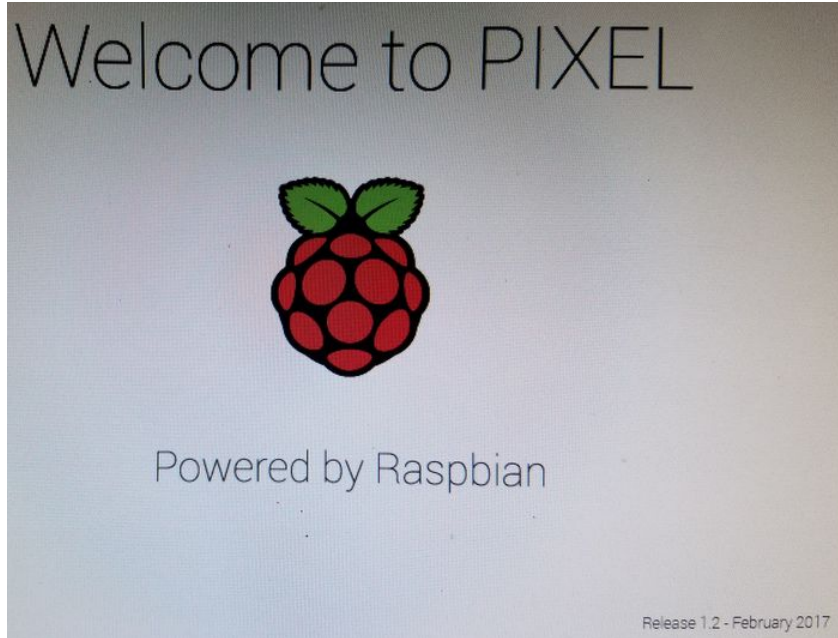
<http://www.wired.co.uk/article/raspberry-pi-future>

Raspberry Pi Hardware Line-up

- 2/29/12 - Raspberry Pi 1 Model B is introduced (Broadcom BCM2835 SoC)
- Raspberry Pi 1 Model A - simpler, less expensive than Model B)
- 5/14/13 - RPi Camera Module v1, 1080p, 720p and 640x480p video
- 2014 - Raspberry Pi 1 Model B+
- 2/15 - Raspberry Pi 2 is introduced (more memory, Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 with 256 KB shared L2 cache)
- 2/29/16 - Raspberry Pi 3 Model B, with WiFi, Bluetooth and USB boot, Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache)
- 11/15 - Raspberry Pi Zero (\$5, reduced IO and GPIO, Broadcom BCM2835, 1GHz ARM11 core, 512MB of LPDDR2 SDRAM)
- 5/16 - Pi Camera Module v2 , an 8 megapixel camera.
- 2/28/17 - Launch of Raspberry Pi Zero W (adds WiFi and Bluetooth to RPZ, price \$10)

See <http://www.raspiworld.com/viewtopic.php?t=13> and https://en.wikipedia.org/wiki/Raspberry_Pi

Raspberry Pi - A Future Focused on Software?



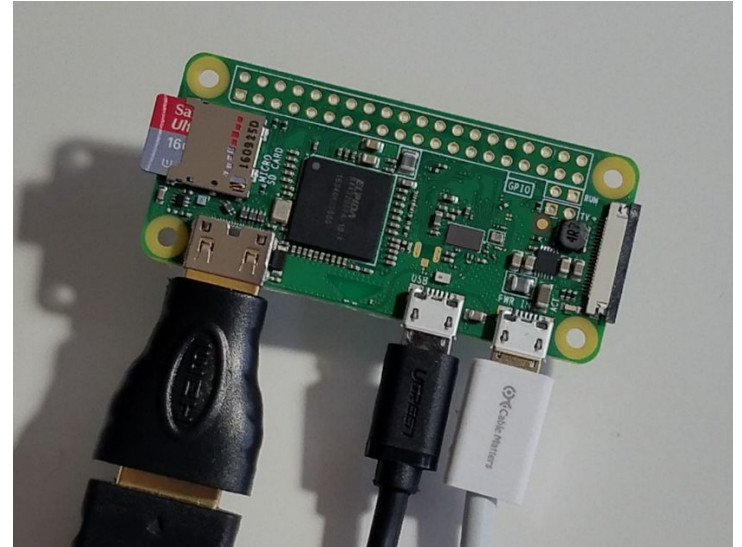
“As it sells its 12 millionth board, Raspberry Pi reveals why it's shifting away from hardware

For the next few years, Raspberry Pi will focus on its software not hardware”

Source: <http://www.wired.co.uk/article/raspberry-pi-future>

Feature list for RPi Zero W

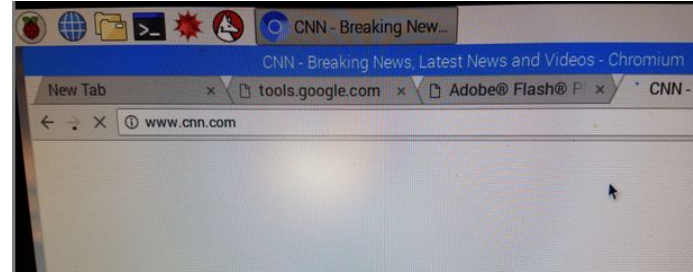
- Dimensions: 65mm × 30mm × 5mm
- SoC: Broadcom BCM2835
- CPU: ARM11 running at 1GHz
- RAM: 512MB
- Wireless: 2.4GHz 802.11n wireless LAN
- Bluetooth: Classic 4.1 and LE
- Power: 5V, via micro USB connector
- Storage / Output: MicroSD / Micro USB
- GPIO: 40-pin GPIO, unpopulated
- Pins: Run mode, unpopulated
- RCA composite, unpopulated
- Camera Serial Interface (CSI)
- Video & Audio: 1080P HD video & stereo audio via mini-HDMI connector



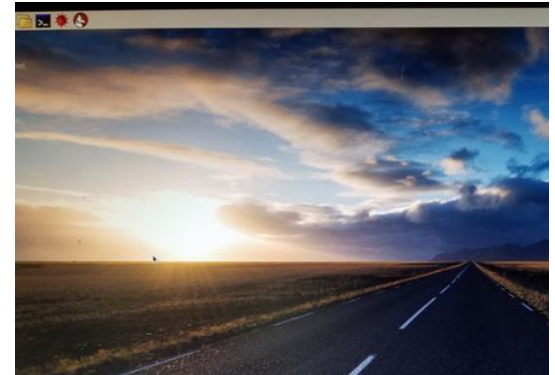
Source <https://www.raspberrypi.org/magpi/pi-zero-w/>

RPi Zero W - From Startup

1. Download Raspbian / Jessie
2. Write image onto microSD
3. Insert microSD, connect tiny HDMI, connect USB Hub (with keyboard/mouse), connect USB power source (after which it Blinks to life)
4. When it boots up, click on the WiFi icon / turn on WiFi and connect to a WiFi Access Point (or edit wpa_supplicant.conf by command line)
5. sudo nano /etc/default/keyboard and set language to “us”
6. sudo raspi-config (host name, enable SSH and camera, and set passwords)
7. sudo apt-get update, and then
8. sudo apt-get upgrade (this takes a while...) - followed by reboot
9. Install Go 1.8 (follow directions on next slide)



```
pi@raspberrypi:~$ sudo apt-get upgrade
Reading state information... Done
The following extra packages will be installed:
  golang-doc golang-go golang-go-linux-arm golang-go.tools golang-src
The following RM packages will be installed:
  golang-golang-doc golang-golang-go-linux-arm golang-go.tools golang-src
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
Need to get 25.7 MB of archives.
After this operation, 102 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://mirrorsirector.raspbian.org/raspbian/jessie/main golang-src armhf 2:1.3-1 [5,124 kB]
Get:2 http://mirrorsirector.raspbian.org/raspbian/jessie/main golang-go-linux-arm armhf 2:1.3-1 [19,207 kB]
Get:3 http://mirrorsirector.raspbian.org/raspbian/jessie/main golang-go armhf 2:1.3-1 [7,375 kB]
Get:4 http://mirrorsirector.raspbian.org/raspbian/jessie/main golang-doc all 2:1.3-1 [16,950 kB]
Get:5 http://mirrorsirector.raspbian.org/raspbian/jessie/main golang all 2:1.3-1 [202 B]
Get:6 http://mirrorsirector.raspbian.org/raspbian/jessie/main golang-go.tools armhf 2:1.3-1 [16,950 kB]
Fetched 25.7 MB in 1min 43s (249 kB/s)
Selecting previously unselected package golang-src.
Reading database ... 70%
```



Configuring WiFi from the Command Line

ADDING THE NETWORK DETAILS TO THE RASPBERRY PI

Open the `wpa-supPLICANT` configuration file in nano:

```
sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
```

Go to the bottom of the file and add the following:

```
network={
    ssid="The_ESSID_from_earlier"
    psk="Your_wifi_password"
}
```

In the case of the example network, we would enter:

```
network={
    ssid="testing"
    psk="testingPassword"
}
```

See <https://www.raspberrypi.org/documentation/configuration/wireless/wireless-cli.md>

Example of /etc/wpa_supplicant/wpa_supplicant.conf

```
GNU nano 2.5.3      File: wpa_supplicant.conf      Modified
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
country=GB

network={
    ssid="your_ssid_here"
    psk="your_password_here"
    key_mgmt=WPA-PSK
}

^G Get Help      ^O Write Out    ^W Where Is     ^K Cut Text     ^J Justify
^X Exit          ^R Read File    ^\ Replace      ^U Uncut Text  ^T To Spell
```


Remote Control your RPi by Various methods

- IP address
- Via Weaved or Dataplicity
- VNC
- SSH
- SFTP
- SCP
- SSHFS
- Rsync
- FTP
- Web Server

Install Go 1.8

1. `wget https://storage.googleapis.com/golang/go1.8.linux-armv6l.tar.gz`
2. `sudo tar -C /usr/local -xzf go1.8.linux-armv6l.tar.gz`
3. `sudo nano ~/.bashrc`
4. Then add the following:
5. `export PATH=/usr/local/go/bin:$PATH`

Set the Keyboard to US

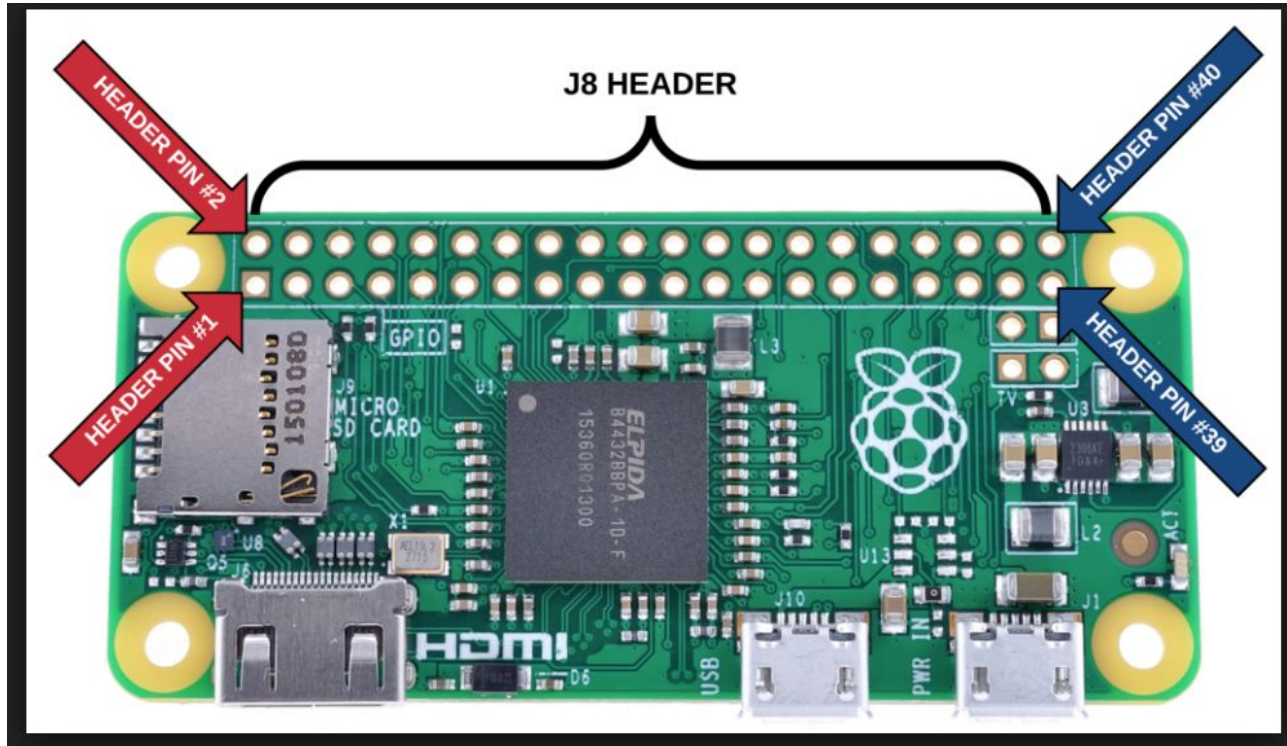
1. `sudo nano /etc/default/keyboard`
2. Change `XKBLAYOUT="gb"` to `XKBLAYOUT="us"`
3. Ctrl-X followed by yes to save
4. Reboot

nmap

Use nmap to find your Raspberry Pi

```
nmap 18.2.1.1/24 | grep ssh ...
```

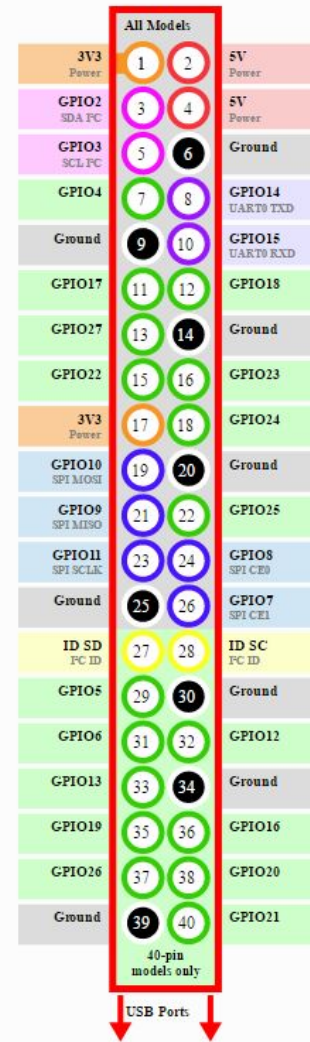
RPi Zero W Numbering



GPIO Zero

<https://gpiozero.readthedocs.io/en/stable/>

<https://gpiozero.readthedocs.io/en/stable/recipes.html#led>



Pins

<http://abyz.co.uk/rpi/pigpio/>

- 40 pin expansion header (J8).
- Hardware revision numbers of 16 or greater.
- User GPIO 2-27 (0 and 1 are reserved).

	GPIO	pin	pin	GPIO	
3V3	-	1	2	-	5V
SDA	2	3	4	-	5V
SCL	3	5	6	-	Ground
	4	7	8	14	TXD
Ground	-	9	10	15	RXD
ce1	17	11	12	18	ce0
	27	13	14	-	Ground
	22	15	16	23	
3V3	-	17	18	24	
MOSI	10	19	20	-	Ground
MISO	9	21	22	25	
SCLK	11	23	24	8	CE0
Ground	-	25	26	7	CE1
ID_SD	0	27	28	1	ID_SC
	5	29	30	-	Ground
	6	31	32	12	
	13	33	34	-	Ground
miso	19	35	36	16	ce2
	26	37	38	20	mosi
Ground	-	39	40	21	sclk

What apps are installed?

Here are ways to find out what is pre-installed

- Preinstalled automatic - `apt-mark showauto`
- Manually installable - `apt-mark showmanual`
- Search it: `apt-mark showauto | grep spi`
- Save it: `apt-mark showauto > packagelist.txt`
- Save it: `apt-mark showmanual > packagelist.txt`

What packages are installed?

- Version, architecture, description table: `dpkg-query -l`
- Check status: `dpkg-query -l '*' | less`
- Package names only, one per line: `dpkg-query -f '${binary:Package}\n' -W`
- Search: `dpkg-query -l '*golang*`
- Show installed packages: `dpkg -l | grep '^.i'`

Install Some Extra Goodies

- FileZilla - `sudo apt-get install filezilla`
- MP4box - `sudo apt-get install -y gpac`
- MPV - video player
- ...

Camera

Full camera software documentation can be found at

<https://www.raspberrypi.org/documentation/raspbian/applications/camera.md>

<https://www.raspberrypi.org/documentation/configuration/camera.md>

Run raspi-config, choose option 5 - interfacing. Then enable the camera and reboot.

There are three applications provided: raspistill, raspivid, and raspistillyuv. raspistill and raspistillyuv are very similar and are intended for capturing images; raspivid is for capturing video.

Photos via Camera-raspistill

For all options, run raspistill

```
raspistill -o cam.jpg
```

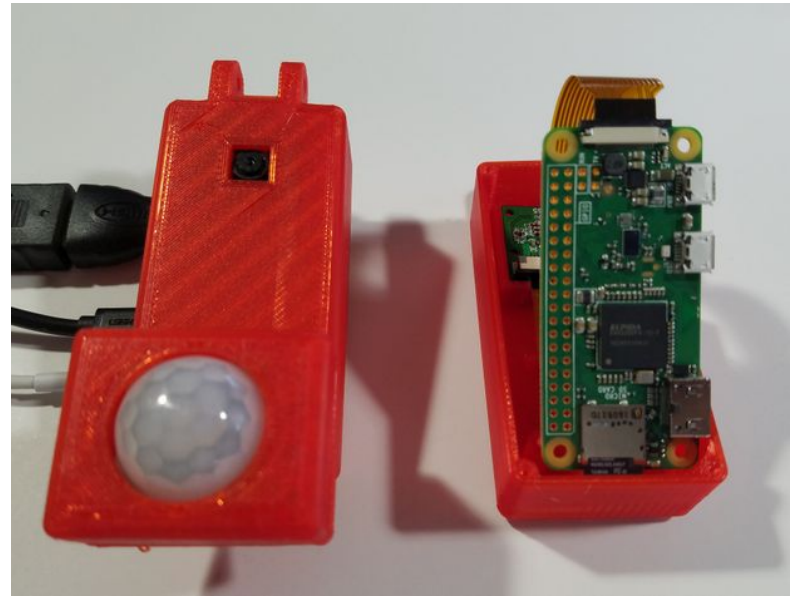
VERTICAL FLIP & HORIZONTAL FLIP

```
raspistill -vf -hf -o cam2.jpg
```

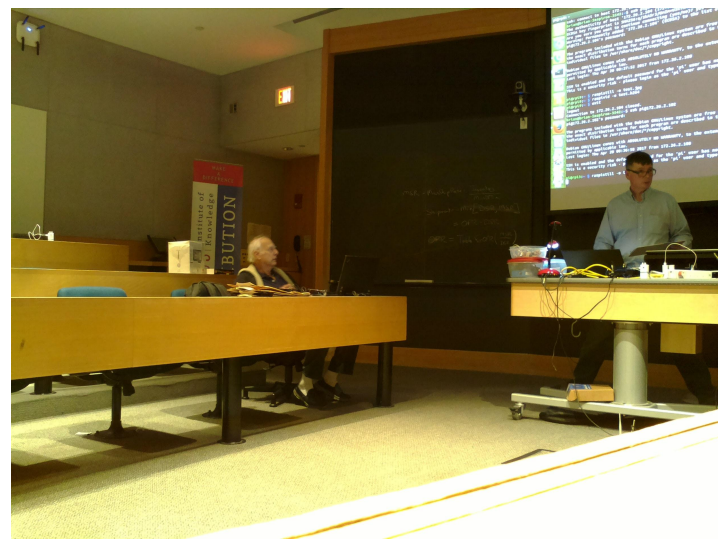
```
#!/bin/bash
```

```
DATE=$(date +"%Y-%m-%d_%H%M")
```

```
raspistill -vf -hf -o /home/pi/camera/$DATE.jpg
```



Images from Raspberry Pi Zero W devices in classroom



Let's make a video (and MP4 it)

<https://www.raspberrypi.org/documentation/usage/camera/raspicam/raspivid.md>

```
# 30 seconds of raw vid at 640x480 and 150k B/s bit rate into a pvideo.h264 file:  
raspivid -t 30000 -w 640 -h 480 -fps 25 -b 1200000 -p 0,0,640,480 -o pvideo.h264  
# Wrap the raw video with an MP4 container:  
MP4Box -add pvideo.h264 pvideo.mp4  
# Remove the source raw file, leaving the remaining pvideo.mp4 file to play  
rm pvideo.h264
```

Audio, AV / Media

Sudo apt-get install audacity

Sudo apt-get install libav-tools

For audio streamed over Bluetooth - you need to install a few things

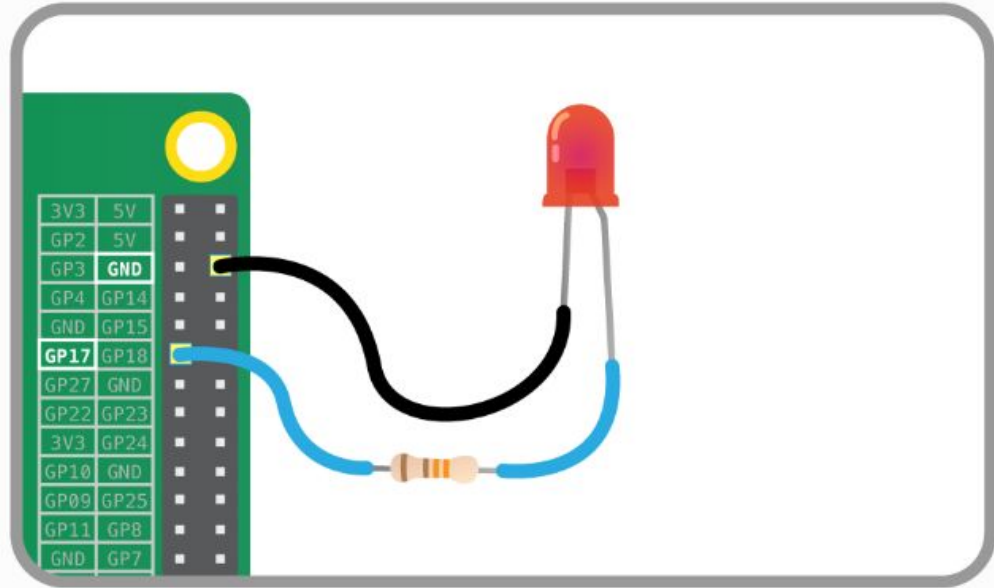
sudo apt-get install pulseaudio pavucontrol pulseaudio-module-bluetooth

<https://www.raspberrypi.org/magpi/bluetooth-audio-raspberry-pi-3/>

try mpg123 (apt-get install mpg123)

LED

Blink



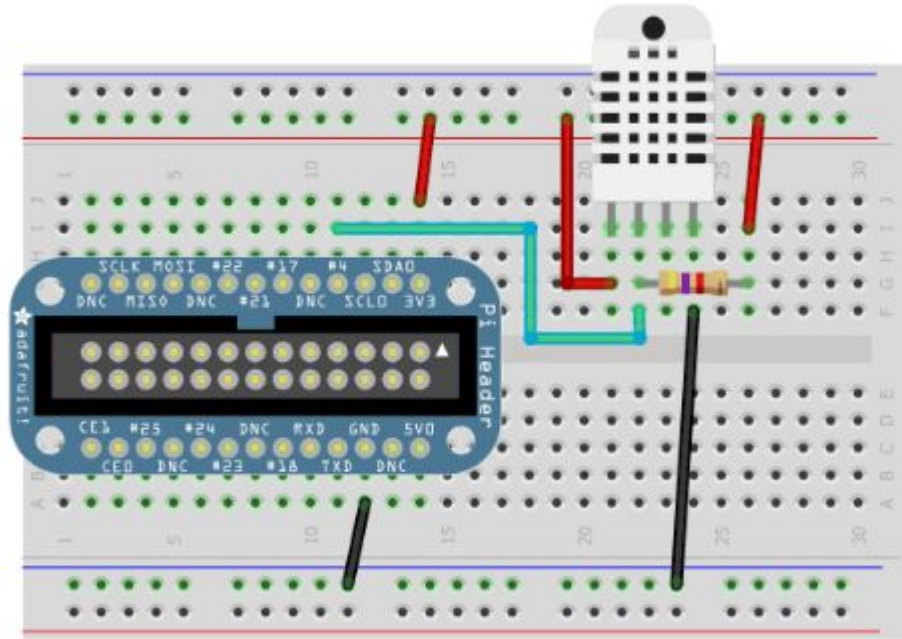
Turn an `LED` on and off repeatedly:

```
from gpiozero import LED
from time import sleep

red = LED(17)

while True:
    red.on()
    sleep(1)
    red.off()
    sleep(1)
```


Temp and Humidity



<https://learn.adafruit.com/dht-humidity-sensing-on-raspberry-pi-with-gdocs-logging>

Temp & Humidity requires installs ...

https://github.com/adafruit/Adafruit_Python_DHT

```
sudo apt-get update
```

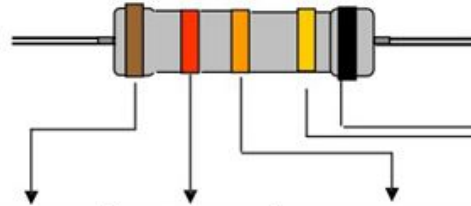
```
sudo apt-get install build-essential python-dev
```

Then, install the AdaFruit Library

https://github.com/adafruit/Adafruit_Python_DHT

And run samples ...

Ready or Resistance?



COLOR	1 ST DIGIT	2 ND DIGIT	MULTIPLIER	TOLERANCE	IDENTIFICATION
BLACK	0	0	1		WIREWOUND RESISTOR
BROWN	1	1	10	F ($\pm 1\%$)	
RED	2	2	100		
ORANGE	3	3	1,000		
YELLOW	4	4	10,000		
GREEN	5	5	100,000		
BLUE	6	6	1000,000		
VIOLET	7	7	10,000,000		
GREY	8	8			
WHITE	9	9			
GOLD			0.1	J ($\pm 5\%$)	
SILVER			0.01		

Questions? Discussion?