INTRODUCTION TO THE RASPBERRY PI

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What is going to be covered

- Introduction to the Raspberry Pi
- Technical overview of Raspberry Pi models
- Comparing the Raspberry Pi with other devices – e.g., Arduino
- How do I get started?
- Examples
- Resources
- Q & A

Introducing the Raspberry Pi

The Raspberry Pi is part of a family of low-cost, high-performance computers that people use to learn, solve problems, and have fun.

The UK-based charity, the Raspberry Pi Foundation, is the organization that is responsible for the Pi. They work “to put the power of digital making into the hands of people all over the world, so they are capable of understanding and shaping our increasingly digital world.”

Introducing the Raspberry Pi

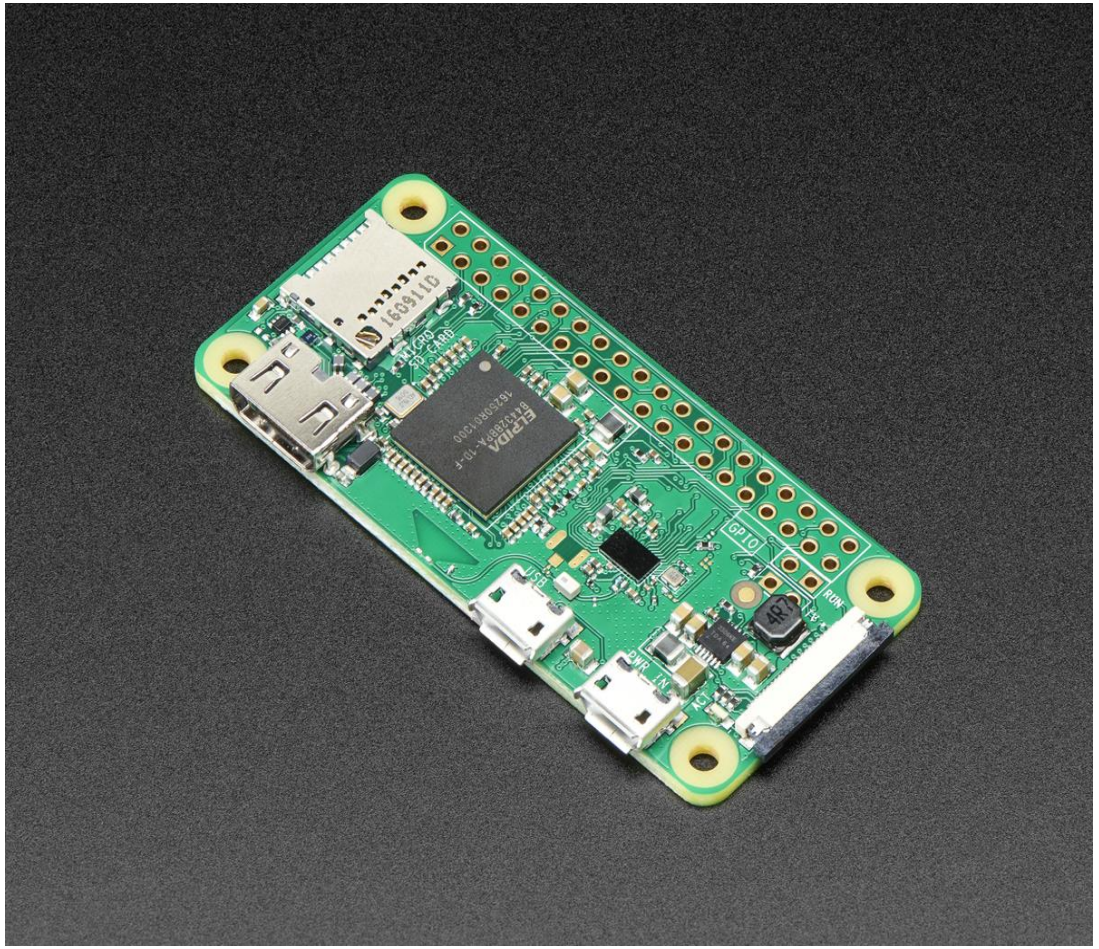
The first Pi, the Model 1 B, was released in April of 2012 and the most recent one, the Model 3 B+, was released on March 14, 2018 (Pi Day 2018). Some models (e.g., Model 2) have been omitted for space.

Model	Released	CPU Speed	Memory	Cost (USD)
Pi Model 1 B	Apr 2012	700 MHz	256 MB	$25
Pi Model 1A	Feb 2013	700 MHz	256/512 MB	$25/$20
Pi Zero	Nov 2015	1 GHz	512 MB	$5
Model 3 B	Feb 2016	1.2 GHz	1 GB	$35
Pi Zero W	Feb 2017	1 GHz	512 MB	$10
Pi Zero WH	Jan 2018	1 GHz	512 MB	$14
Model 3 B+	Mar 2018	1.4 GHz	1 GB	$25

Raspberry Pi 3 Model B+ - $35-$40

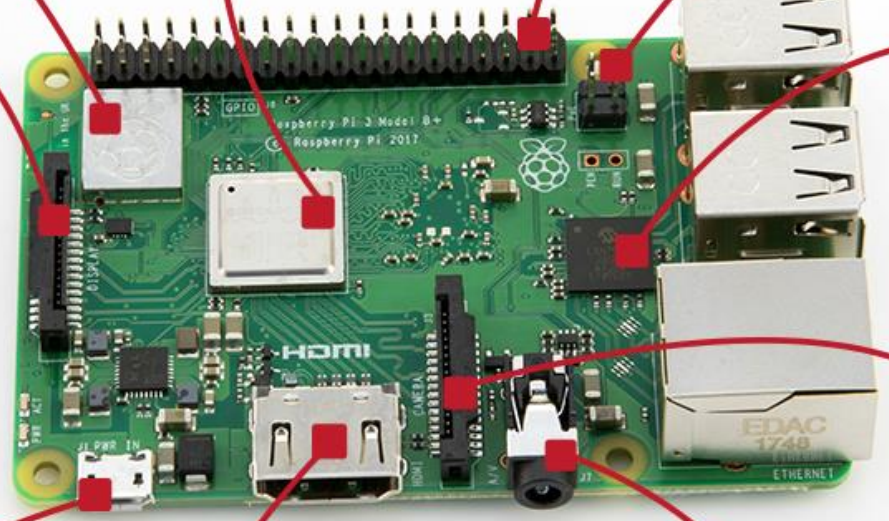
- 1.4 GHz, 64 bit, quad-core CPU
- 1 GB RAM
- Ethernet with POE option
- 802.11 b/g/n/ac wireless 2.4/5 GHz
- Bluetooth 4.2
- Bluetooth Low Energy (BLE)
- Full size HDMI
- 4 USB 2.0 ports
- HAT-compatible 40-pin header
- Composite video and audio out
- Camera and display port connectors

Raspberry Pi Zero/W/WH - $5, $10, $14



- 1 GHz, single-core CPU
- 512 MB RAM
- 802.11 b/g/n wireless 2.4 GHz only
- Bluetooth 4.1
- Bluetooth Low Energy (BLE)
- Mini HDMI
- 1 USB (On-The-Go compatible port)
- Micro USB power
- HAT-compatible 40-pin header
- Composite video and reset headers
- CSI camera connector

Raspberry Pi 3 Model B+



Extended 40-pin GPIO header

Power over Ethernet (PoE) header
(requires separate PoE HAT)

2.4GHz and 5GHz IEEE
802.11.b/g/n/ac wireless LAN,
Bluetooth 4.2, BLE

Broadcom BCM2837B0, Cortex-A53
64-bit SoC @ 1.4GHz
with 1GB LPDDR2 SDRAM

4 × USB 2.0 ports and
Faster Ethernet over USB 2.0
(maximum throughput 300Mbps)

MIPI DSI display port

2.2 inches
56mm

MIPI CSI camera port

85mm
3.35 inches

5V/2.5A DC via micro
USB connector

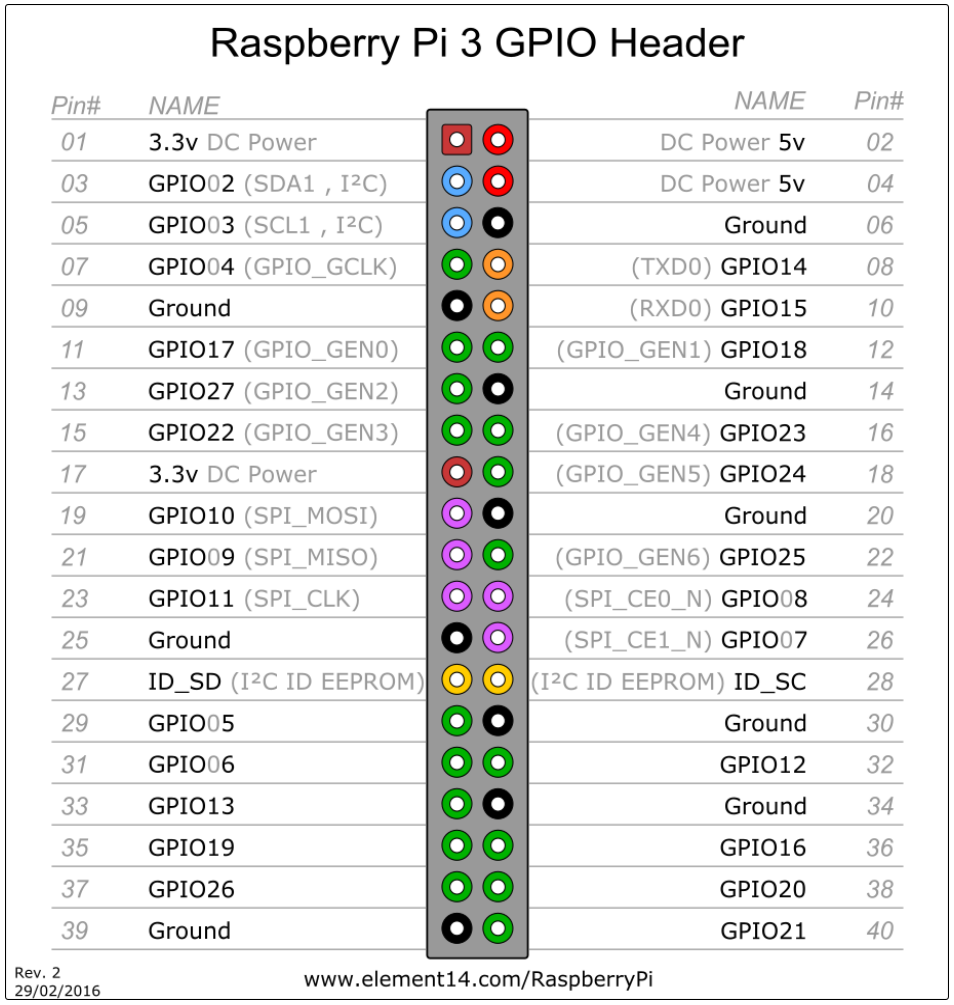
Full size HDMI

4 pole stereo output and composite video port

element14.com/RaspberryPi

element14 COMMUNITY

General Purpose Input/Output (GPIO) Header



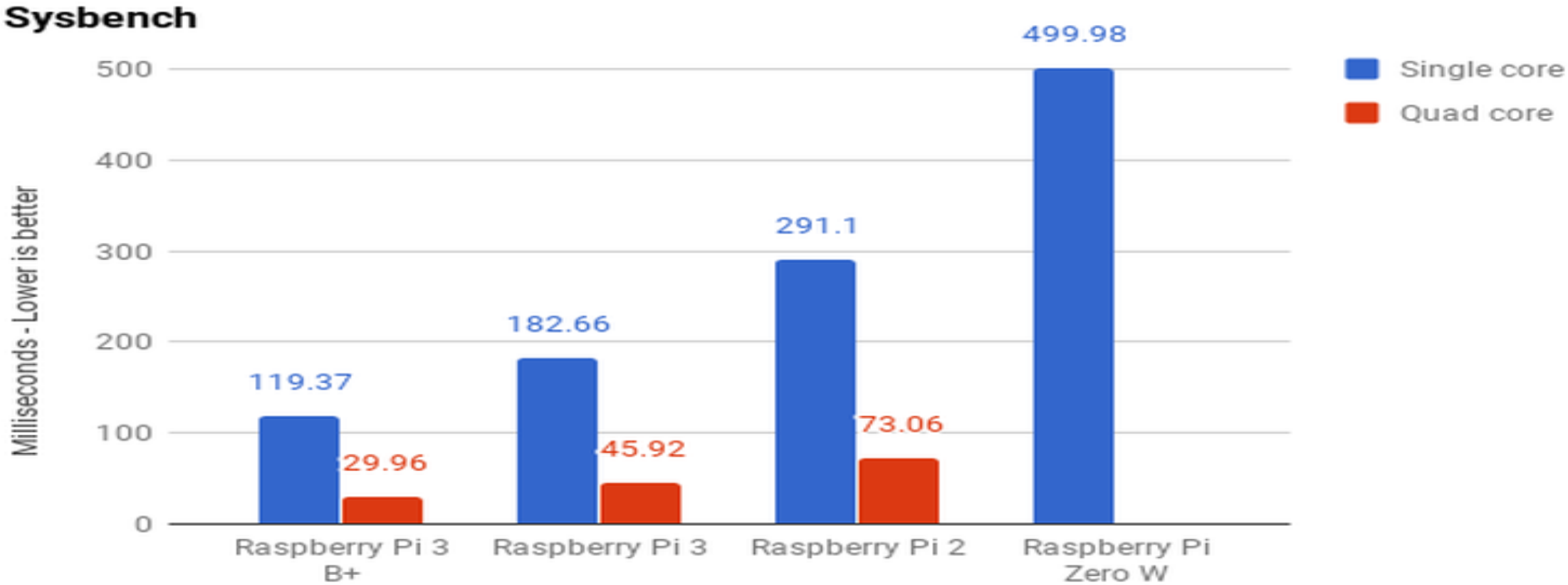
Besides the USB ports, the GPIO header is another way that external devices can be interfaced with the Raspberry Pi.

GPIO pins can be configured to be digital inputs or digital outputs. No analog input, but other strategies can be used to read input voltage.

Hardware serial TX/RX, I2C, and SPI.

Limited drive (sink/source) capacity (8 ma per pin on power up, 16 ma maximum).

Important: The Raspberry Pi is a 3V device. Do not apply more than 3.3 volts or less than 0 volts to the GPIO pins.



https://www.techrepublic.com/article/raspberry-pi-3-model-b-review-hands-on-with-the-new-board/

Power Consumption and Software

- Power consumption varies by model, but is approximately 1.5 watts when idle and a maximum of 6 watts under stress (aka doing things like SDR). The B+ has the highest power profile, which was a bit surprising at first glance.
- Free operating systems (OS) are available, nearly all Linux based.
  - Graphical user interface (e.g., desktops)
  - Command line/shell only distributions as well
  - Most are bundled with productivity applications (OpenOffice, etc.)
  - Screen readers are supported as well (although not JAWS)

Software

- The current “default” OS is Raspbian, based on Debian Stretch and paired with the PIXEL desktop. Other Linux distros available include CentOS, Ubuntu, and a handful of others.
- Custom distros are also available that are designed for out-of-the-box, plug-and-play applications
  - Home Assistant (home automation)
  - OpenHAB (home automation)
  - SDRPlay (software defined radio)
- Lots of ways to be productive right from the start.

But I want to run Windows

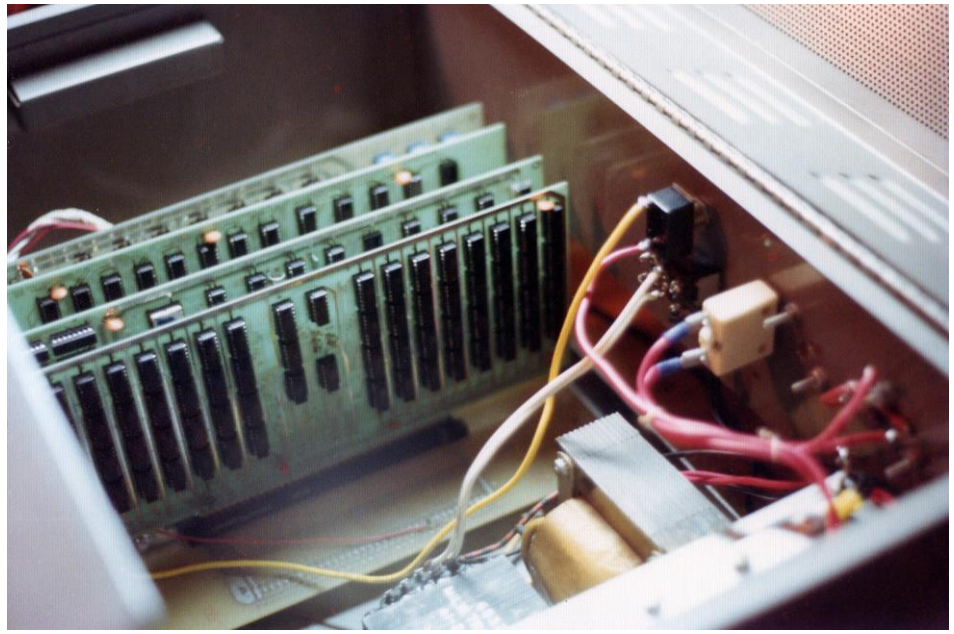
Well, you can, kind-of

- Windows 10 IoT (Internet of Things) Core is available
- Windows 10 for ARM (Advanced Reduced-instruction set computer Machine)
- Mixed reviews, I haven't been impressed with Core and ARM not yet ready

WINE?

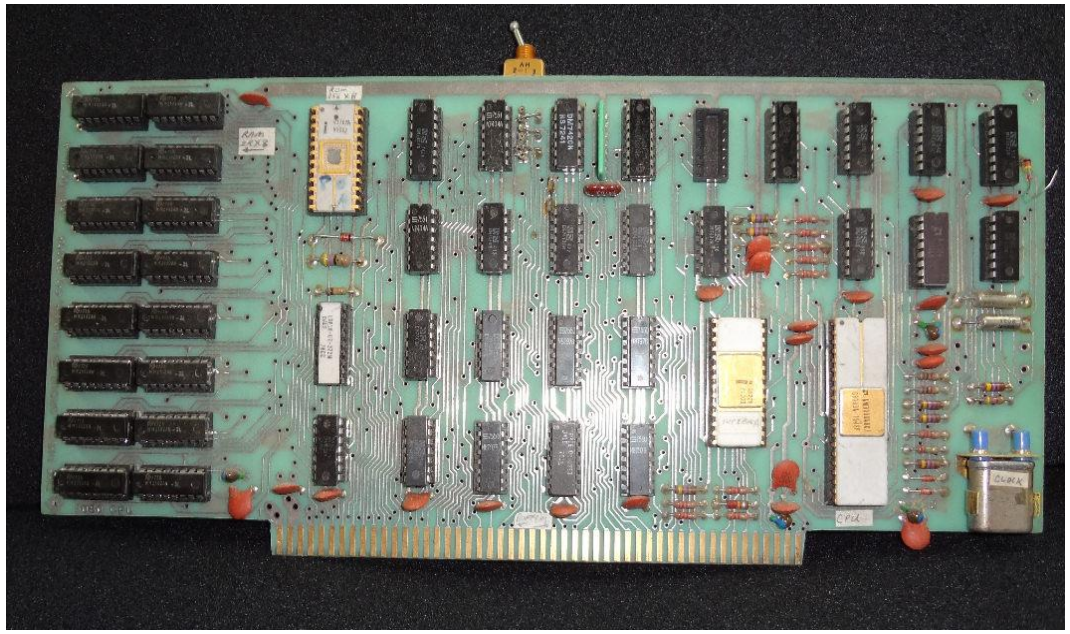
- Wine Is Not an Emulator!
- Designed to run Windows binaries under Linux
- Windows binaries tend to be X86/i586 not ARM, so these processors need to be emulated before passing along to WINE.

Performance comparison



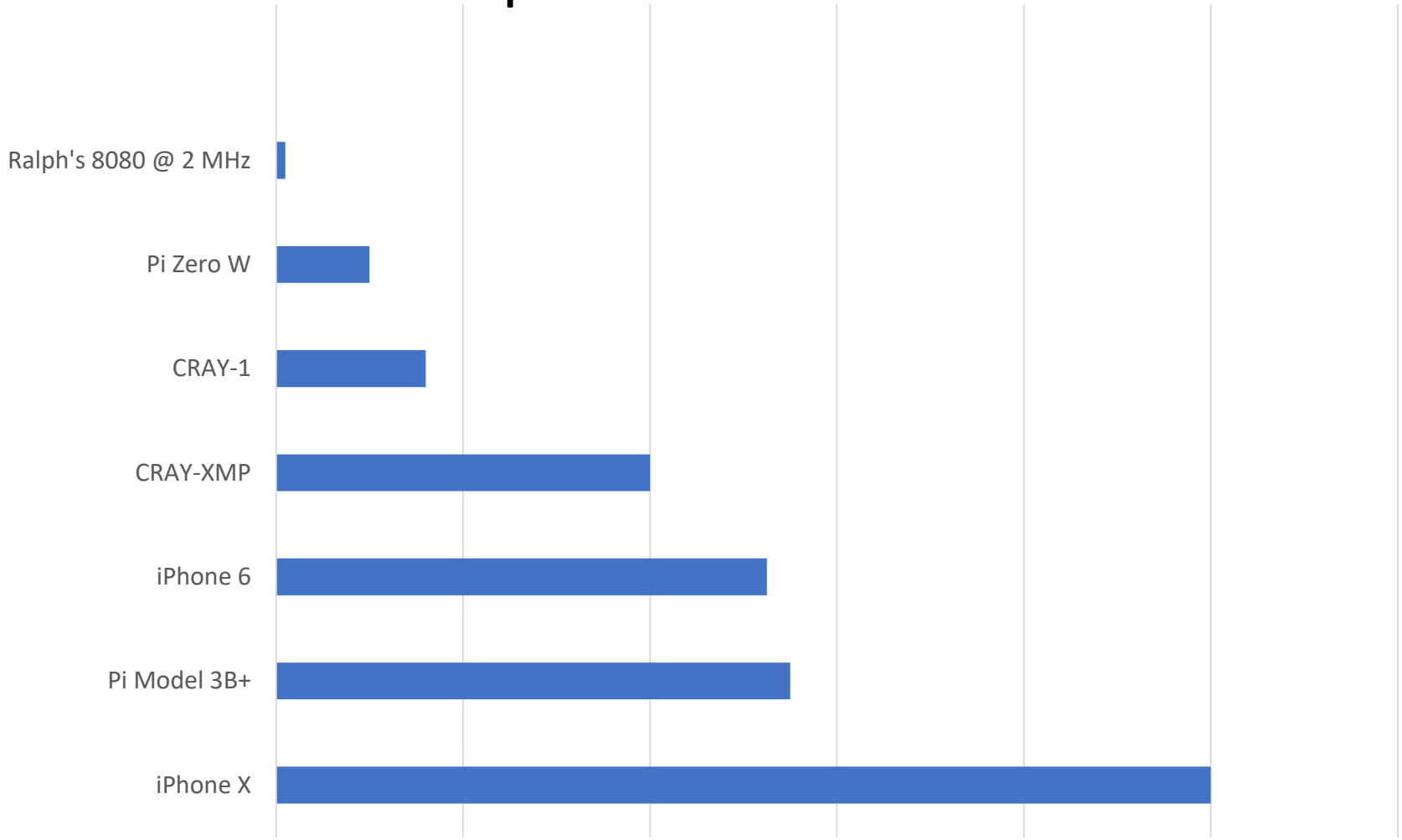
My first computer that I built, circa 1975 – Digital Group 8080/Z80 designed by Dr. Robert Suding, W0LMD/SK

Performance comparison



vs

Performance comparison



Raspberry Pi vs “Arduino”

- Arduino is a micro-controller
- Raspberry Pi, a general purpose micro-computer
- Each has its strengths, depending on the purpose
- Overlap in functionality
- Often work together in a symbiotic relationship
  - Arduino as a data gatherer and pre-processor
  - Pi for the analytics, presentation, or data archiving

Raspberry Pi vs “Arduino”

Which is best for a starter system?

Not as easy to answer.

How Do I Get Started?

Getting Started – The essentials

Raspberry Pi 3 , Pi Zero W, or Pi Zero WH (with header).

MicroSD card – 4 GB or larger. Class 10 recommended.

5V supply capable of delivering 2.5 amps; average draw much less than 1A.

My switchers have been pretty quiet.

USB Keyboard and mouse – wireless dongles work, Bluetooth as well.

HDMI cable (Mini-HDMI for Pi Zero)

Case. Highly recommended and large variety available.

A means to transfer software image to MicroSD card.

Getting Started – The extras

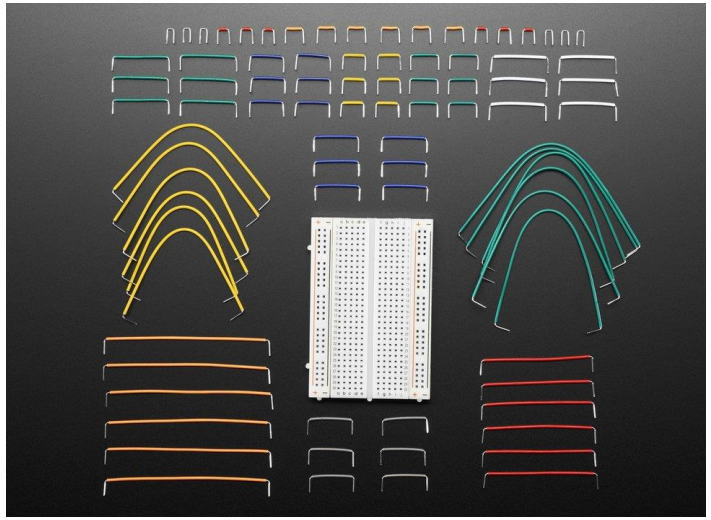
Breadboard

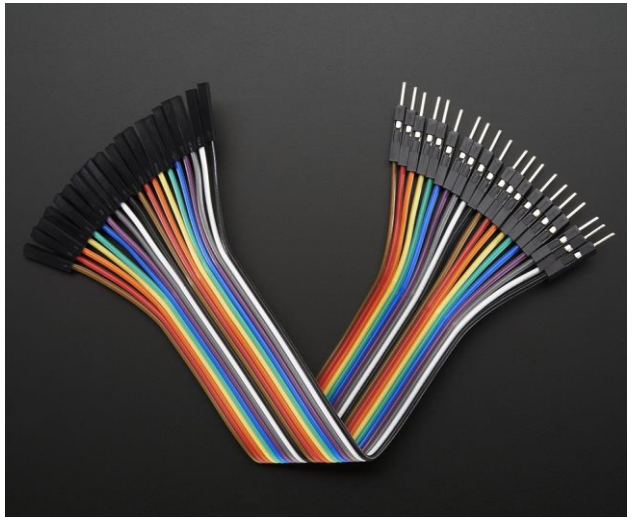
Wire jumpers for breadboard

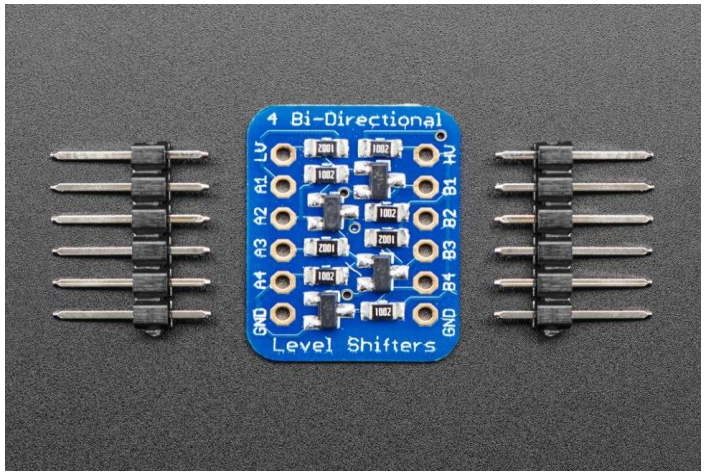
Jumper assortment (MF, FF, and MM)

Bi-directional level converter from 5V logic level to 3V

MicroSD card reader, if not built in to your computer.







GPS, Sensors, Relays, HATs, Oh My

GPS board (Did I hear you say, APRS?)

Weather sensors – Temperature, humidity, and barometric pressure

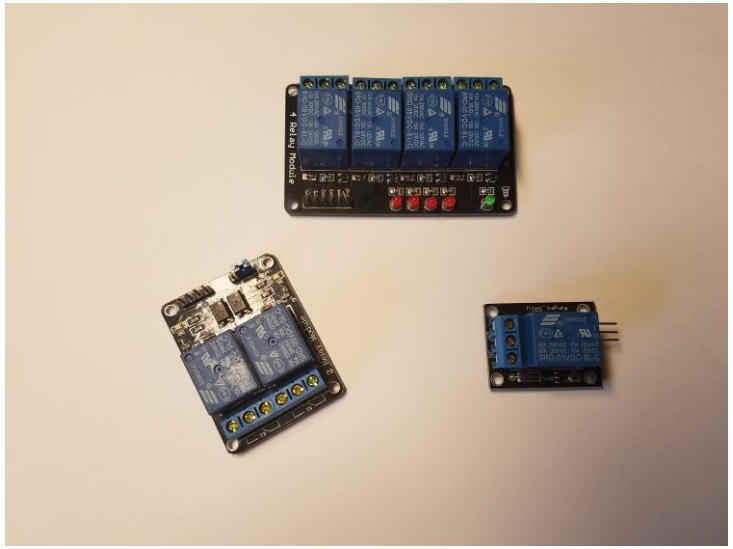
Motion and proximity sensors, range finders (laser TOF, IR, and ultrasonic), sound and noise detectors.

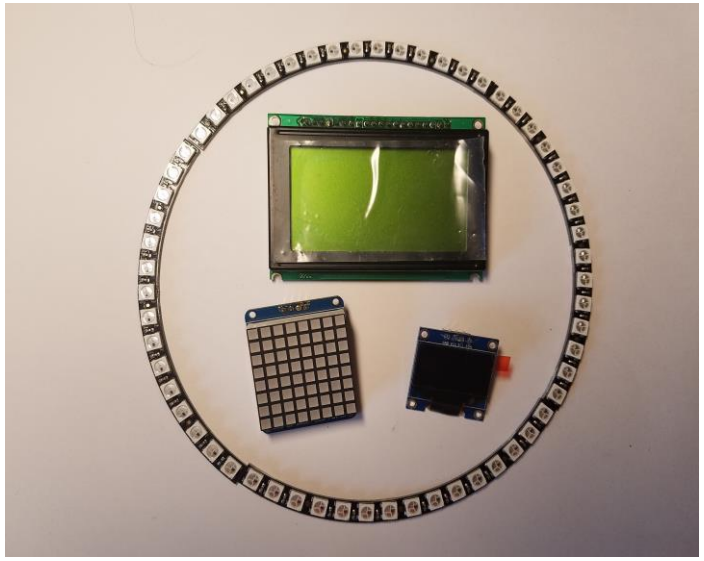
Relay boards to isolate Pi from mains.

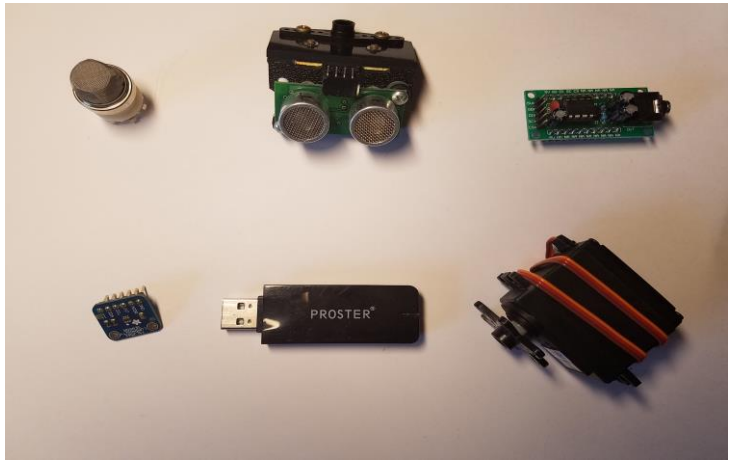
Video and still cameras

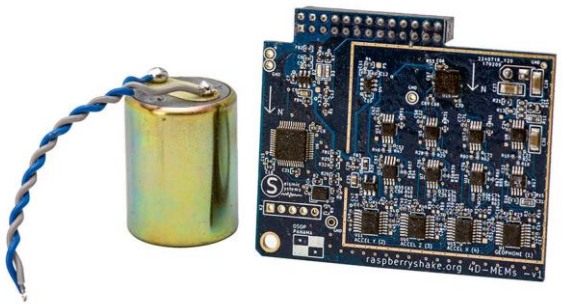
Daughter boards (Hardware Attached on Top or HAT)

And much, much more.









Let’s Get Started – Step by Step

The Raspberry Pi site (https://www.raspberrypi.org) has a wealth of information about setting up and using your Raspberry Pi.

There is a page on installing an operating system on the Pi, which can be seen here:

https://www.raspberrypi.org/documentation/installation/installing-images/

The next few slides will summarize the process.

Let’s Get Started – Step by Step

1. Obtain a software image
   a. https://www.raspberrypi.org/downloads/
   b. http://www.sdrplay.com/software/SDRplay_RPi3_V0.3.img.7z
   c. https://www.microsoft.com/en-us/software-download/windows10IoTCore

2. Download and move the image to the Micro SD card
   a. Download the Raspberry Pi image to your local computer.
   b. Insert a MicroSD card into your computer’s card reader or external adapter.
   c. Using a disk image utility, such as Etcher (https://etcher.io Windows, Mac, or Linux), transfer the image to the MicroSD card.

3. Plug the MicroSD card into the Pi, contacts side up.

Let’s Get Started – Step by Step

4. Attach a monitor to the Pi using the HDMI, Mini-HDMI, or Composite video port.
5. Plug in a USB keyboard and mouse (or dongle for USB kb and mouse).
6. Attach 5V power supply (2.0-2.5 amps) and apply power.
7. If all goes well, you will see four Raspberry Pi images and the operating system will begin to boot.
8. The desktop will display after a minute or so (or the login prompt if you are not using the desktop).

Let’s Get Started – Step by Step

9. Configure the WiFi settings, if you want the Pi to be on the network.
10. Under the Configuration menu, set the time zone, keyboard language, and WiFi country.
11. Optionally, turn on SSH (secure shell) and the VNC (Virtual Network Computing) server. This will allow access to the Pi from other computers. USE WITH CAUTION AND CHANGE THE DEFAULT PASSWORD!

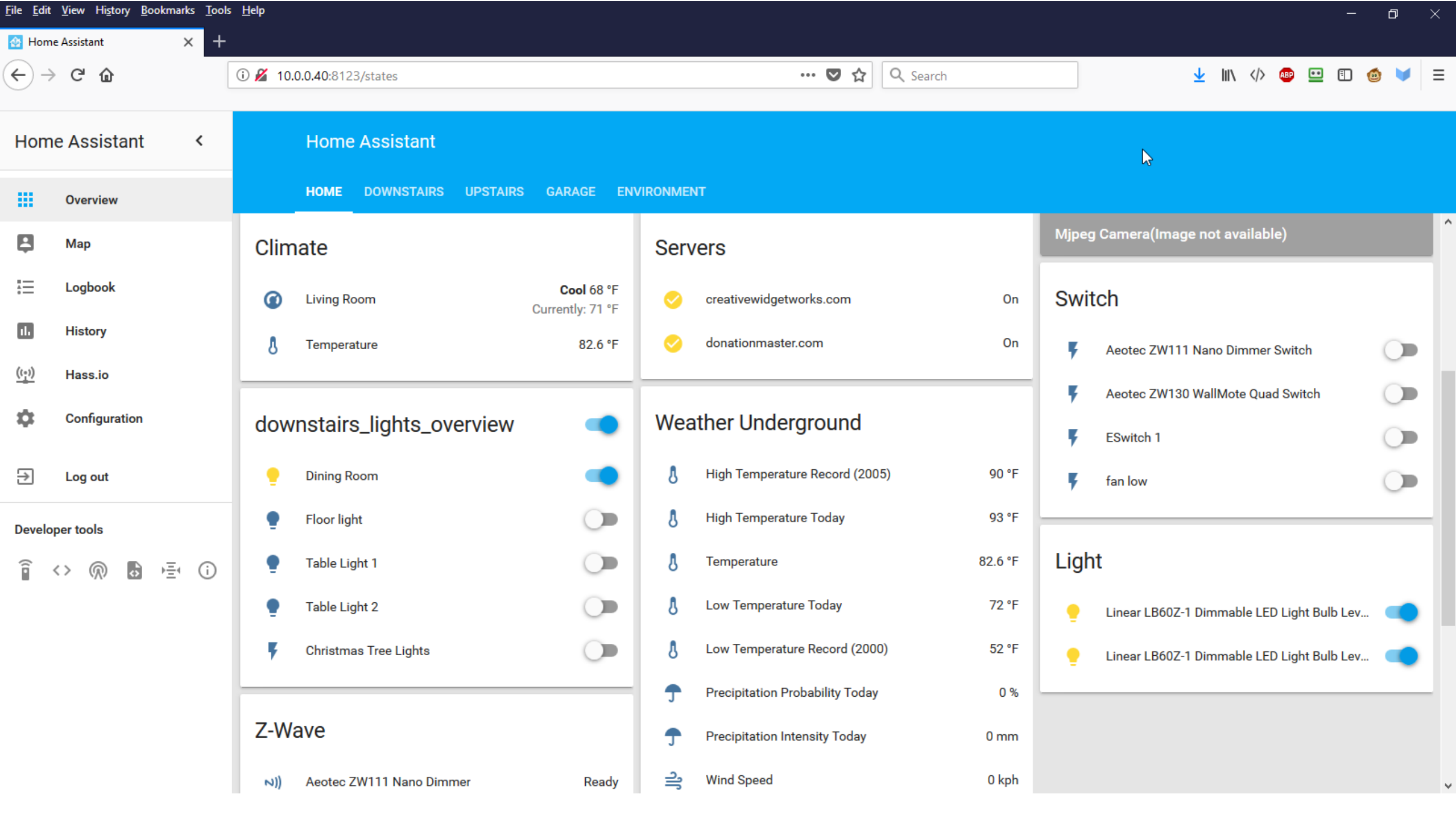
What can I do with this thing?

Home Automation

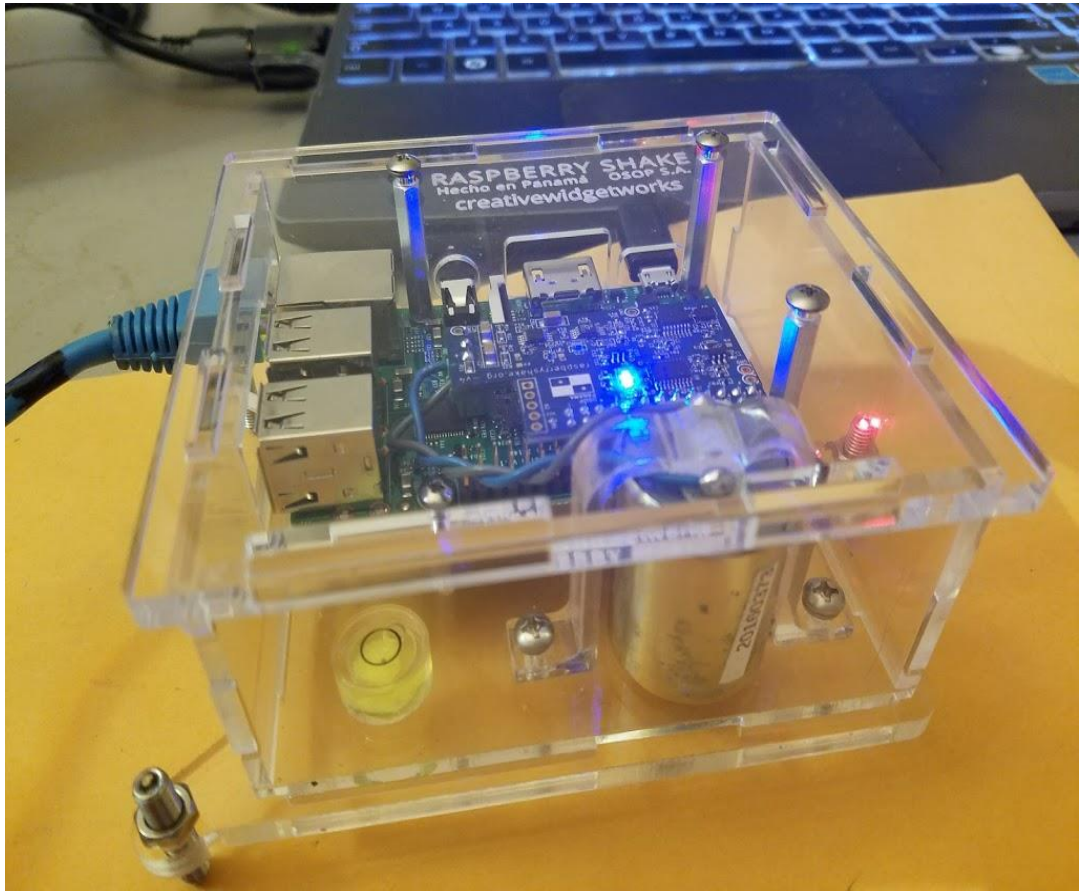
Home Assistant https://www.home-assistant.io/

OpenHAB https://www.openhab.org/

- Raspberry Pi “ready-to-flash” images available
- Highly customizable
- Alexa and Google Home supported
- Custom integrations such as homebrew controllers and radio control are easily incorporated and controlled locally (e.g., not in the cloud)

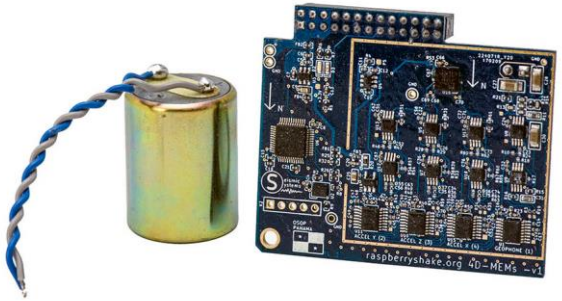

File Edit View History Bookmarks Tools Help
Home Assistant
10.0.0.40:8123/states
Search
Home Assistant
Overview
Map
Logbook
History
Hass.io
Configuration
Log out
Developer tools
Home Assistant
HOME
DOWNSTAIRS
UPSTAIRS
GARAGE
ENVIRONMENT
Climate
Living Room
Cool 68 °F
Currently: 71 °F
Temperature
82.6 °F
Servers
creativewidgetworks.com
On
donationmaster.com
On
Mjpeg Camera(Image not available)
Switch
Aeotec ZW111 Nano Dimmer Switch
Aeotec ZW130 WallMote Quad Switch
ESwitch 1
fan low
downstairs_lights_overview
Dining Room
Floor light
Table Light 1
Table Light 2
Christmas Tree Lights
Weather Underground
High Temperature Record (2005)
90 °F
High Temperature Today
93 °F
Temperature
82.6 °F
Low Temperature Today
72 °F
Low Temperature Record (2000)
52 °F
Precipitation Probability Today
0 %
Precipitation Intensity Today
0 mm
Wind Speed
0 kph
Light
Linear LB60Z-1 Dimmable LED Light Bulb Lev...
Linear LB60Z-1 Dimmable LED Light Bulb Lev...
Z-Wave
Aeotec ZW111 Nano Dimmer
Ready

Monitor Earthquakes

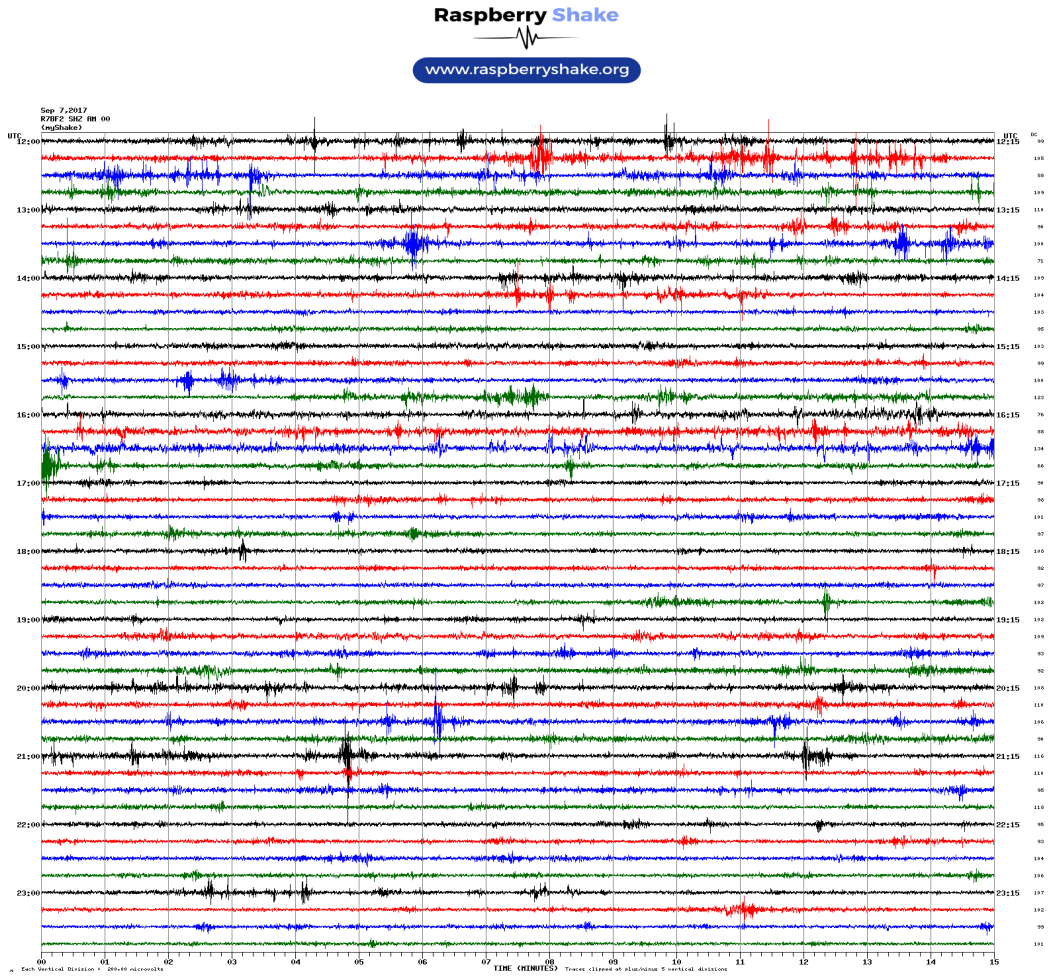


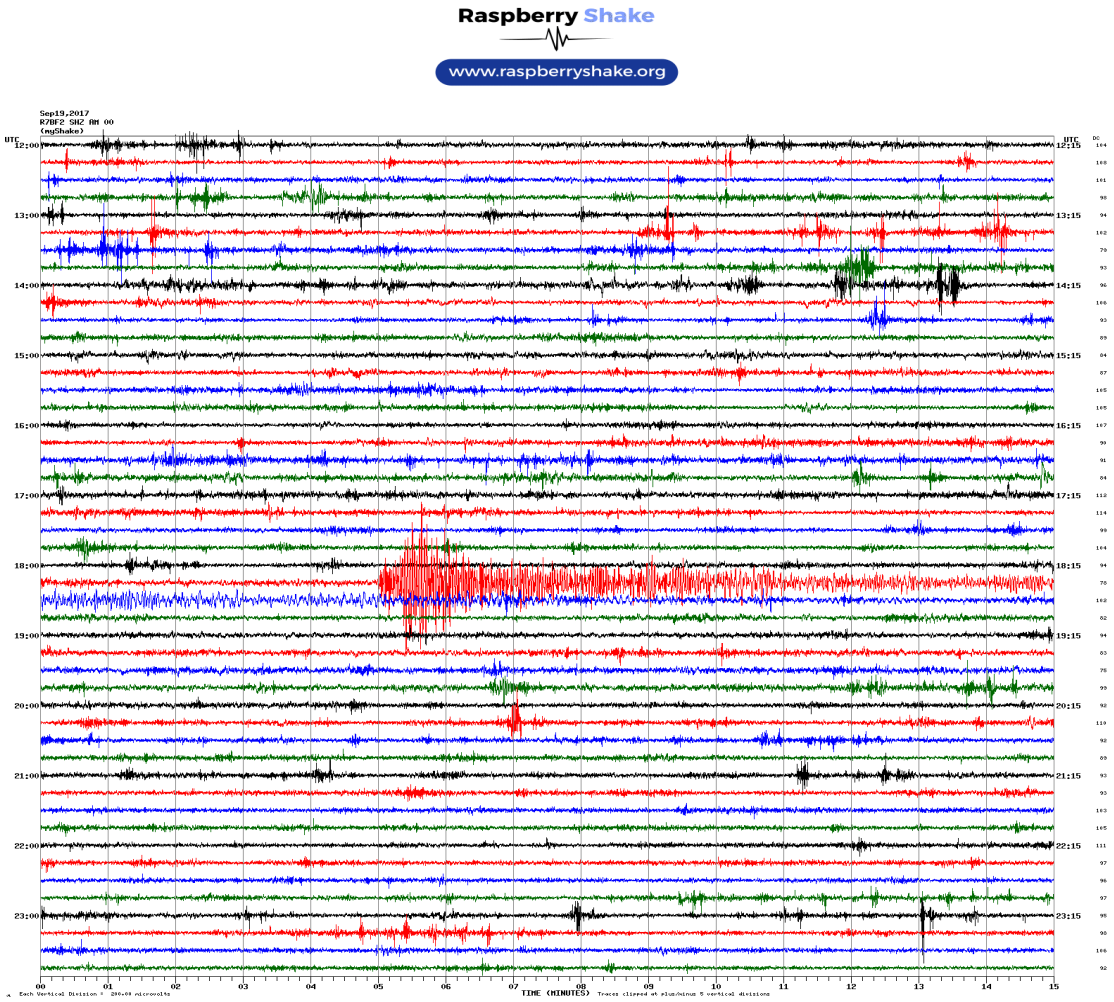
A world-wide network of sensors operated by citizen scientists.

Data is streamed and combined with data from USGS, Gempa, and others to provide an unprecedented view of seismic activity – including rocket launches and underground nuclear tests.

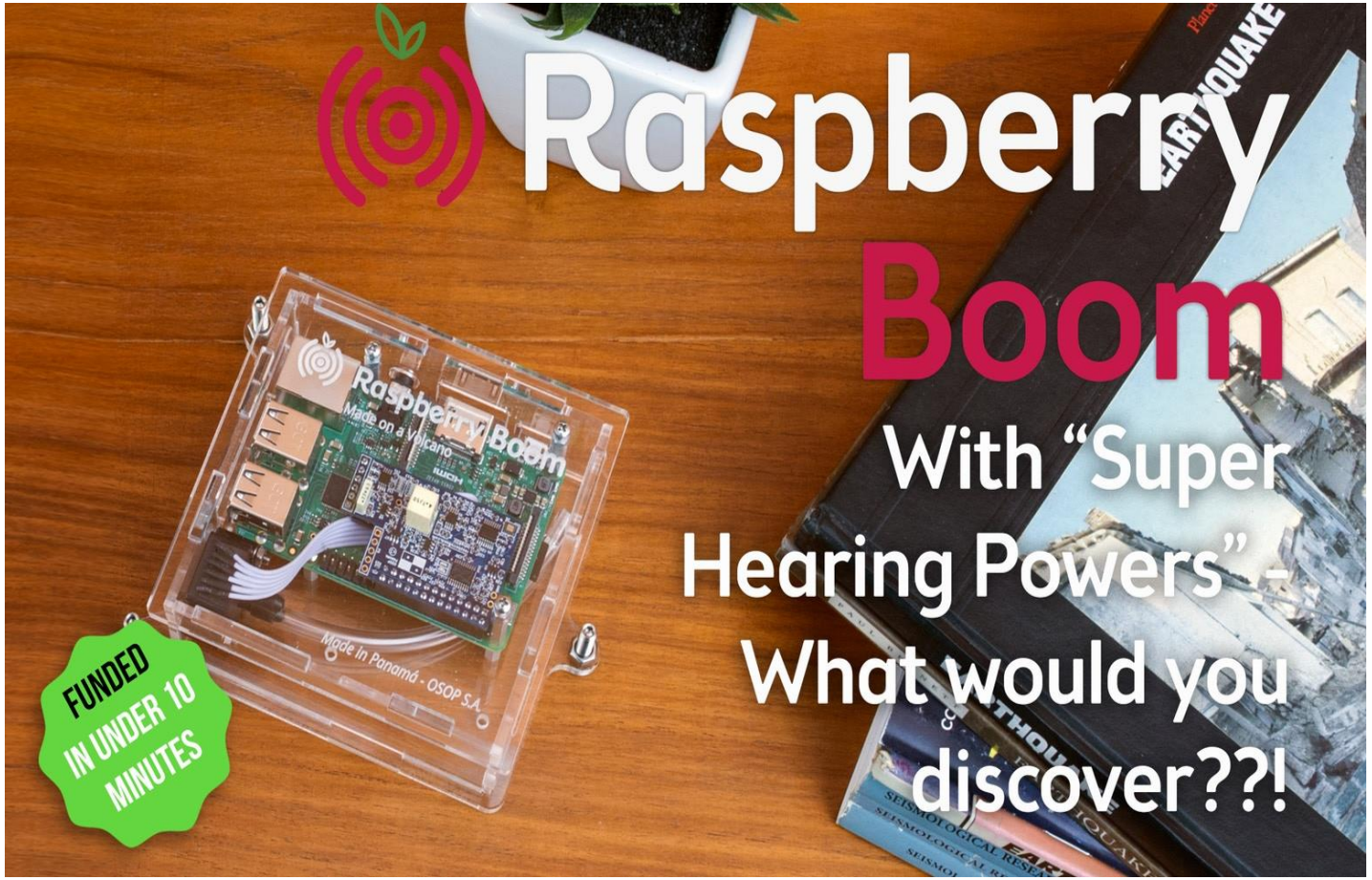


Monitor Earthquakes





Atmospheric Monitor



Building upon the Raspberry Shake's data collection and reporting framework, the Boom is an infrasound monitor.

I will deploying this unit soon and I am looking forward to seeing what it can detect.

An infrasound monitor is well suited to detect explosions, avalanches, thunder, tornadoes, fireworks, rocket launches, and more.

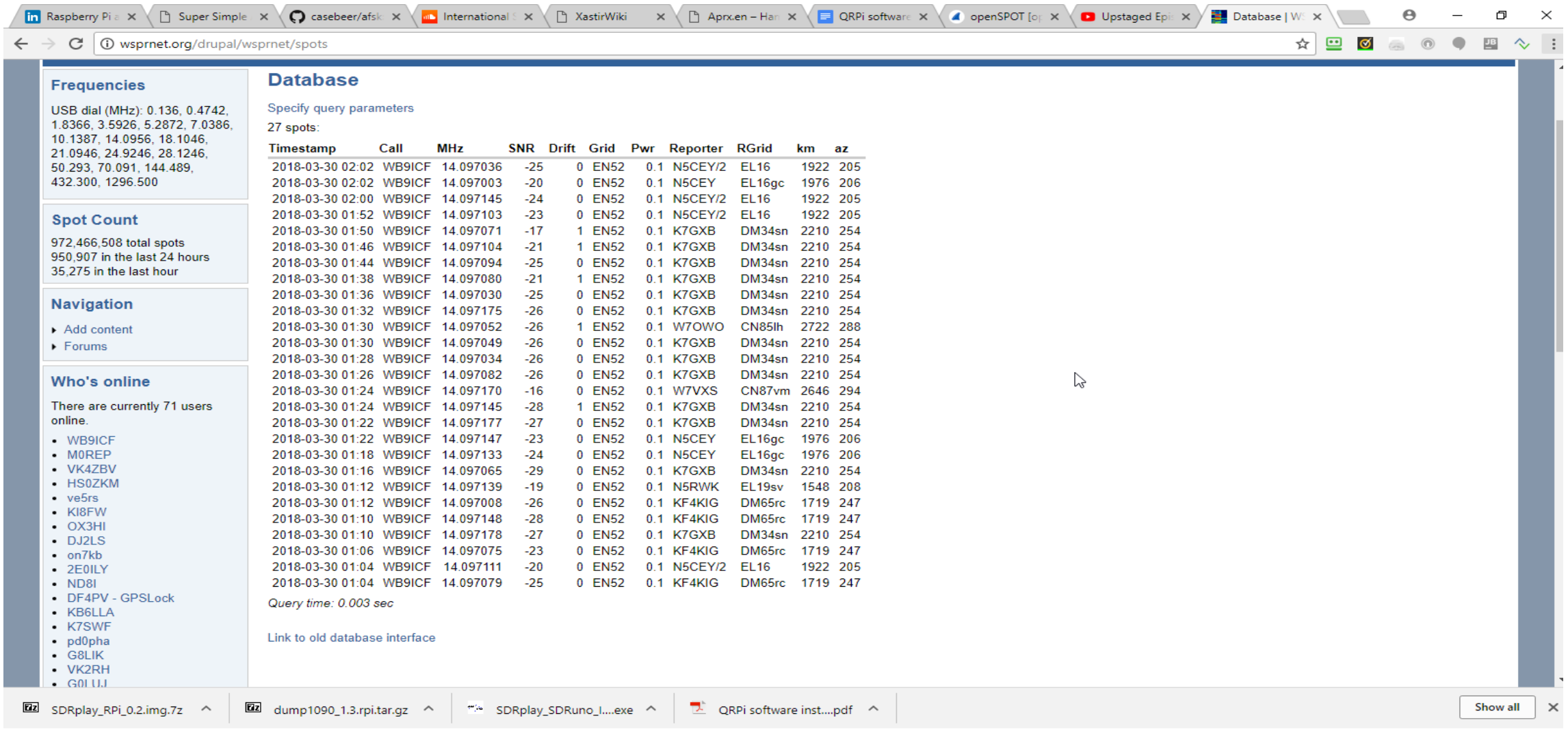
WSPR Transmitter

A GPIO pin can be used to generate a wide range of frequencies!

The output is a square wave, so it needs to pass through a low-pass (LP) filter to clean up the waveform.

The LP filter can be homebrewed, but Tucson Amateur Packet Radio has produced a Pi HAT that combines the filter with a buffer to protect the Pi.

WSPR Transmitter – 1691 miles with .1 watt



Now for some live demos

- Raspberry Pi Desktop walkthrough
- Google Voice Kit
- Raspberry Boom and the earthquake data center
- SDRPlay distro
  - ADS-B (dump1090)
  - CubicSDR
  - SDR-J DAB receiver
  - SoapySDR/SoapySDRPlay
  - SoapyRemote