



# Introduction to embedded development IS1204

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# hardware

Android, telephones/OTG

Rpi, BB, Odroid etc small

Arduino

Development boards, AVR, PIC, ARM, STM

Wireless development boards AVR

# operating system?

None. Bare

Arduinio

Contiki

TinyOs

Android

Linux

# developer toolchain for building firmware

Arduinio integrated

gcc, + c-library

sdcc stm8, pic

Android, Eclipse, traditional make

Mbed, AVR studio etc

# getting the toolchain/environment

Pre-built environment by vendor or project

Virtual environment (Contiki)

Getting compiled binaries apt-get install etc

Get build scripts and build from source

# programming the target uploading firmware

Serial Bootloader. Via serial port, UART, USB  
ISP (Special programmer for MCU)  
JTAG (Special programmer for MCU expensive)  
USB (Serial bootloader)  
Other

# wired comm. & interfaces

USB

GPIO (General-Purpose Input/Output)

TTL (Transistor–Transistor Logic) Serial

SPI (Serial Peripheral Interface)

I2C (Inter-Integrated Circuit)

RS 232

# wireless comm. & interfaces

WiFi (IEEE 802.11x)

3g/4G (add ref)

Bluetooth (expired IEEE 802.15.1), BLE

IoT (IEEE 802.15.4)

ZigBee (IEEE 802.15.4)

Other ISM (The industrial, Scientific and Medical)  
Modules(433/868/915 MHZ)

# add-ons and break-out boards

Almost everything... Just some I2C examples

Accelerometer & gyro (MPU-6050)

Magnetometer (HMC5883)

Temp & RH (SHT21, SHT25)

Pressure (BMP180, MS5611)

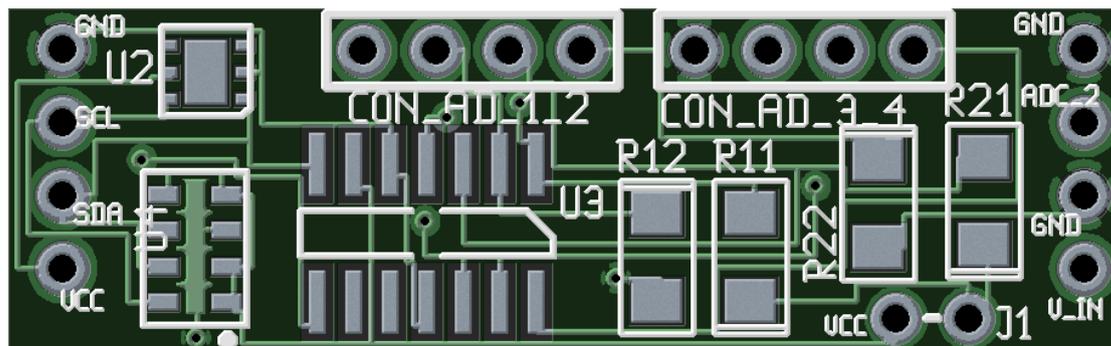
Hi-RES AD converter (MCP3424)

Lightning (AS3935)

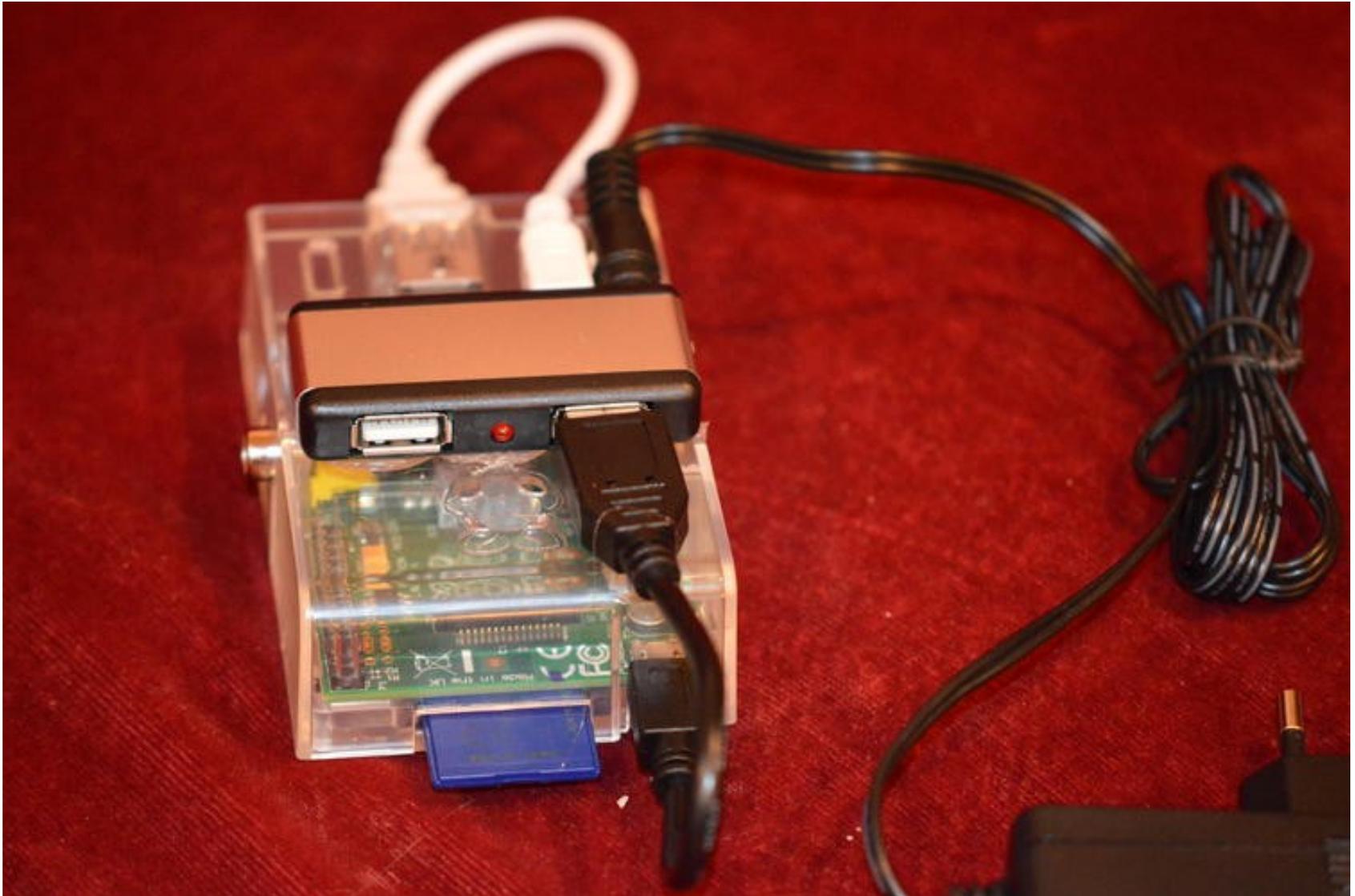
Gamma, beta radiation (RD3024) TTL/Pulse

# break-out boards do it yourself?

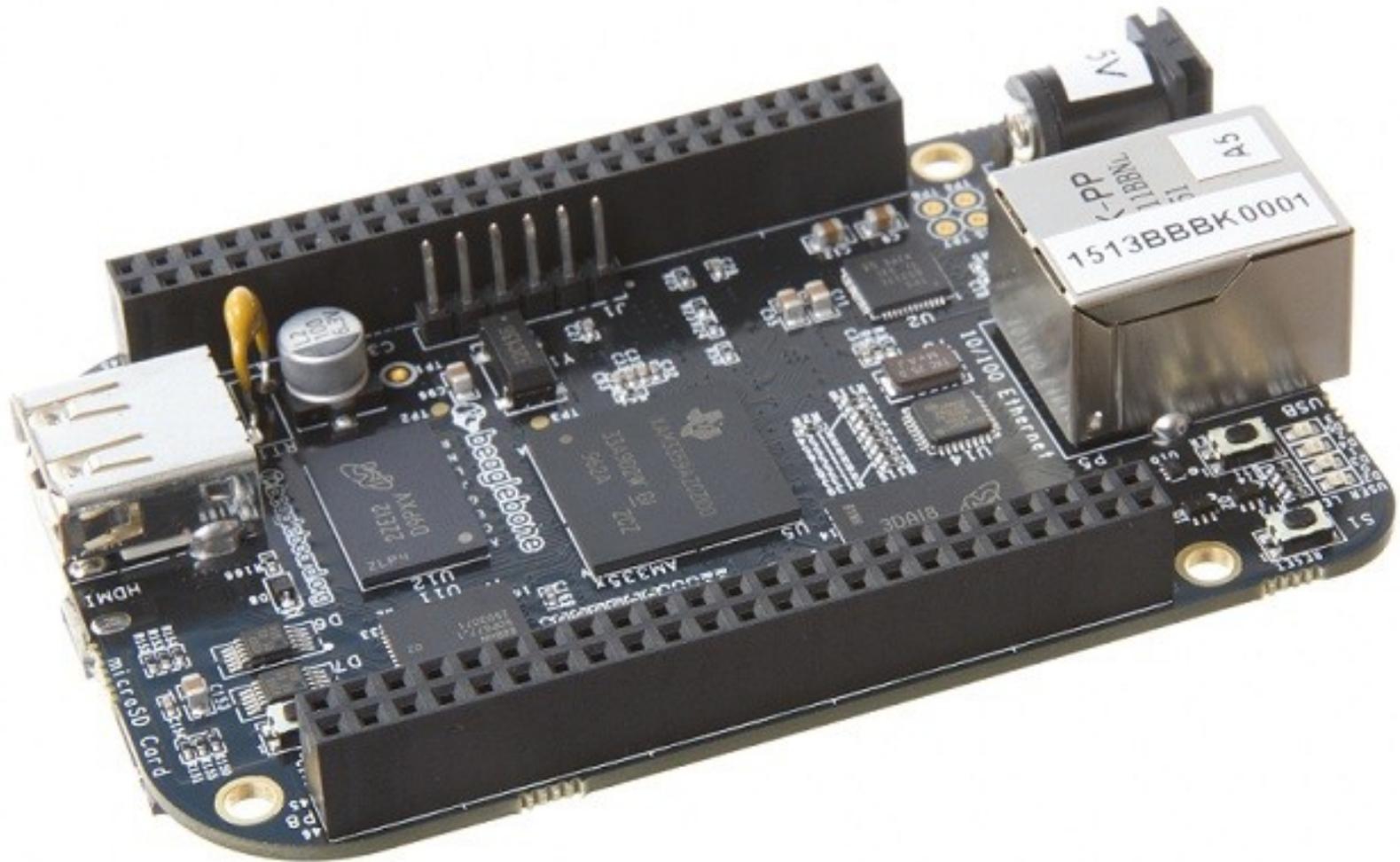
Relatively easy... SHT25, MS5611, MCP3424 for WIMEA meteorological project.



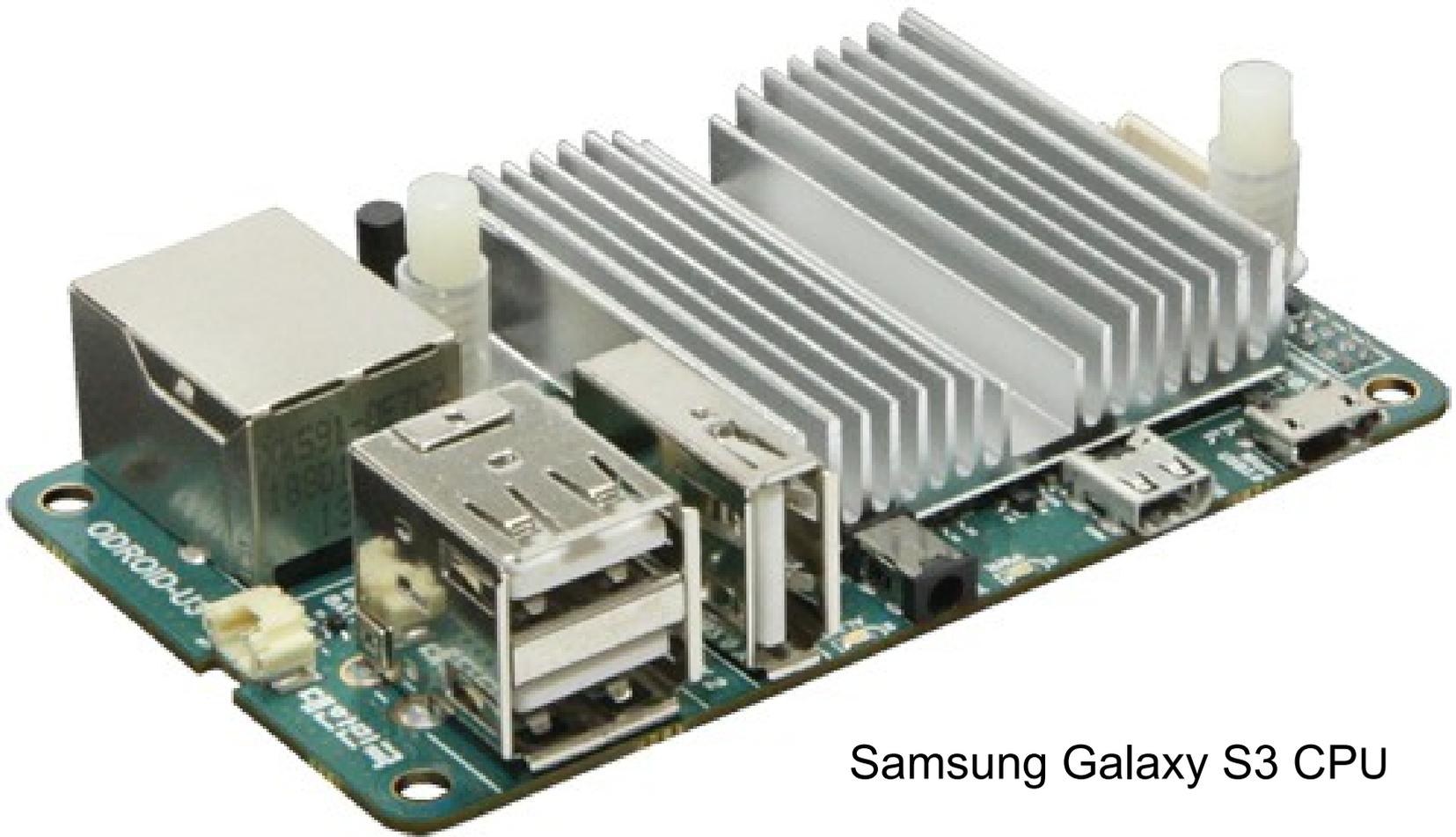
# RPI & USB hub unit



# Beaglebone Black, TI SoC

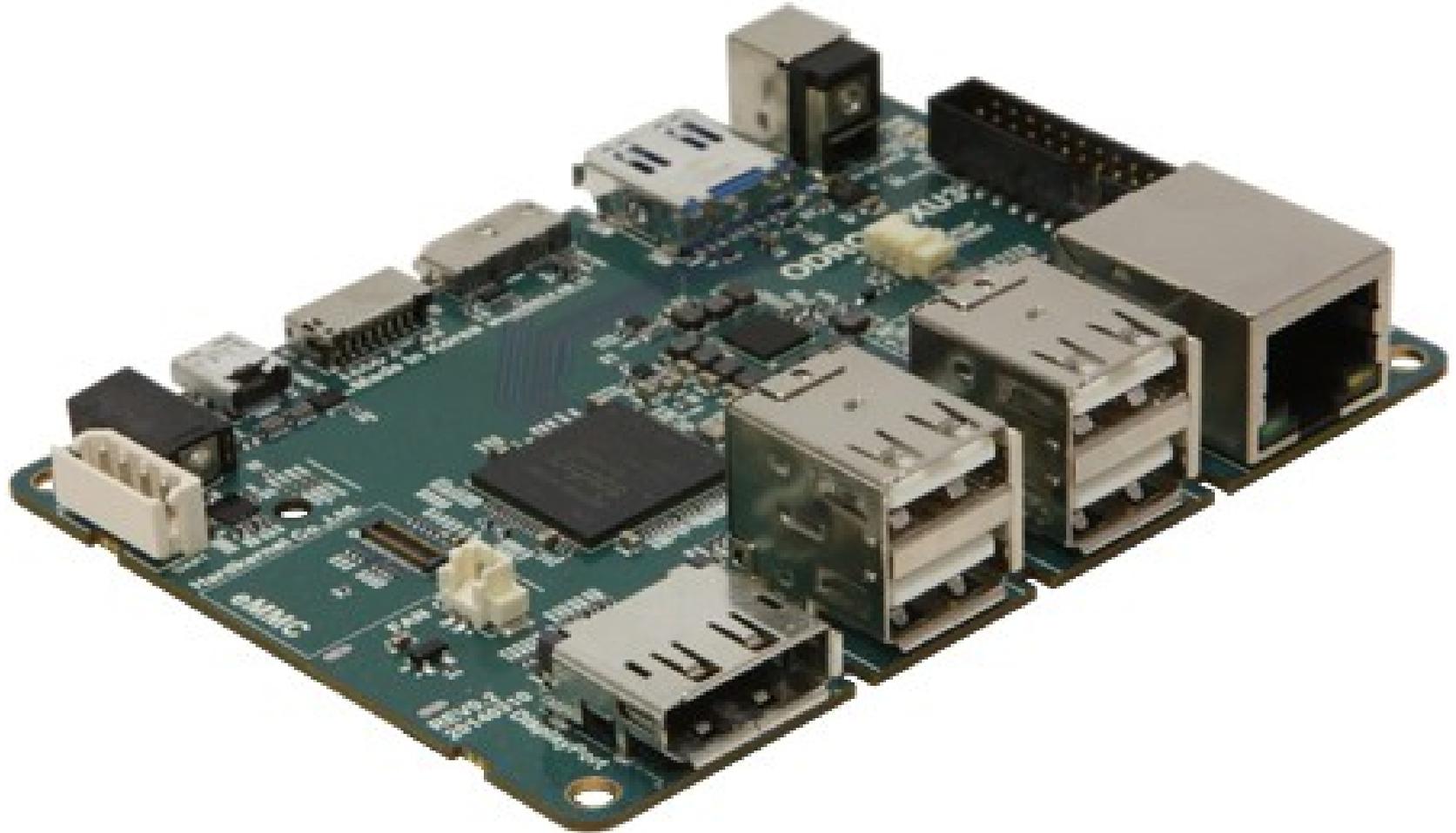


# Odroid 1.7 GHz 4 cores



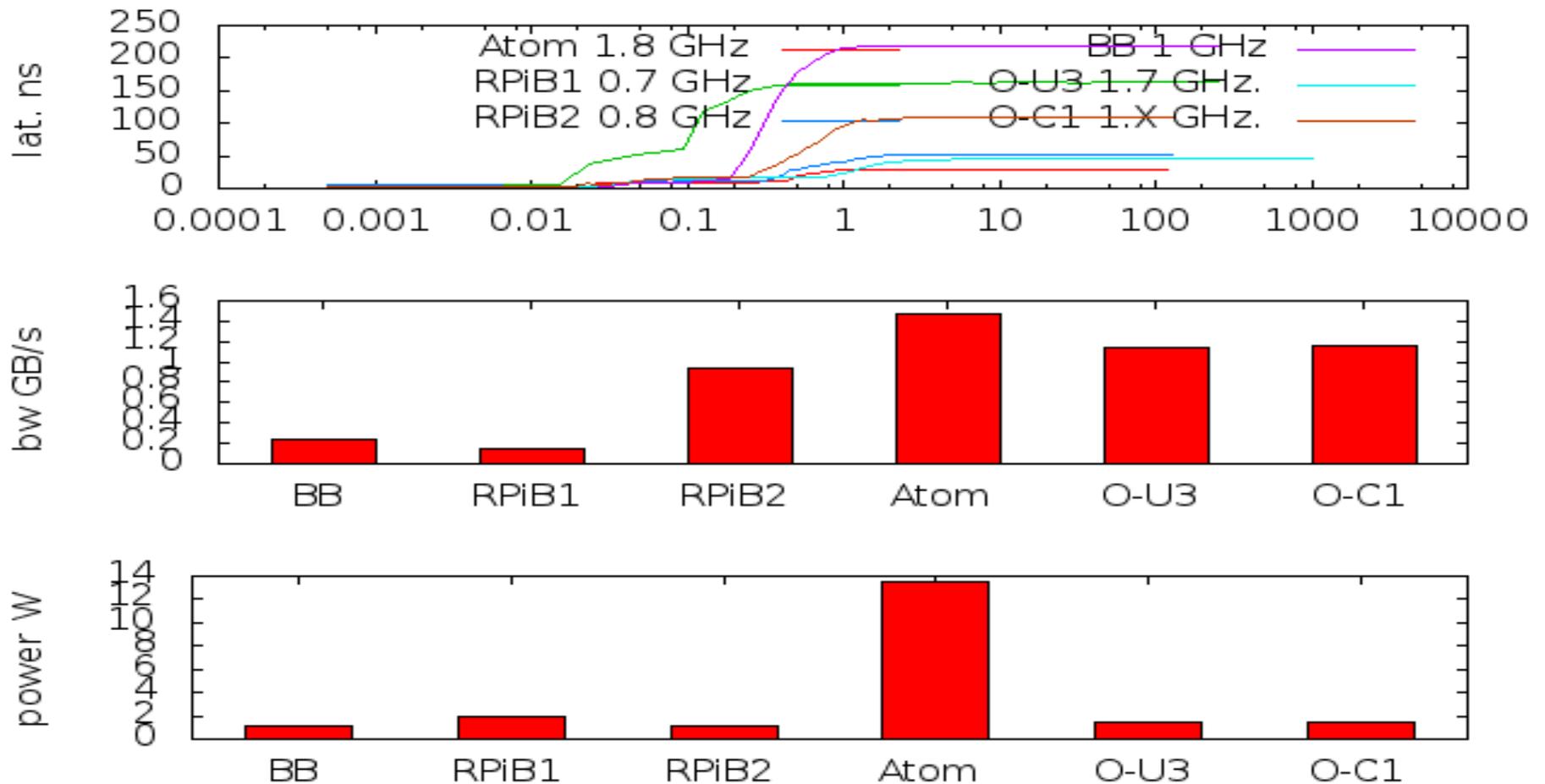
Samsung Galaxy S3 CPU

Odroid XU3: 4 cores @ 2.0 GHz  
4 cores @ 1.4 GHz, USB 3.0



# performance vs power

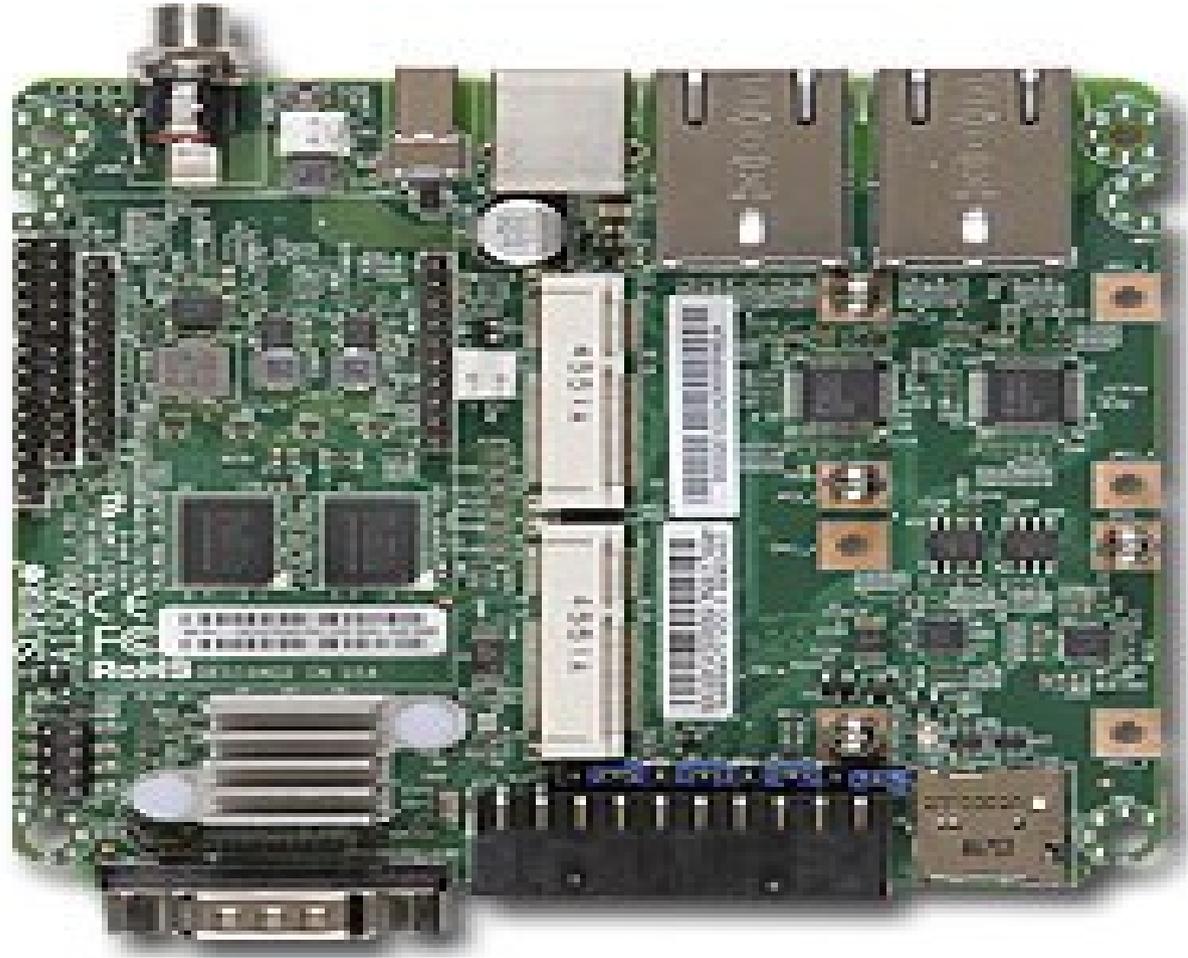
Mem. latency, mem. bandwidth & idle power. Plot rev 1.7



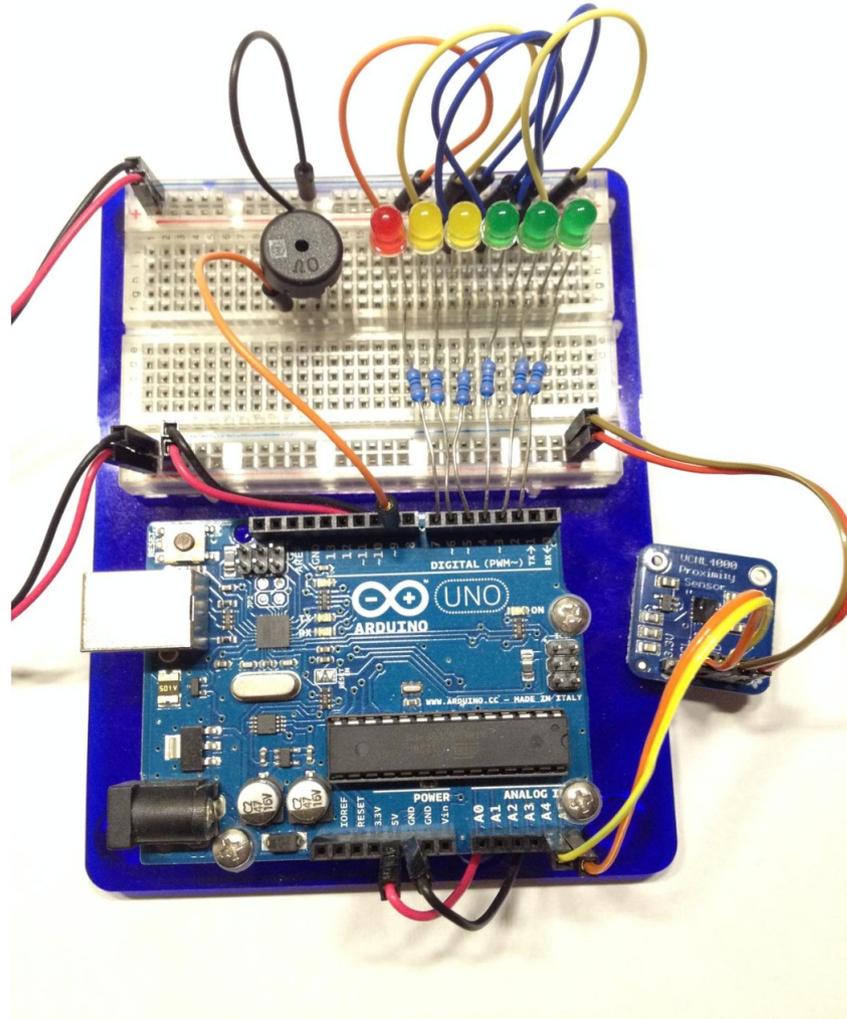
# Intel Quark @ 2.2W

Quark™ SoC X1021  
(16K Cache, 400 MHz)  
512MB DDR3 ECC  
2x Mini-PCI-E slots;  
1x ZigBee module socket  
2x 10/100Mbps LAN

32 bit  
1 Core

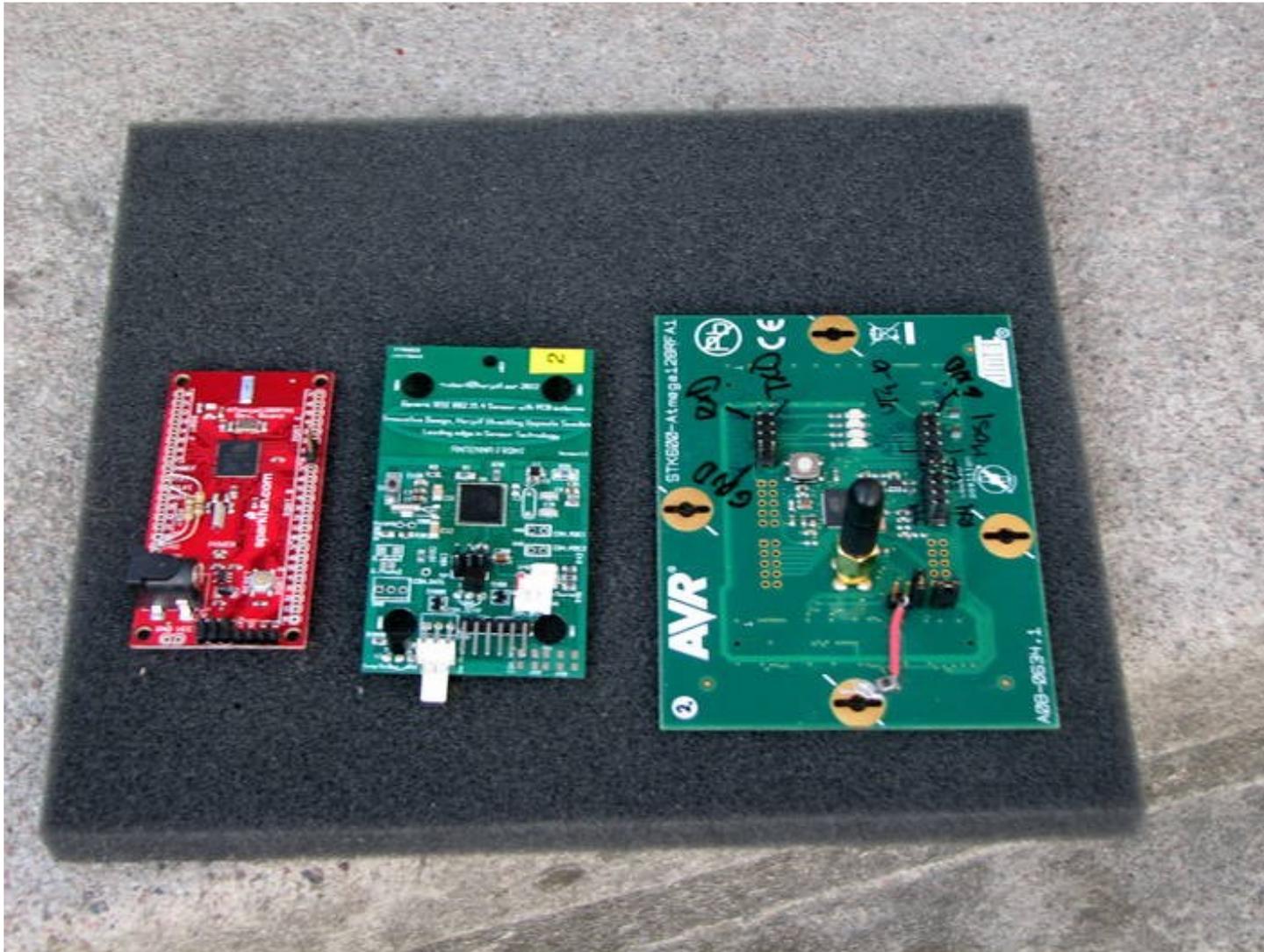


# Arduino

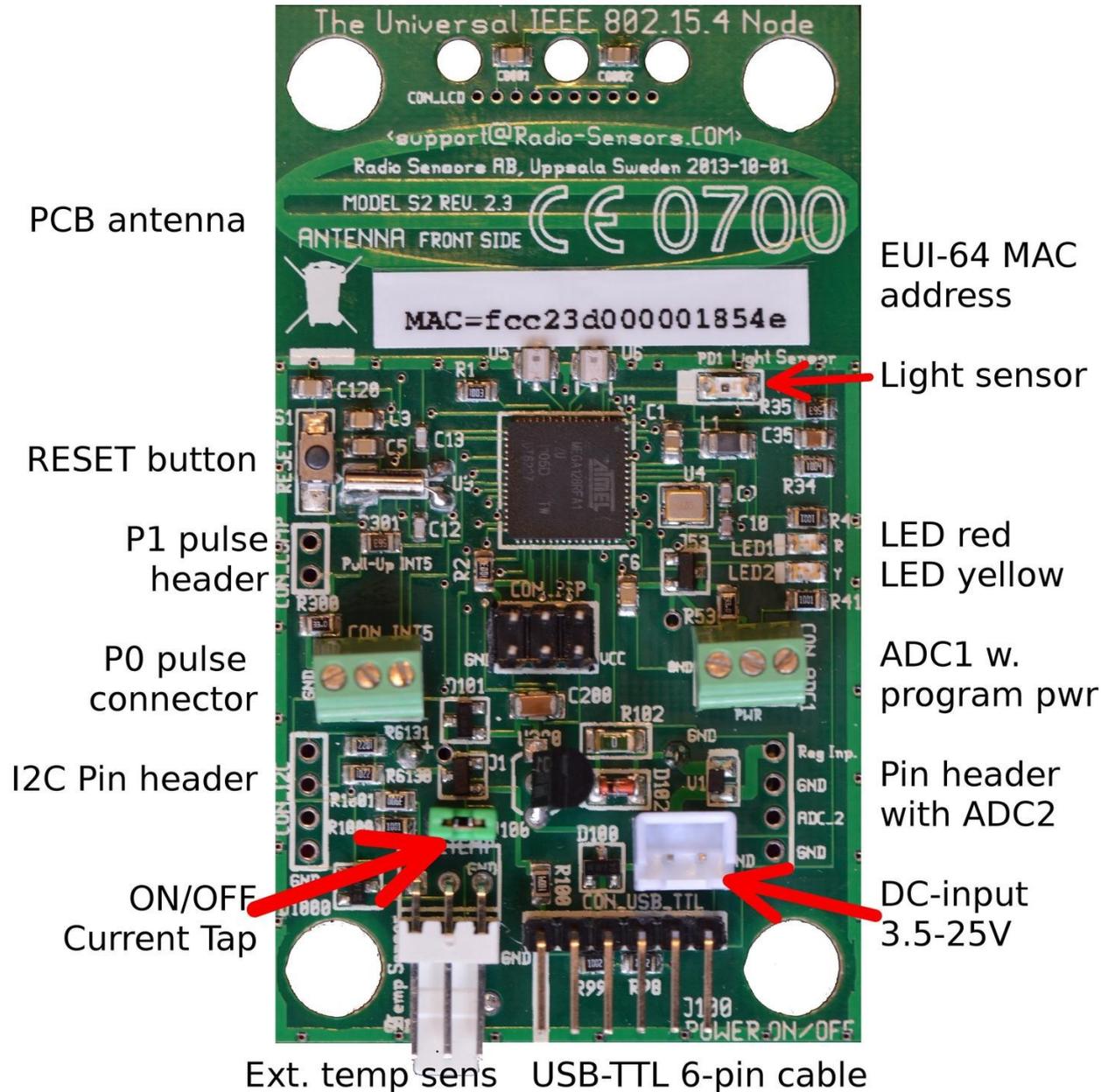


# Contiki Programming Experiences

MCU boards w. Builtin IEEE802.15.4 radio transceiver



# WSN IEEE 802.15.4 Sensor Node



# Rpi interface & connections

- USB
  - Beg kraft.
- Ethernet
  - 100 Mbps
  - SD-kort stort
- HDMI
- Terminal port /dev/ttyAMA0
- I2C
- SPI
- GPIO

# Development Support Collaboration

Repository essential

Git, CVS, SVN  
Public [github.com](https://github.com)

Suggestion git

# Arduino cont.

## Arduino in general

- \* Atmega processor family
- \* Lots of “Arduino” implementations (dozens!)
  - Different versions of the processor, memory sizes etc
  - Different number of in- and output pins
  - 3.3V or 5V
- \* Customized development environment "Arduino IDE"
  - Written in java, available on Windows, Mac and Linux
  - Are there any alternative? The editor sucks (on Mac at least!)
- \* Very easy to get it up and running
- \* Easy to find help and information on the 'net
- \* Low cost hardware, cheapest development board is less than 100 kr
- \* ...but you need accessories as well
  - breadboards
  - wire
  - all sorts of components, sensors etc
  - etc

# Referenser

Arduino Cookbook (2nd ed,) Michael Margolis,  
<http://shop.oreilly.com/product/0636920030935.do>

<http://makezine.com/2014/03/05/and-the-winner-is-2/>

Lot's of info and project via web.

The One Watt Initiative IEA in 1999