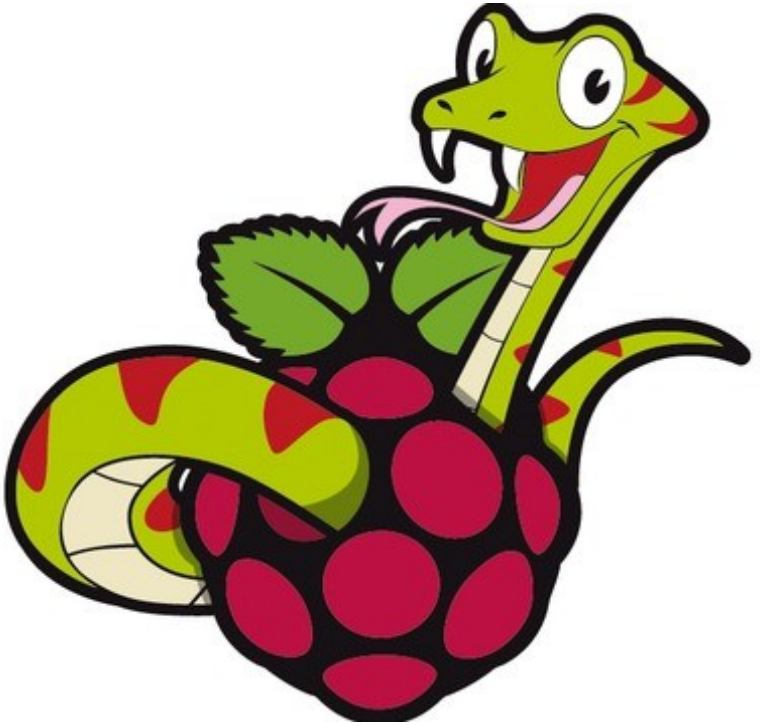
Python on Raspberry Pi



Jordi Binefa i Martínez

R+D+i engineer at electronics.CAT

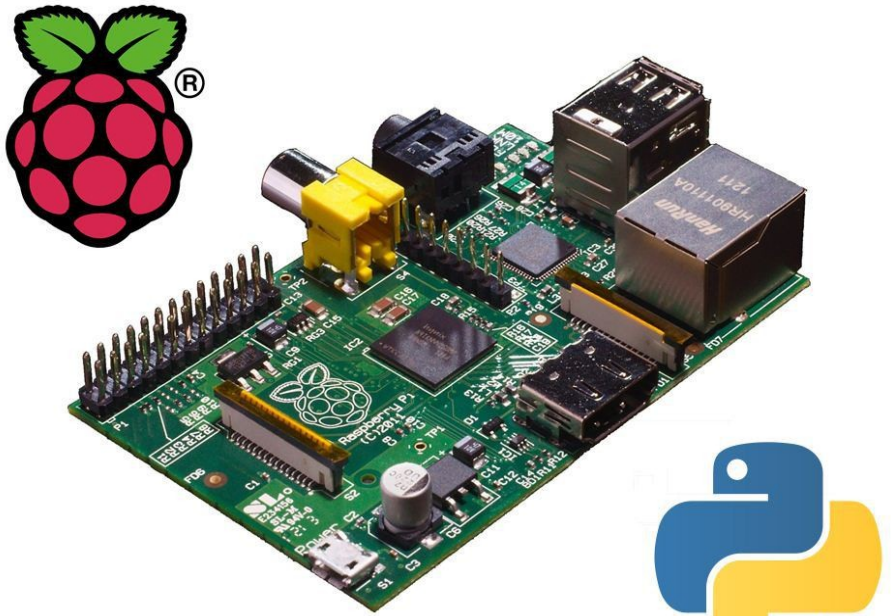
Vocational training teacher at JESUÏTES El Clot Escola del Clot

open source hardware

Sept 12, 2013

* Introduction to Raspberry PI

Brief introduction: the hardware, available distributions, the community, projects, ...



* Manipulating the Raspberry PI GPIO pins with Python

Introduction to the GPIO expansion ports and the Python library RPi.GPIO with real in vivo example.

What is the Raspberry Pi ?

"*We think that the lack of programmable hardware for children – the sort of hardware we used to have in the 1980s – is undermining the supply of eighteen year olds who know how to program, so that's a problem for universities, and then it's undermining the supply of 21 year olds who know how to program, and that's causing problems for industry*"

- Co-founder Eben Upton

Raspberry Pi Foundation

- Non profit British charity
- Promotes basic computer science in schools
- Small: day to day work done by one full-time paid employee and volunteers
- Manufacturing and sales licensed to distributors:

Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

What is the Raspberry Pi ?

- Project originally started in 2006
- Eventually decide on ARM architecture
- Alpha boards Aug 2011
- Beta boards Dec 2011
- Sales launched Febraury 2012
- First batch of 10,000 boards in March 2012

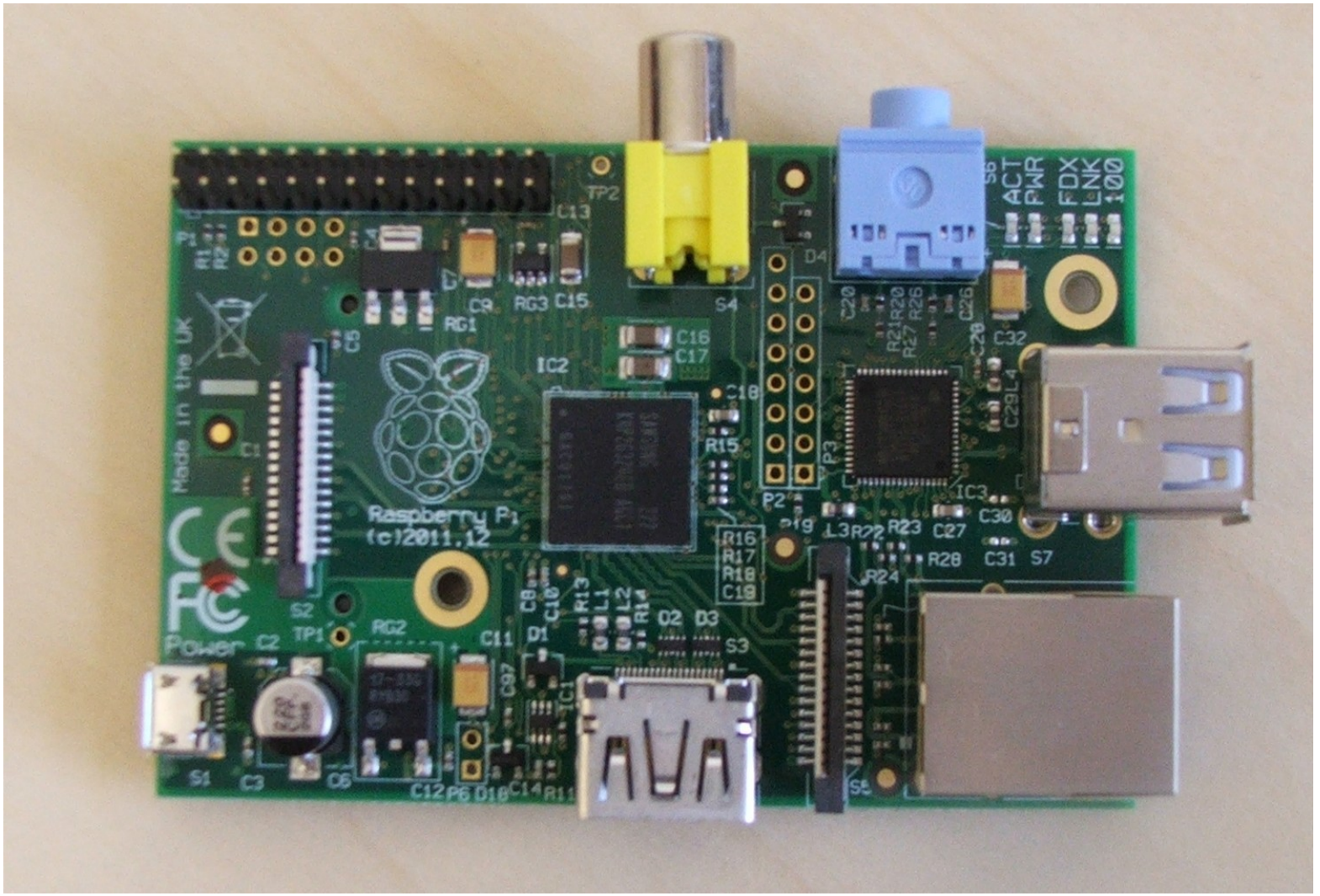
Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

What is the Raspberry Pi ?

- Two licensed manufacturers/distributors
- Initially unable to keep up with orders
- Two million people registered interest in pre-orders
- As of early July 2012: production 4,000 per day, approx 200K shipped
- Most manufacturing now done in the UK

Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

What is the Raspberry Pi ?



What's with the name ?

- Nostalgia: a number of early home computers had "fruit" names, e.g. Apple, Apricot, Tangerine

- PI is from "Python Interpreter", the official programming language for the Raspberry Pi

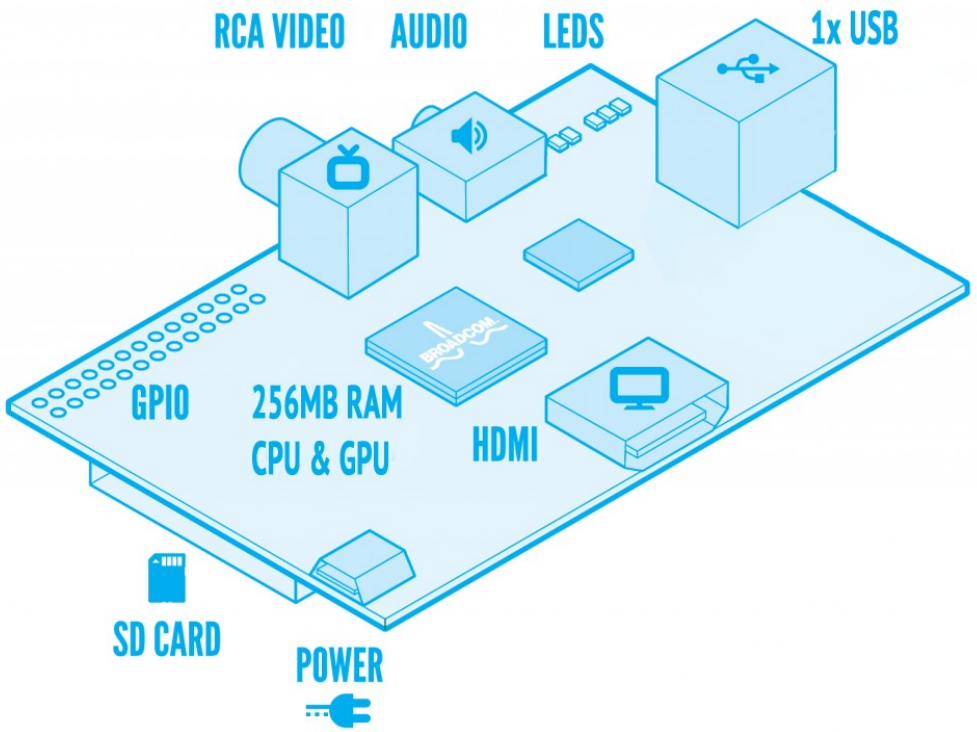
RaspberryPi

python

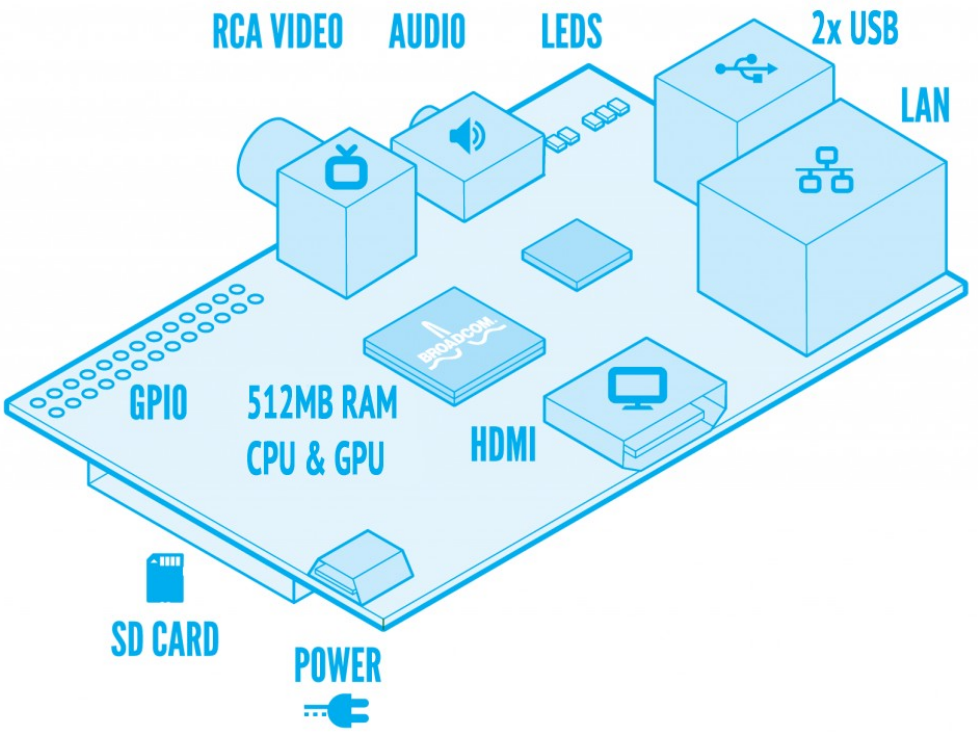
Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

Hardware

RASPBERRY PI MODEL A - $25



RASPBERRY PI MODEL B - $35



Hardware

- Credit card sized computer
- CPU: Broadcom BCM2835 SOC
- 700MHz ARM 11 with floating point
- Videocore 4 GPU capable of BluRay quality 1080p30 video using H.264 at 40Mbits/s
- OpenGL ES2.0 and OpenVG
- SD card for mass storage (can also use USB after booting)
- Model A: 256MB RAM, 1USB port
- Model B: 512MB RAM, 2USB ports, Ethernet

Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

Hardware

- Composite and HDMI video out
- Sound output over HDMI and 3.5mm audio jack; can use USB microphone for input
- Header with GPIO ports
- Powered by 5V over micro USB (2.5W/3.5W. Could use battery, i.e. 4 AA cells. Power by computers's USB is not recommended)
- No RTC (gets time from network)
- Memory not expandable

Hardware

- Retail price US$25 (Model A) / US$35 (Model B)
- Board only: tipically add HDMI monitor, SD card, USB keyboard and mouse, power supply
- Some users may use television and second hand keyboard/mouse to save on cost
- Hardware schematics available

Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

Input devices - Mouse, Keyboard

- USB mouse and keyboard supported
- Can use (powered) hub if more than two USB devices needed

Source : QtDD12 - Qt on Raspberry Pi - Jeff Tranter

Output Devices and Touchscreen

- HDMI and composite video out
- Can use DVI or VGA monitor with adaptor
- Standard touch screen monitors with HDMI should work out of box if they emulate a USB mouse
- Chalkboard Electronics has compatible 10 inch touchscreen with HDMI to LVDS interface board

Other Hardware

- GPIO, serial, SPI, I2C, JTAG ports
- brought out on 26-pin connector P1 + 8-pin connector P5 (2nd rev)
- use caution if used directly as no protection from overvoltage, etc
- MIPI CSI-2 (Camera Serial Interface) on connector S5
- DSI (Display Serial Interface) on connector S2 for driving LCD (no drivers currently)
- Rev 2 board makes some small changes

GPIO pinout

Raspberry Pi Version 1

3.3V	1	2	5V
I2C0 SDA	3	4	DNC
I2C0 SCL	5	6	GROUND
GPIO4	7	8	UART TXD
DNC	9	10	UART RXD
GPIO 17	11	12	GPIO 18
GPIO 21	13	14	DNC
GPIO 22	15	16	GPIO 23
DNC	17	18	GPIO 24
SP10 MOSI	19	20	DNC
SP10 MISO	21	22	GPIO 25
SP10 SCLK	23	24	SP10 CE0 N
DNC	25	26	SP10 CE1 N

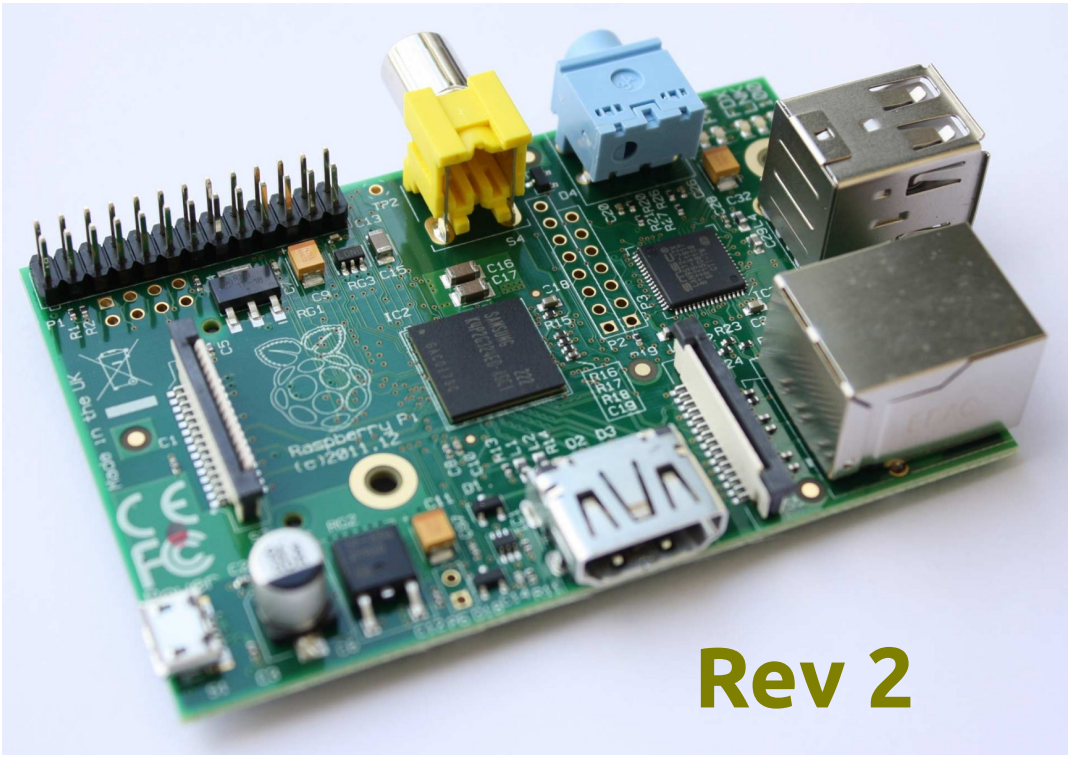
Raspberry Pi Version 2

3.3V	1	2	5V
I2C1 SDA	3	4	5V
I2C1 SCL	5	6	GROUND
GPIO4	7	8	UART TXD
GROUND		10	UART RXD
GPIO 17	11	12	GPIO 18
GPIO 27	13	14	GROUND
GPIO 22	15	16	GPIO 23
3.3V	17	18	GPIO 24
SP10 MOSI	19	20	GROUND
SP10 MISO	21	22	GPIO 25
SP10 SCLK	23	24	SP10 CE0 N
GROUND	25	26	SP10 CE1 N

For full details see http://elinux.org/Rpi_Low-level_peripherals

Raspberry Pi Model B

Rev 1



Rev 2

Available distributions

Raspbian, **Pidora**, **Arch**, **OpenELEC**, Moebius, Raspbian Server Edition, Red Sleeve Linux, IPFire, Raspberry Pi Thin Client, BerryTerminal, GeeXboX ARM, DarkElec, OpenEIEC, **RaspBmc**, XBian, RasPlex, PwnPi, ha-pi, Kali, i2pBerry, Bodhi, Gentoo, Adafruit - Occidentalis v0.1, **RISC OS**, Pi Parted, PiBang Linux, Plan 9, NetBSD, FreeBSD, SlaXBMCRPi, PiMAME, PiBox, Debian (Squeeze/6.x), …

Detailed explanation at http://elinux.org/RPi_Distributions

Comparision of ARM architectures and families

Architecture	Family
ARMv1	ARM1
ARMv2	ARM2, ARM3
ARMv3	ARM6, ARM7
ARMv4	StrongARM, ARM7TDMI, ARM9TDMI
ARMv5	ARM7EJ, ARM9E, ARM10E, XScale
ARMv6	ARM11, ARM Cortex-M
ARMv7	ARM Cortex-A, ARM Cortex-M, ARM Cortex-R
ARMv8	Not available yet. They will be 64 bits processors

ARMv5 Platforms

	Processor	RAM	NAND	Ethernet	USB	SATA
OLinuXino	Freescale i.MX233 454MHz	64MB		10/100	2	
OpenRD	Marvell Kirkwood 1.2GHz	512MB	512MB	Gigabit	7	2
Pogoplug Series 4	Marvell Kirkwood 800MHz	128MB	128MB	Gigabit	3	1
Pogoplug v2 (Pink/Gray)	Marvell Kirkwood 1.2GHz	256MB	128MB	Gigabit	4	
Seagate DockStar	Marvell Kirkwood 1.2GHz	128MB	256MB	Gigabit	4	
Seagate GoFlex Home	Marvell Kirkwood 1.2GHz	128MB	256MB	Gigabit	1	1
Seagate GoFlex Net	Marvell Kirkwood 1.2GHz	128MB	256MB	Gigabit	1	2
SheevaPlug	Marvell Kirkwood 1.2GHz	512MB	512MB	Gigabit	1	
TonidoPlug	Marvell Kirkwood 1.2GHz	512MB	512MB	Gigabit	1	
TonidoPlug 2	Marvell Armada 310 800MHz	512MB	512MB	Gigabit	1	1
ZyXEL NSA320	Marvell Kirkwood 1.2Ghz	512MB	128MB	Gigabit	3	2

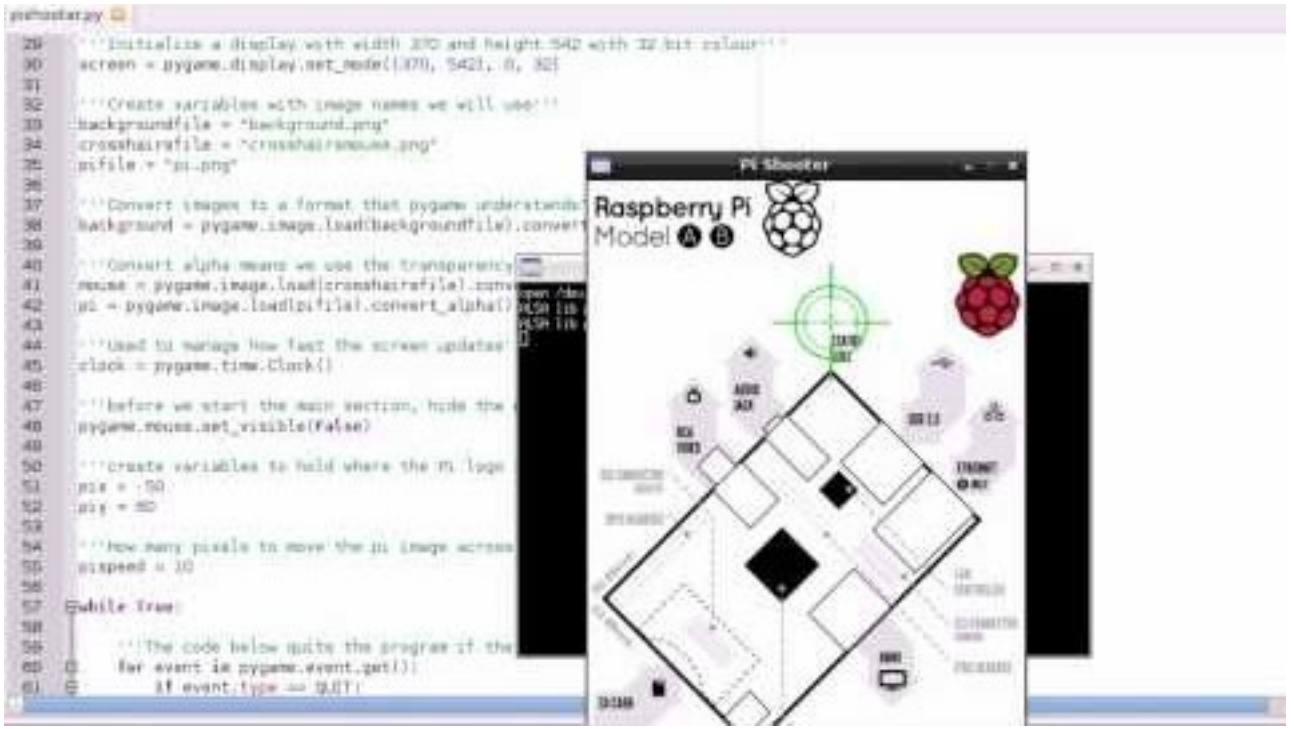
ARMv6 Platforms

	Processor	RAM	NAND	Ethernet	USB	SATA
Pogoplug Pro/Video/v3	PLX 7820 700MHz Dual-core	128MB	128MB	Gigabit	4	1
Raspberry Pi	Broadcom BCM2835 700MHz	256MB		10/100	2 (100mA max)	

ARMv7 Platforms

	Processor	RAM	Ethernet	SD	USB	Wireless
BeagleBoard	TI OMAP 3530 720MHz	256MB	10/100	Full SD	1	
BeagleBoard-xM	TI DM3730 1GHz	512MB	10/100	Micro SD	4	
BeagleBone	TI AM3358 720Mhz	256MB	10/100	Micro SD	2	
CuBox	Marvell Armada 510 800MHz	1024MB	Gigabit	Micro SD	2	
Gumstix Overo	TI OMAP 35xx 600/720MHz	512MB	10/100	Micro SD	Exp	B/G, Bluetooth v2.0 + EDR
IGEP v2	TI DM3730 1GHz	512MB	10/100	Micro SD	2	B/G, Bluetooth v2.0 + EDR
Mele A100	Allwinner A10 1.0Ghz	512MB	10/100	Full SD	3	B/G/N
Nitrogen6X	Freescale i.MX6 Quad 1GHz	1024MB	Gigabit	Micro SD	2	B/G/N
PandaBoard	TI OMAP 4430 1GHz Dual-core	1024MB	10/100	Full SD	2	B/G/N, Bluetooth v2.1 + EDR
TrimSlice	NVIDIA Tegra 2, 1GHz Dual-core	1024MB	Gigabit	Full and Micro SD	4	Optional B/G/N, Optional Bluetooth

Python on Raspberry Pi



https://dl.dropboxusercontent.com/u/65254823/oshw20130912/PiShooterV2.zip

Install Python Module RPi.GPIO

```
$sudo apt-get update
$sudo apt-get install python-dev
$sudo apt-get install python-rpi.gpio
$sudo aptitude install python-serial
$sudo aptitude install python-netifaces

$sudo usermod -a -G dialout pi
```

http://code.google.com/p/raspberry-gpio-python/wiki/BasicUsage

Using Rpi.GPIO reading inputs

```
1  #!/usr/bin/env python
2
3  from time import sleep
4  import os
5  import RPi.GPIO as GPIO
6
7  GPIO.setmode(GPIO.BCM)
8  GPIO.setup(29, GPIO.IN)
9  GPIO.setup(28, GPIO.IN)
10 GPIO.setup(18, GPIO.IN)
11 GPIO.setup(7, GPIO.IN)
12
13 while True:
14         if ( GPIO.input(29) == False ):
15                 print "GPIO 29 pressed"
16         if ( GPIO.input(28) == False ):
17                 print "GPIO 28 pressed"
18         if ( GPIO.input(18) == False ):
19                 print "GPIO 18 pressed"
20         if ( GPIO.input(7) == False ):
21                 print "GPIO 7 pressed"
22         sleep(0.1);
23
```

https://dl.dropboxusercontent.com/u/65254823/oshw20130912/py00.py

Using Rpi.GPIO writing outputs

```
1  #!/usr/bin/env python
2
3  from time import sleep
4  import os
5  import RPi.GPIO as GPIO
6
7  GPIO.setwarnings(False)
8
9  GPIO.setmode(GPIO.BCM)
10 GPIO.setup(8, GPIO.OUT)
11 GPIO.setup(10, GPIO.OUT)
12 GPIO.setup(9, GPIO.OUT)
13 GPIO.setup(11, GPIO.OUT)
14
15 GPIO.output(8,0)
16 GPIO.output(10,0)
17 GPIO.output(9,0)
18 GPIO.output(11,0)
19
```

```
19
20 while True:
21         GPIO.output(8,1)
22         sleep(0.5);
23         GPIO.output(8,0)
24         sleep(0.5);
25         GPIO.output(10,1)
26         sleep(0.5);
27         GPIO.output(10,0)
28         sleep(0.5);
29         GPIO.output(9,1)
30         sleep(0.5);
31         GPIO.output(9,0)
32         sleep(0.5);
33         GPIO.output(11,1)
34         sleep(0.5);
35         GPIO.output(11,0)
36         sleep(0.5);
```

https://dl.dropboxusercontent.com/u/65254823/oshw20130912/py01.py

Raspberry Pi IP address

```
1  #!/usr/bin/python
2
3  import netifaces
4
5  interfaces = netifaces.interfaces()
6  for i in interfaces:
7      if i == 'lo':
8          continue
9      iface = netifaces.ifaddresses(i).get(netifaces.AF_INET)
10     if iface != None:
11         for j in iface:
12             print j['addr']
13
14
```

https://dl.dropboxusercontent.com/u/65254823/oshw20130912/pyIP01.py

Serial Port at Raspberry Pi

```
1  #!/usr/bin/python
2
3  import serial
4
5  print "Python serial port sample"
6
7  rpiSerialPort = '/dev/ttyAMA0'
8  ser = serial.Serial(rpiSerialPort,115200)
9
10 ser.write("\n\rFrom Raspberry Pi\n\r")
11 ser.close()
12
```

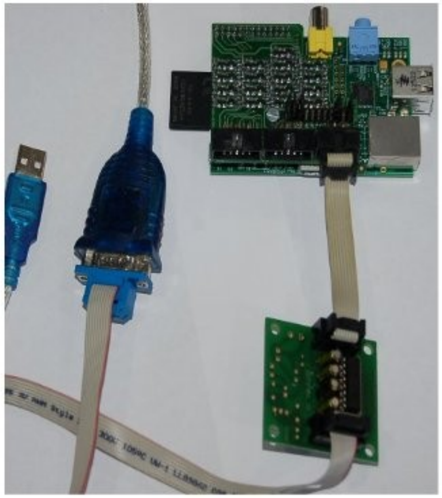
https://dl.dropboxusercontent.com/u/65254823/oshw20130912/serial00.py

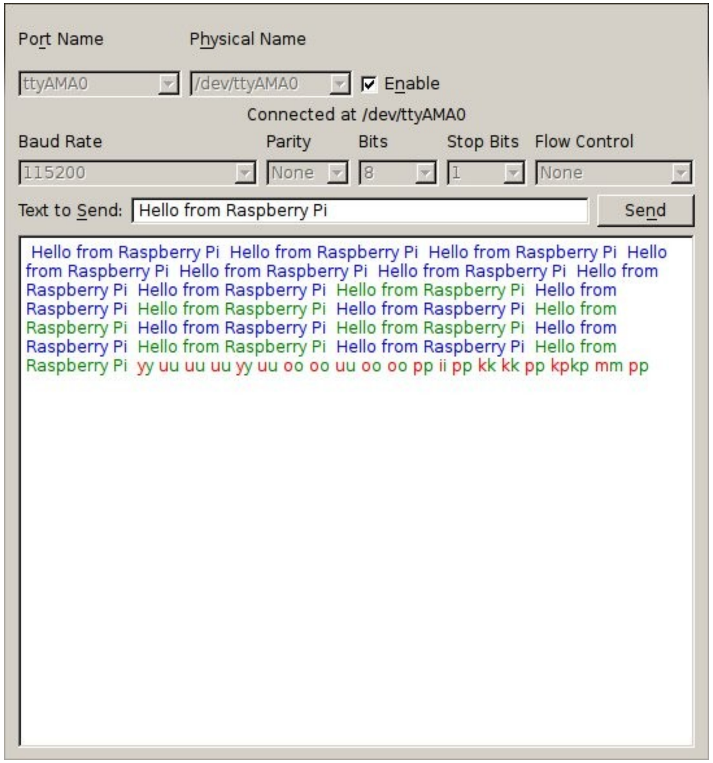
Reading IP through Serial Port

```
1  #!/usr/bin/python
2
3  import serial
4  import netifaces
5
6  print "IP serial port"
7
8  rpiSerialPort = '/dev/ttyAMA0'
9  ser = serial.Serial(rpiSerialPort,115200)
10
11 interfaces = netifaces.interfaces()
12 for i in interfaces:
13     if i == 'lo':
14         continue
15     iface = netifaces.ifaddresses(i).get(netifaces.AF_INET)
16     if iface != None:
17         for j in iface:
18             print j['addr']
19             ser.write(j['addr'])
20 ser.close()
21
```

https://dl.dropboxusercontent.com/u/65254823/oshw20130912/serial01.py
http://binefa.com/blog/2013/08/ip-raspberry-pi-sense-pantalla/

Harware for Serial Port at Raspberry Pi



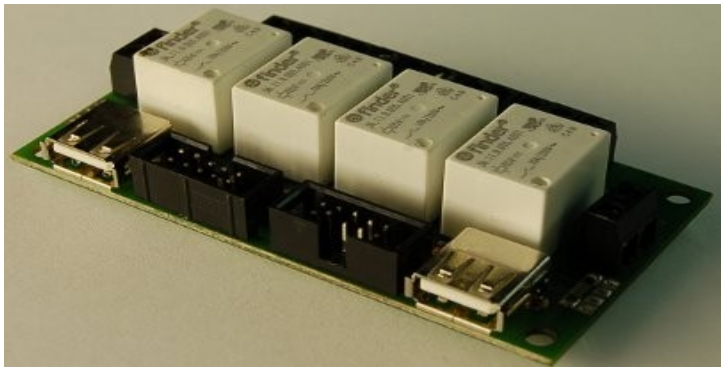


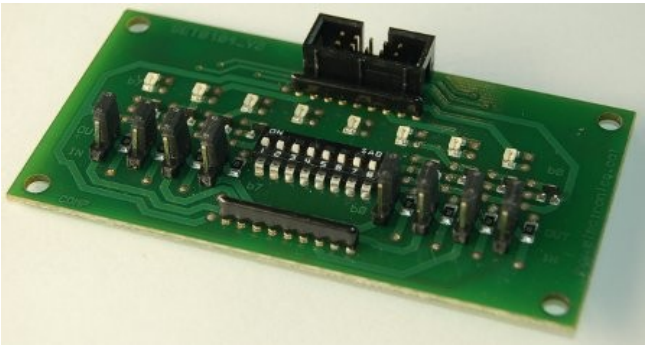
How to install qtTerm on Raspberry Pi :

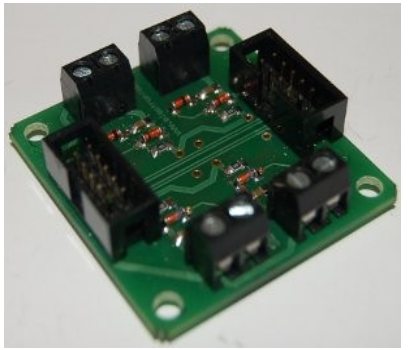
http://electronics.cat/code/3Bpi/rs232/setRs232up.html

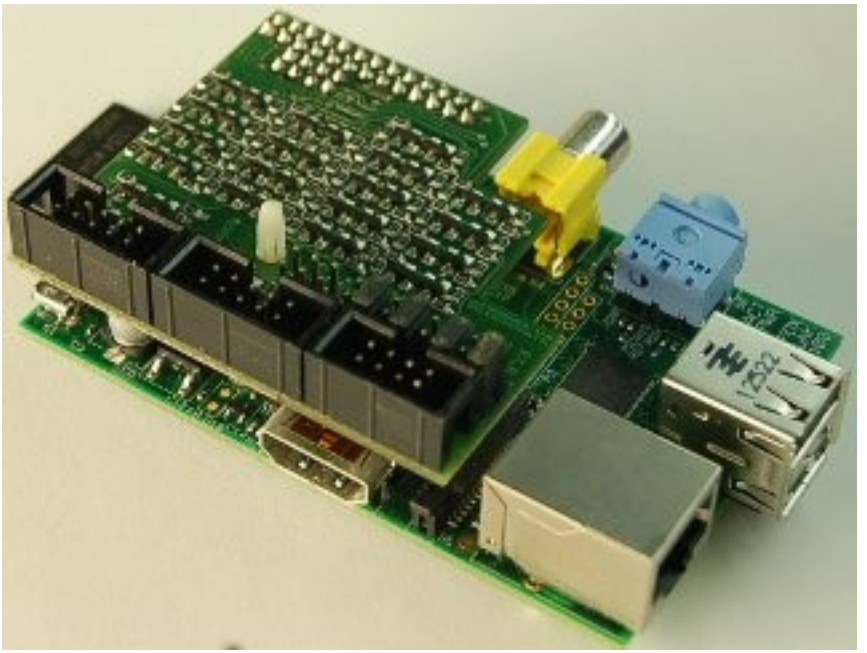
http://code.google.com/p/qtterm/

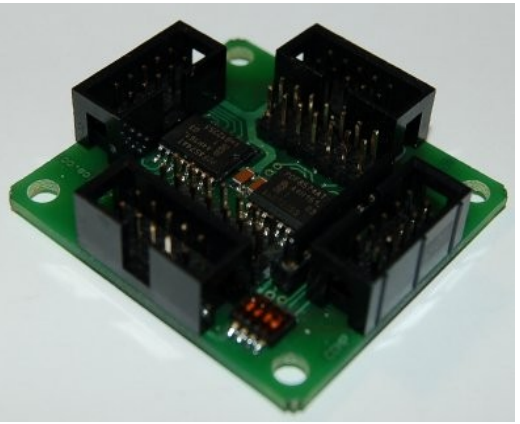
Hardware for Raspberry Pi











http://www.electronics.cat/

WebIOPi

WebIOPi is a fully integrated Internet of Things framework for the Raspberry Pi.

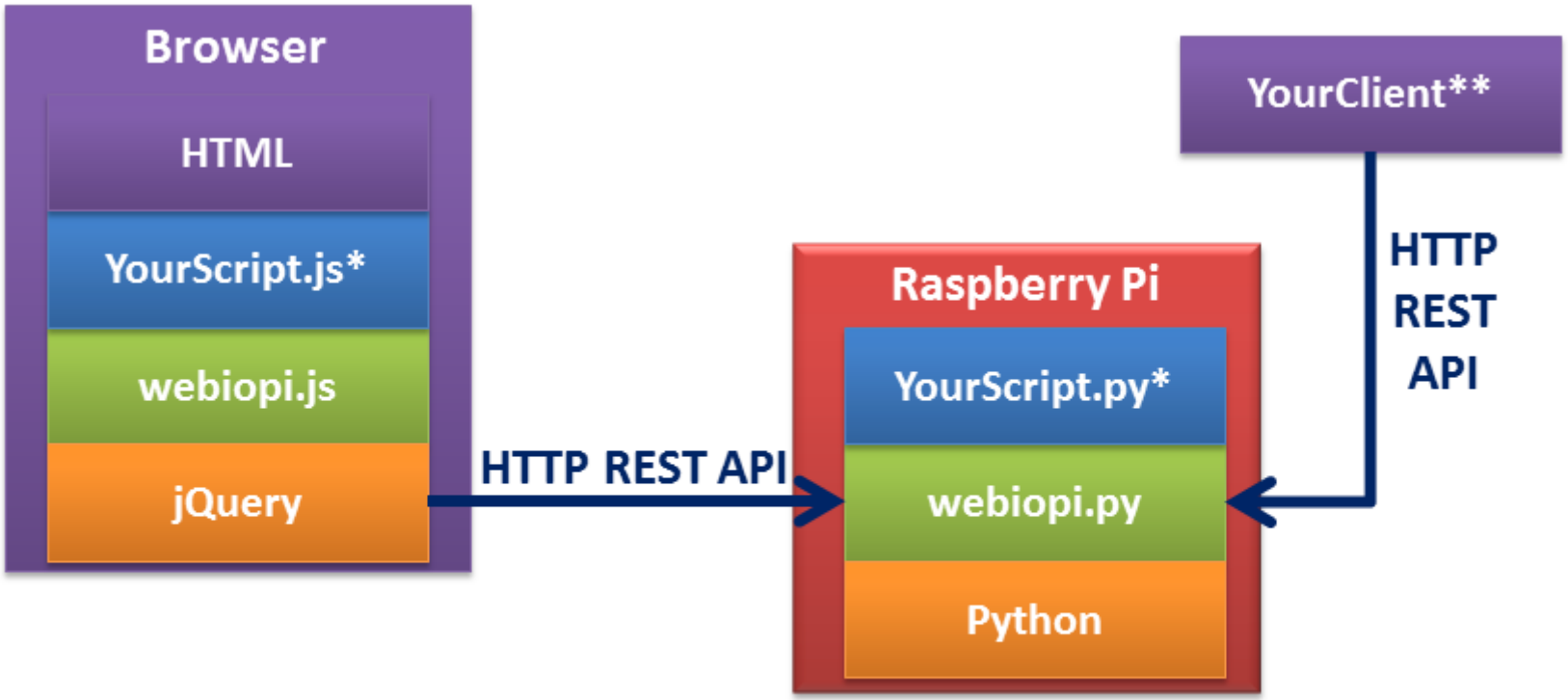
Control, debug, and use your Pi's GPIO locally or remotely, from a browser or any app.

WebIOPi is the perfect Swiss-knife to make connected things with the Raspberry Pi.

Developed and provided by Eric PTAK (aka trouch).

http://code.google.com/p/webiopi/

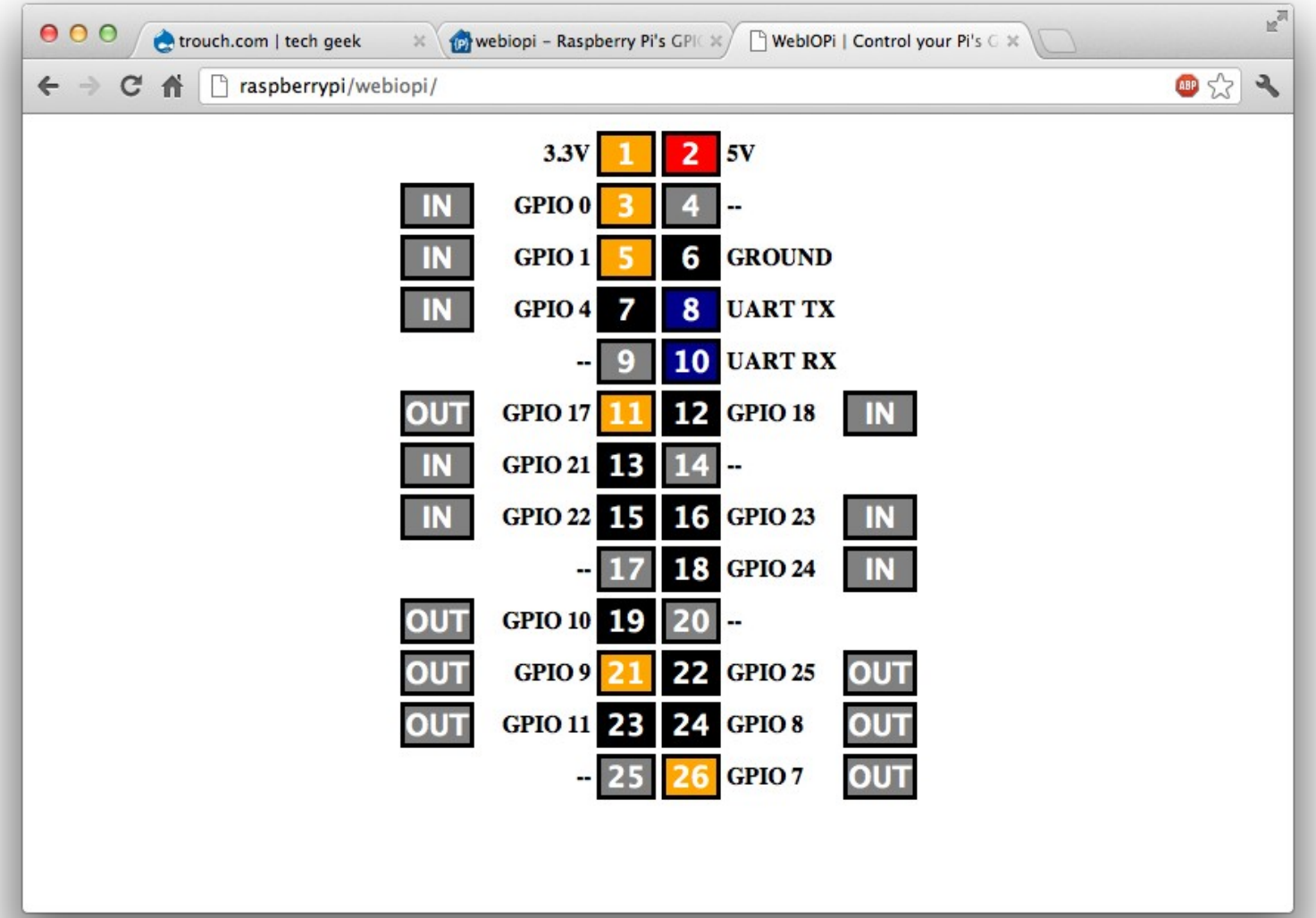
WebIOPi



** Optional, allows you to customize the interface and the behavior*
*** Use REST API from any technology/language*

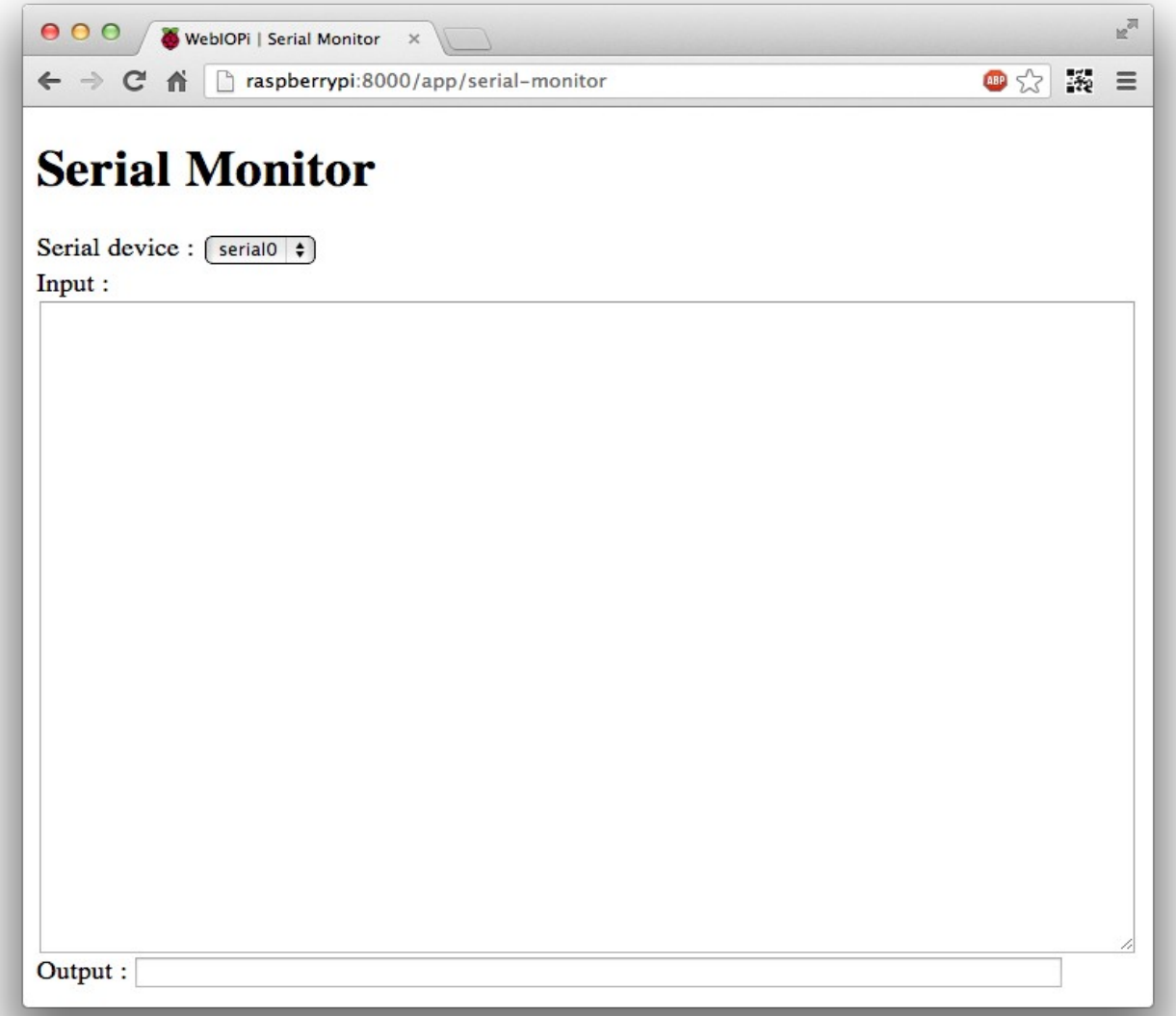
http://code.google.com/p/webiopi/

WebIOPi



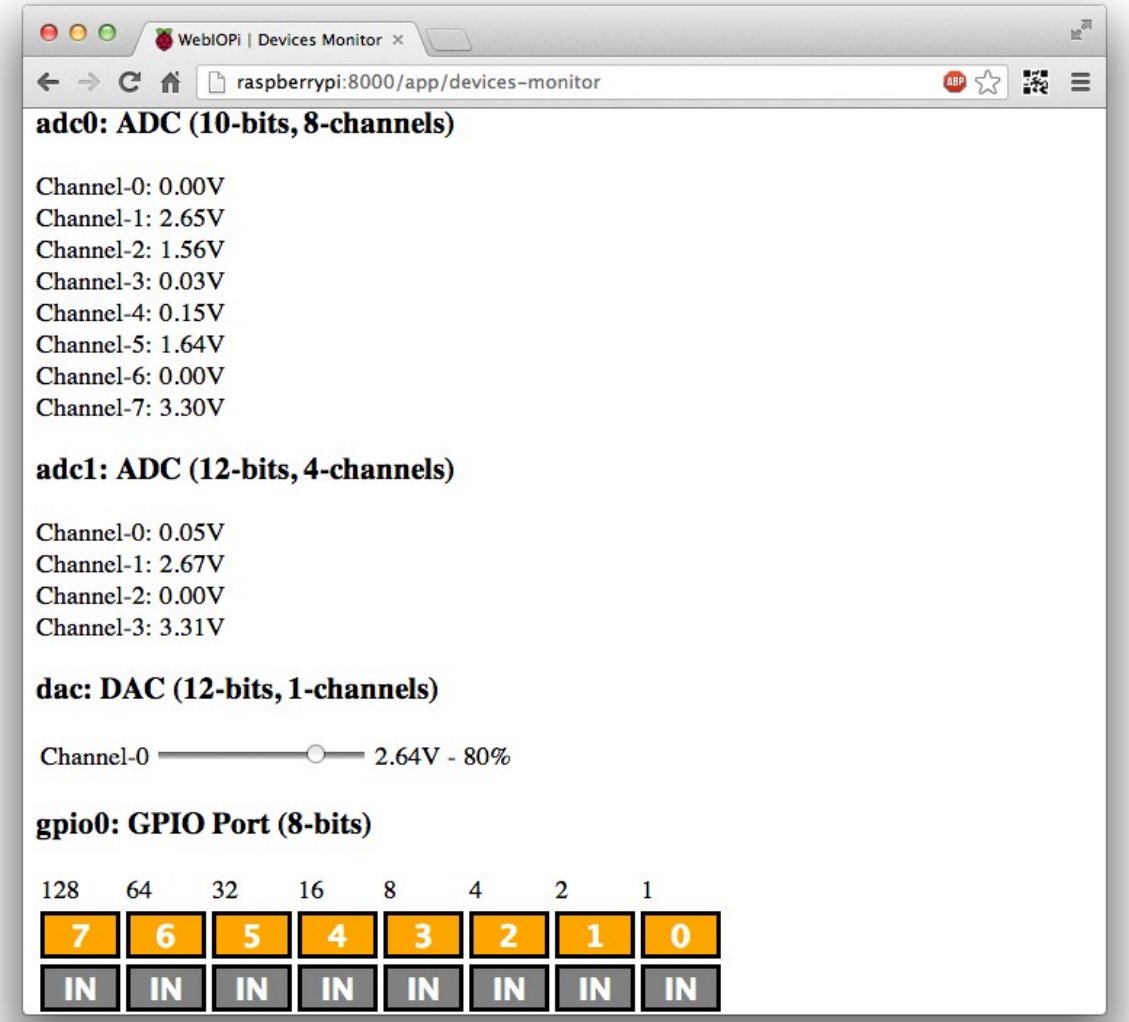
http://code.google.com/p/webiopi/

WebIOPi



http://code.google.com/p/webiopi/

WebIOPi


WebIOPi | Devices Monitor
raspberrypi:8000/app/devices-monitor
adc0: ADC (10-bits, 8-channels)
Channel-0: 0.00V
Channel-1: 2.65V
Channel-2: 1.56V
Channel-3: 0.03V
Channel-4: 0.15V
Channel-5: 1.64V
Channel-6: 0.00V
Channel-7: 3.30V
adc1: ADC (12-bits, 4-channels)
Channel-0: 0.05V
Channel-1: 2.67V
Channel-2: 0.00V
Channel-3: 3.31V
dac: DAC (12-bits, 1-channels)
Channel-0
2.64V - 80%
gpio0: GPIO Port (8-bits)
128 64 32 16 8 4 2 1
7 6 5 4 3 2 1 0
IN IN IN IN IN IN IN IN

wiringPi

http://wiringpi.com/

Some links

Install Python Module RPi.GPIO
http://www.raspberrypi.org/

Embedded Linux
http://elinux.org/RPi_Hub

8 bits gcc -avr compiler
http://www.nongnu.org/avr-libc/

Qt multiplatform API (Linux, Embedded, Windows, Mac)
http://qt-project.org/

QtDD12 - Qt on Raspberry Pi - Jeff Tranter
http://www.youtube.com/watch?v=4tM1TRUtfQE

Library to use serial port on Qt
http://code.google.com/p/qextserialport/

Arduino-like library for Raspberry Pi
https://projects.drogon.net/raspberry-pi/wiringpi/

IoT framework for Raspberry Pi (Rest on HTTP and CoAP)
http://code.google.com/p/webiopi/

Serial terminal based on qextserialport
http://code.google.com/p/qtterm/

Miller and driller CNC machine
http://sourceforge.net/projects/qtcnc/files/

Questions ...

… and demo.

Farewell

This presentation : **http://ves.cat/hmlw**

Contact e-mail : **jordibinefa@electronics.cat**

https://twitter.com/electronicscat

https://twitter.com/JordiBinefa

LinkedIn **http://es.linkedin.com/pub/jordi-binefa/13/717/90b**

http://oshw.binefa.net/

http://binefa.com/blog/

http://electronics.cat/

Thanks for your attendance