

Making a Fridge Semi-Smart With Arduino & Raspberry Pi

Lloyd Matthews

Quick history of Raspberry Pi...

- Origins
 - Raspberry Pi Foundation (2008, UK)
 - Non-profit, dedicated to education
 - cheap PC to get children interested in computing
 - Inspired by BBC Micro (1981)
 - Eben Upton (St Johns College Cambridge), Peter Lornas (Norcott Technologies), David Braben (game developer)
 - Why “Raspberry Pi” ?
 - Follows 1980’s UK/US naming of computers after fruits and nuts (Acorn, Tangerine, Apple)
 - Original design only supported *Python*
 - Now supports many other languages

Model history

- Pi 1
 - Model B
 - February 2012, \$35
 - Ethernet, 2 USB ports. 700 MHz 32-bit processor, full-size SD, 512MB RAM, 1080p HDMI video
 - Google gave 15K Model B's to UK schools in Jan 2013
 - Model A
 - Lower-cost/power/weight version of Model B
 - Same size, but no Ethernet jack, 256 MB RAM, 1 USB port
 - Mainly used for embedded systems, robotics, low-SWAP projects
 - Model Zero
 - Half the size and cost of Model A, with 1 GHz processor

Model history (cont.)

- Pi 2 Model B
 - February 2015
 - Same size and features as Model B+; plus quad-core processor, microSD, and 1GB RAM
- Current generation
 - **Pi 3 Model B**
 - March 2016 (Fry's: \$35)
 - Same size as features Pi 2 Model B+; plus Wi-Fi, Bluetooth 4.1/LE, 64-bit 1.2 GB processor
 - microSD filesystem: FAT, 4-32 GB
 - > 32 GB possible using multiple partitions
 - Pi Zero W (Wireless)
 - February 2017 (\$10)
 - Same size and features as Pi Zero; plus Wi-Fi, Bluetooth 4.1/LE, MIPI CSI-2 v1.3 (most widely used mobile camera standard)
 - Consider vs Arduino ???

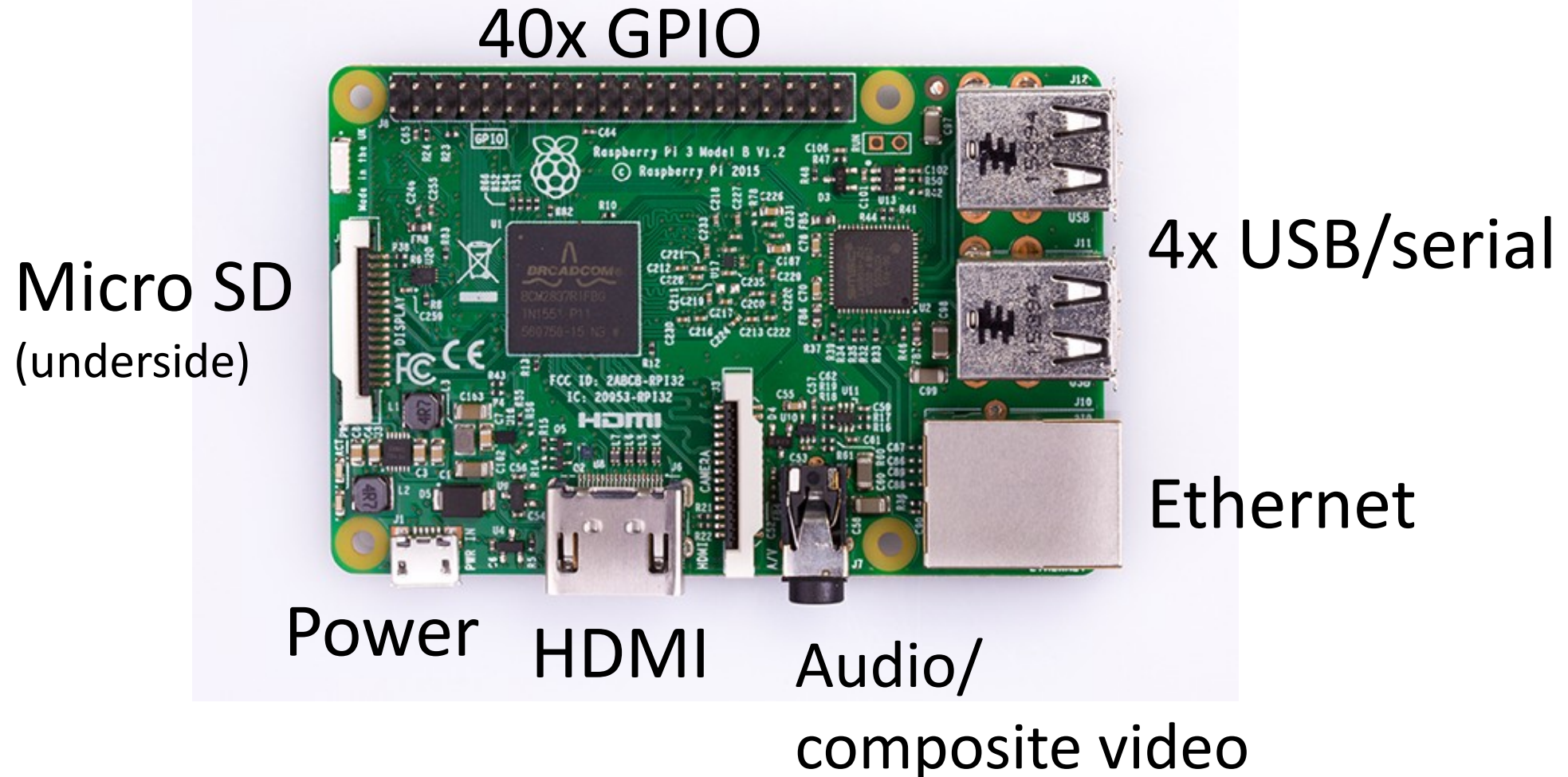
Project

- Log timestamped refrigerator temperature and humidity to cloud storage
 - Plotly, Google Spreadsheets, AWS...
- Use Arduino to gather data, Raspberry Pi (RP) to timestamp it and send it off to the cloud
 - Arduino has A/D converters, RP does not
 - RP has WiFi, most Arduinos do not
 - Supports an architecture with distributed sensor platforms feeding data to a central hub for storage
- Gathering and timestamping is done, cloud part is TBS...

Parts

- Raspberry Pi 3 Model B (\$35 Amazon)
 - HW: 1GB RAM, WiFi, Bluetooth 4.1/LE, 4xUSB, Ethernet, HDMI
 - case (\$8), power supply 5V@2A (\$8), also Amazon
 - 8 GB SD card (free, already had one...)
 - NOOBS (New Out Of the Box Software) OS installer (with Raspbian OS) (free, online)
 - Raspbian includes: Python 2/3, VNC Server, Geany IDE, ...
- OSEPP Mega2560 R3 board (Arduino-compatible) (\$25 Fry's)
- DHT22 temperature/humidity sensor (\$4 eBay)
 - Improved version of DHT11 (accuracy, range)
- jumper wiring
- Windows 10 PC for Arduino development and VNC WiFi connection to RP
 - Software: SD Formatter (for RP OS), Arduino IDE, VNC client (all free)
 - Could also use Windows 7+, Mac or Linux

Raspberry Pi Model 3 B ports



Connect Arduino to RP

- Serial connection for now
 - Unlike RP, most Arduino boards do not have WiFi or BT built in
 - “Shields” available... future project
- Use Arduino IDE’s serial port monitor to test output first!
- Connect USB cable between Arduino USB-mini power/data port and any RP USB port
 - RP can power Arduino this way, but be careful of power drain...
 - Either port `/dev/ttyUSB0` or `/dev/ttyUSB1` will be opened on connection (seems random), so need to check for both
- Note: Arduino and RP serial are TTL (3V/5V) NOT RS-232 (12V)! Don’t connect them directly to an RS-232 port!

Arduino script

(you need to install a couple of libraries in the IDE to support the DHT methods)

```
#include <DHT.h>
```

```
// Globals
```

```
const int BAUDRATE = 9600; // serial port speed
const int DELAY_SEC = 10;  // sampling interval (min 2)
```

```
// data pin DHT22 is connected to
const int DHTPIN = 7;
```

```
DHT dht(DHTPIN, DHT22);
```

```
float hum; //Stores humidity value
float temp; //Stores temperature value
String outstring; // serial output string
```

```
void setup()
```

```
{
    // Set the data pin to input using internal pullup resistor.
    pinMode(DHTPIN, INPUT_PULLUP);

    Serial.begin(BAUDRATE);
    dht.begin();
}
```

```
void loop()
```

```
{
    delay(DELAY_SEC * 1000); // Sampling delay

    //Read data and store it to variables hum and temp
    hum = dht.readHumidity();
    temp = dht.readTemperature();

    // Convert temp from Celsius to Fahrenheit
    temp = (9 * temp / 5) + 32;

    //Print humidity (% , no dec) and temp (degF, 1 dec) to
    serial port
    // Use CSV format
    outstring = String(hum,0) + "," + String(temp,1);
    Serial.println(outstring);
}
```

Python2 script (on RP)

```
import serial, time

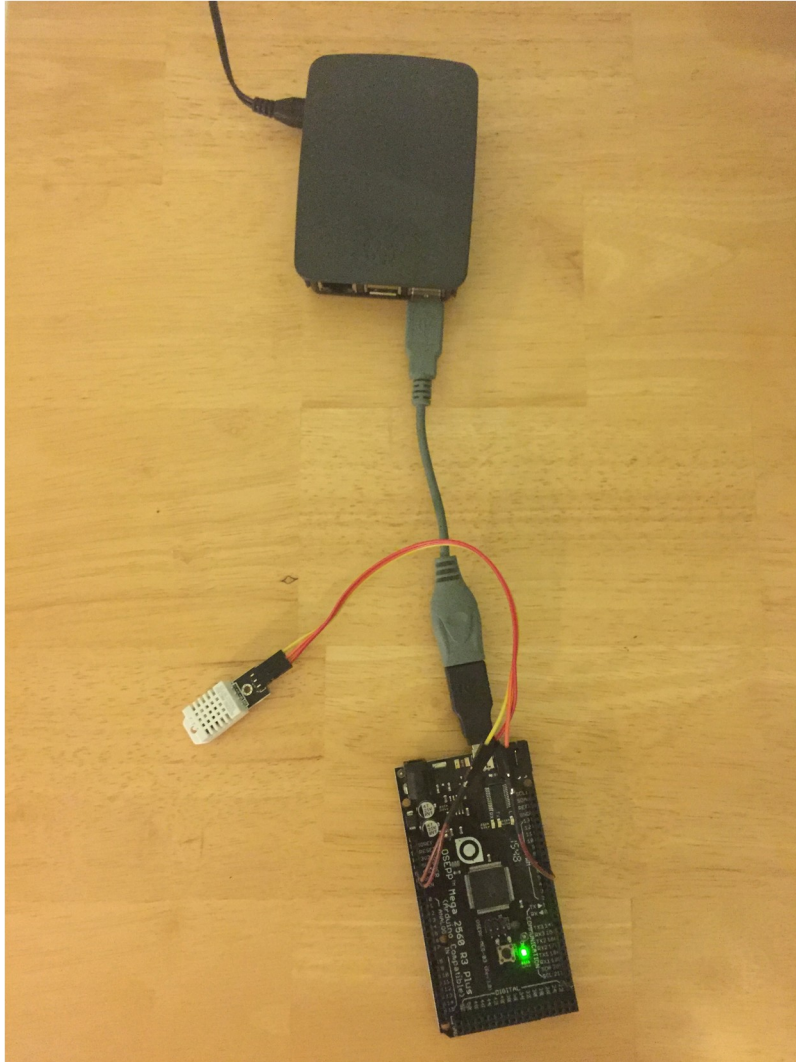
STAMPFMT = '%Y%m%d%H%M%S'

try:
    ser = serial.Serial('/dev/ttyUSB0', 9600)
except Exception, e_noSer0:
    try:
        ser = serial.Serial('/dev/ttyUSB1', 9600)
    except Exception, e_noSer1:
        print "Neither USB serial port was open!"
        exit()

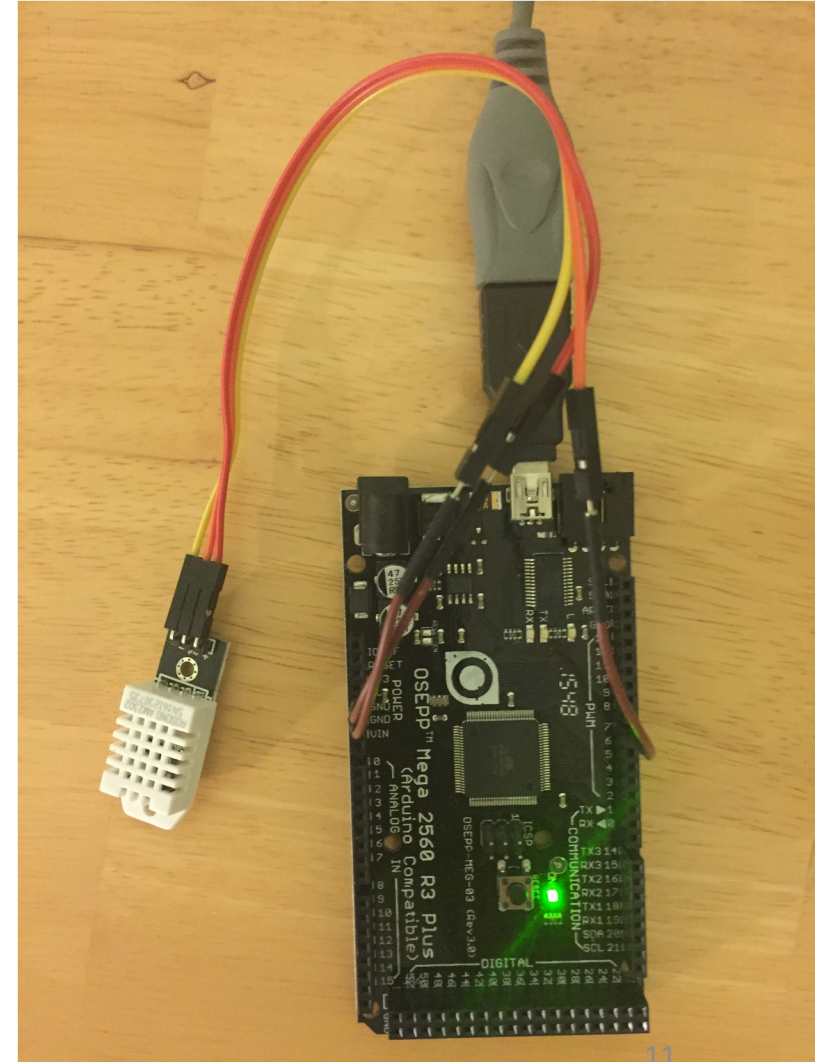
try:
    print "Reading from serial port: " + ser.port
    ser.flushInput()
    while True:
        time.sleep(0.5)
        stamp = time.strftime(STAMPFMT);
        response = ser.readline().rstrip()
        # timestamped data, CSV format
        log = stamp + "," + response
        print log
except Exception, e_SerReadFail:
    print "Error reading from serial port: " + str(e_SerReadFail)
    ser.close()
    exit()
```

Photos

RP with case cover off

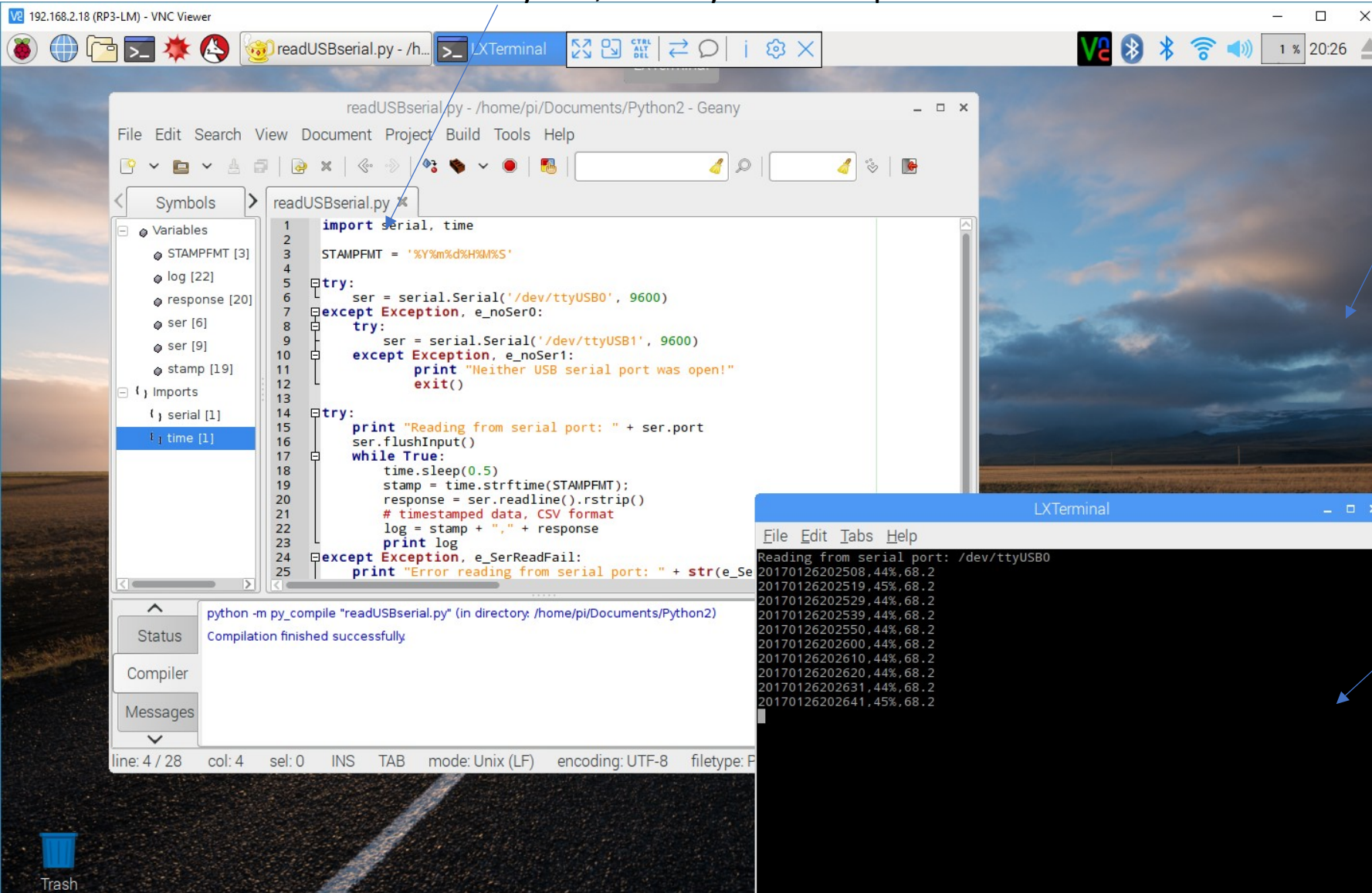


OSEPP Mega2560 and
DHT22 temp/humidity sensor



Screenshot of RP VNC Session on Windows 7 PC


Geany IDE, with Python2 script



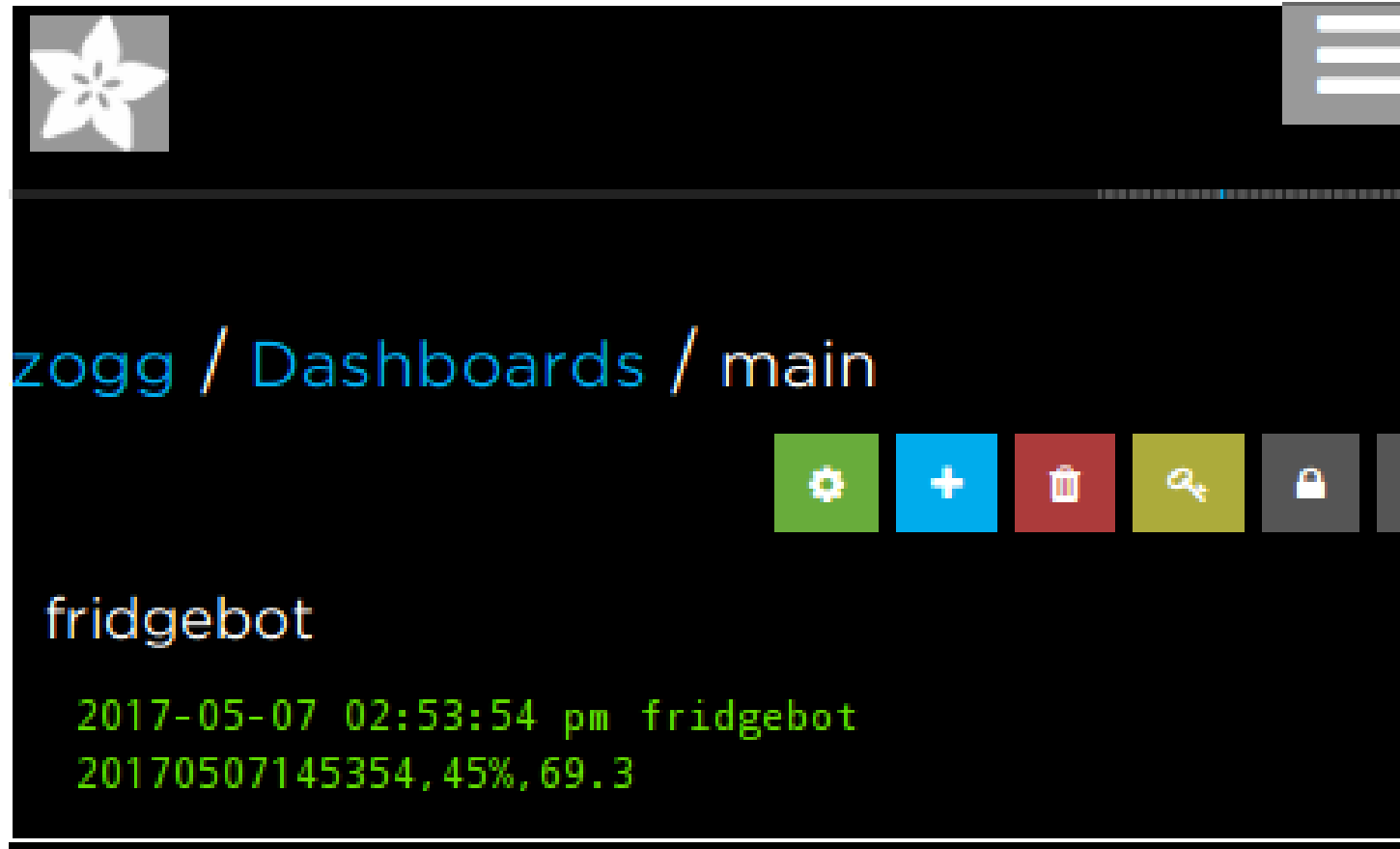
Raspbian OS desktop
VNC session
connected via WiFi

Script execution, showing
showing serial data from
Arduino, timestamped by RP
e.g.
20170126202508,44%,68.2

Easy (and free!) cloud access

- [Adafruit.io](https://adafruit.io)
 - Open beta: Python 3 API, libraries; post data to “feeds”, view in “dashboard”
 - Uses MQTT protocol (mqtt.org)
 - I was able to post data to site with updated Python 3 code
 - 
fridgebot.py
 - Part of Adafruit.com: projects, blogs, shop, etc. etc.
- IFTTT.com
 - “If This Then That”
 - Library of applets that link IoT/cloud services together
 - e.g. Skydrop watering > Google Spreadsheet, Alexa command > Nest thermostat, Adafruit.io feeds...
 - Ability to easily create own applets

Adafruit.io Dashboard



Future plans

- Easy:
 - Expand to to 2 or 3 sensors (freezer, ambient)
 - Store data on RP USB stick or Arduino SD (requires “shield”)
 - IFTTT notification when Adafruit feed temp is over X degrees
- Not so easy?
 - WiFi or BT Arduino “shields” for wireless link to RP instead of direct serial
 - Store data on commercial cloud (e.g. AWS S3)

Links

- <https://www.raspberrypi.org>
- https://en.wikipedia.org/wiki/Raspberry_Pi
- <https://www.mcmelectronics.com/helpers/RaspberryPiModels.html>
- <https://www.osepp.com/electronic-modules/microcontroller-boards/101-osepp-mega-2560-r3-plus>
- <https://www.adafruit.com/product/385> (DHT22 sensor)
- Most of the code was “adapted” from Google searches...

MEGA **PINOUT**