Making Open Source Hardware IoT with Raspberry Pi

Leon Anavi
Konsulko Group
leon.anavi@konsulko.com
OpenIoT Summit
21-23 February, Portland, Oregon
Agenda

- Raspberry Pi add-on boards for IoT
- Raspberry Pi HAT
- Raspberry Pi pHAT
- Designing an open source hardware
- Software support
What is Open Source Hardware?

- Design of physical objects that is publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design.
Open Source Hardware Licenses

- GNU General Public License (GPL)
- Creative Commons Attribution-ShareAlike
- CERN Open Hardware License (OHL)
- TAPR Open Hardware License (OHL)
- FreeBSD
- MIT
- Other
Why Raspberry Pi?

- Low cost credit-card-sized computer
- Good software support
- Huge community

- NOT open source hardware!
Raspberry Pi

- 2009 - Raspberry Pi Foundation
- 2012 - The 1st Raspberry Pi
- 2014 - Raspberry Pi B+
- 2016 - Raspberry Pi Zero
Raspberry Pi Flavors
Many add-on boards
Important Change in B+

Raspberry Pi B (2011) - 26 pins

Raspberry Pi B+ (2014) - 40 pins
Raspberry Pi Flavors
40 Pin Header
Raspberry Pi HAT

INTRODUCING RASPBERRY PI HATS

Since 31st July 2014
Raspberry Pi HAT

Hat ≠ HAT (Hardware Attached on Top)
HAT Requirements

- Form factor and dimensions (65x56mm)
- 40 pin header compatible with Raspberry Pi B+ and the newer models
- EEPROM with device tree fragment

Details:


https://github.com/raspberrypi/hats
pHAT

- Form factor suitable for Raspberry Pi Zero with 4 mount holes and dimensions 65x30mm
- 40 pin through-hole header
- EEPROM not mandatory

*Not an official standard of the Raspberry Pi Foundation*
Sense HAT

- Official product of the Raspberry Pi Foundation
- Sensors for temperature, humidity, barometric pressure, gyroscope, accelerometer, magnetometer
- 8x8 RGB LED matrix
- Five-button joystick
Raspberry Pi HATs, pHATs & Add-ons

Click on a HAT, pHAT or add-on for more details and to see which pins it uses!
Making Your 1st HAT

Requirements:

- Idea (for example: a blinking LED)
- Soldering equipment
- Adafruit Perma-Proto HAT
- Additional hardware resources (depending on the idea)
Data structure with hardware description of the Raspberry Pi HAT stored on EEPROM

- 8 pin DIP I2C EEPROM
- Recommended EEPROM CAT24C32
Flashing the EEPROM

- Download and build eepromutils
  https://github.com/raspberrypi/hats

- Create a text file with description of your HAT using `eeprom_settings.txt` for example

- Generate `.epp` file using `eepmake`

- Flash the binary file to the EEPROM using `eepflash.sh`
EEPROM Wiring

- Flashing the EEPROM: pin 2 and 3
- Reading from the EEPROM: pin 27 and 28
device-tree/hat

- Directory /proc/device-tree/hat
- Information about product name, version, vendor and UUID

```
pi@raspberrypi:~ $ ls /proc/device-tree/hat/
name product product_id product_ver uuid vendor
pi@raspberrypi:~ $ cat /proc/device-tree/hat/product
ANA VI Infrared pHAT
pi@raspberrypi:~ $ cat /proc/device-tree/hat/vendor
ANA VI
pi@raspberrypi:~ $ 
```
Designing PCB

Electronics Design Automation Suites:

- KiCAD (free & open source software)
- Eagle (free for small 2 Layer PCB)
- Other
KiCAD Advantages

- Free & open source software (GPLv3+)
- Cross platform (works on GNU/Linux distributions, MS Windows and Mac OS X)
- Integrated 3D viewer
- Contributions from CERN developers
- Used by Olimex for the design of their new open source hardware boards
HAT Templates

- **KiCAD**
  
  https://github.com/xesscorp/RPi_Hat_Template
  
  http://gitlab.openfet.com/julien/pihat-template

- **Eagle**
  
  http://www.flyfish-tech.com/pub/RasPi-BplusHAT.zip
My OSHW HAT & pHAT

Anavi Flex HAT
https://github.com/AnaviTech/anavi-flex

Anavi Infrared pHAT
https://github.com/AnaviTech/anavi-infrared
Recommendations

- Comply with the minimum requirements of the PCB manufacturer for trace spaces, drills and angular rings.
- Keep in mind the complexity of the assembly process while designing the PCB.
- Consider the location of Raspberry Pi components while placing components on your HAT and avoid any potential negative impact.
Prototypes

PCB printing services from:

- OSHPark (Made in the USA)
- China
- Local
Software

- Python is popular programming language among Raspberry Pi makers
- WiringPi library for C/C++
- WiringPi language bindings: Java, JavaScript (Node.js), PHP, Perl, Go, Rust, etc.
- Other FOSS (LIRC, OpenCV, etc.)
... and one more thing

Share your hardware and software under open source licenses :)
Thank You!

Useful links:

- http://pinout.xyz/
- https://github.com/raspberrypi/hats
- https://github.com/AnaviTech
- http://wiringpi.com/
- http://kicad-pcb.org
- https://oshpark.com/