

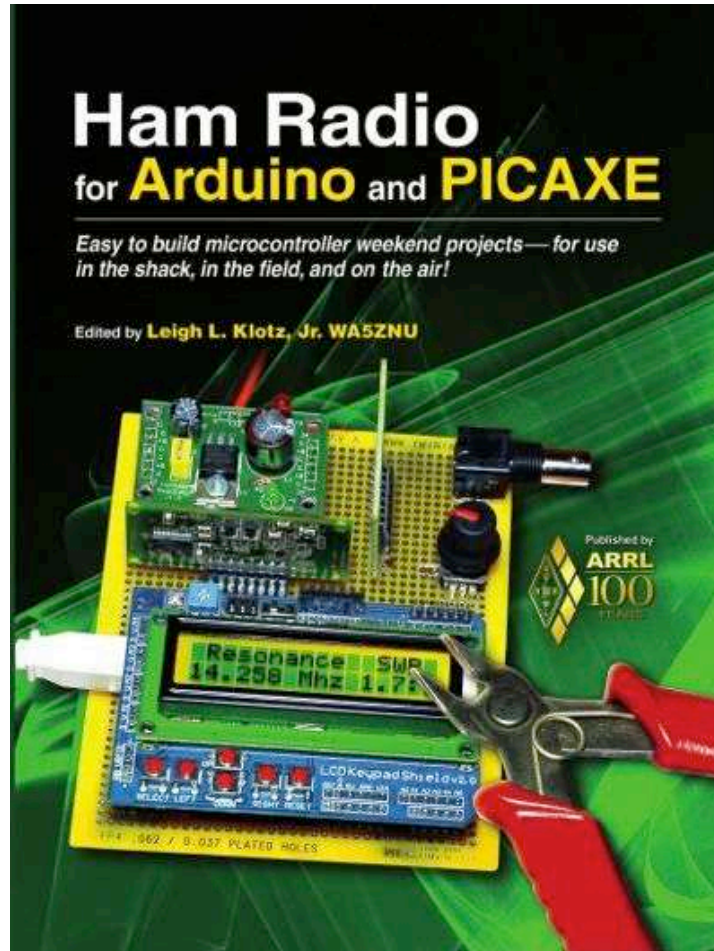
# Ham Radio and Modern Micros Arduino, Picaxe and Beyond

Leigh Klotz, Jr WA5ZNU

OVARC Meeting

2013-11-15

# Arduino, Picaxe, and Beyond

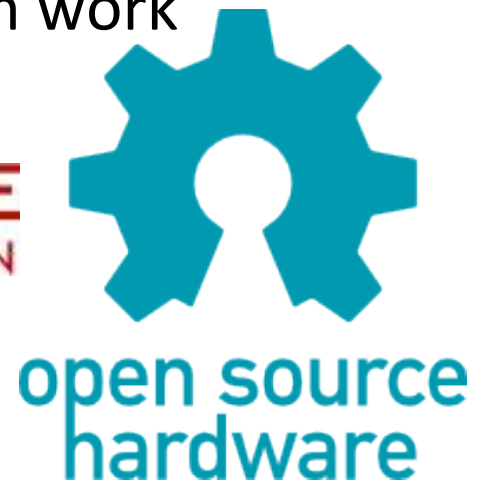


# The Big Picture

- The DiY world is rapidly expanding its options of small computers
- Faster systems are here now and easier-to-use ones are on the way
- Different systems are suited for different types of projects
- *Ham Radio needs to get involved*

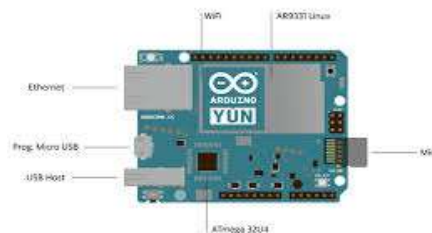
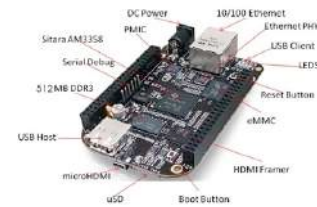
# Open Source Software / Free Software / Open Hardware

- The DiY electronics community is built on these principles.
- These ideals are also part of the ham tradition of promoting the advancement of radio art and science.
- Just as there is a place for commercial ham products, there is also a place for commercial “closed” software
- But just as there is a place for homebrewing, QRP, and construction articles, there is a place for open work



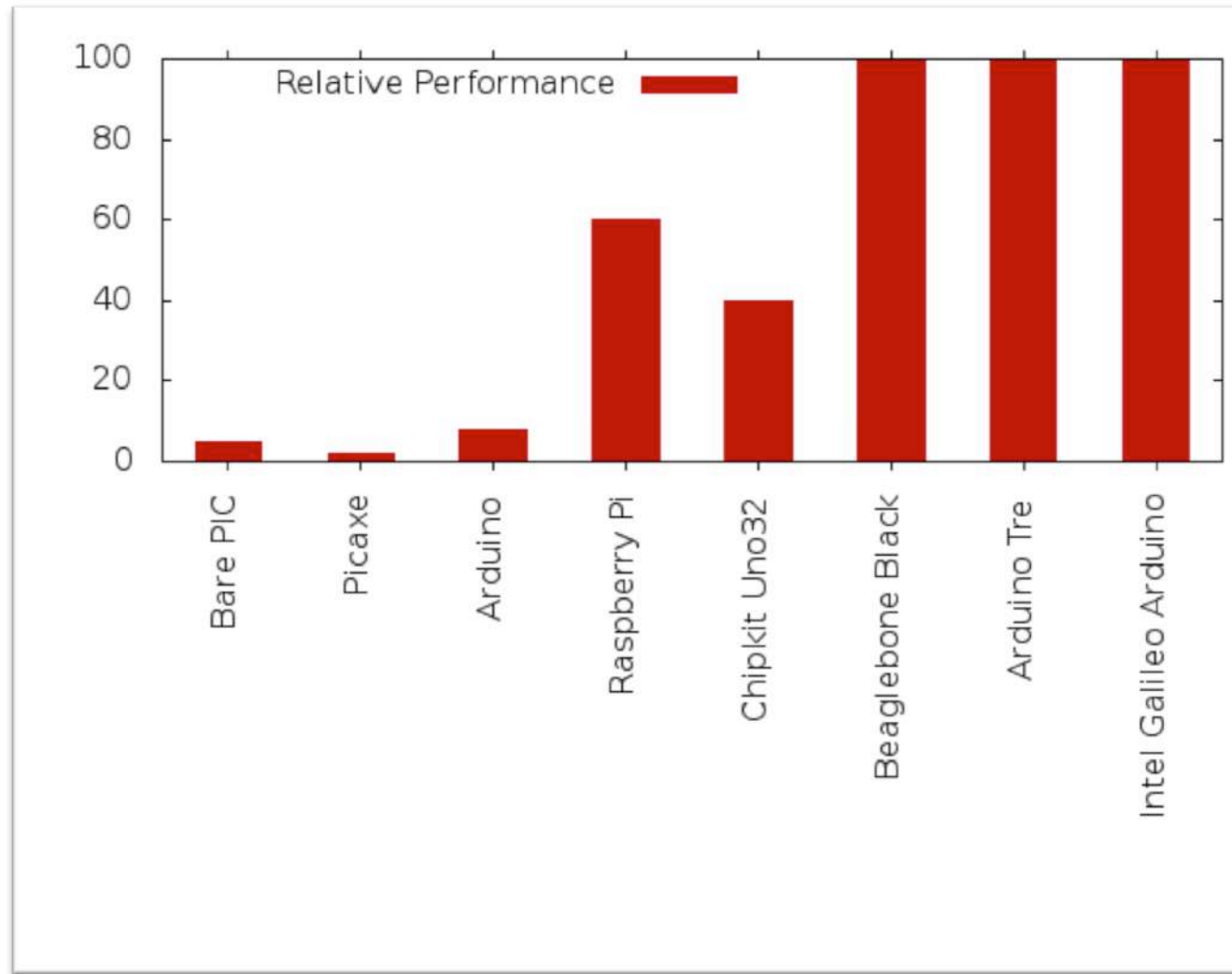
# Points along the Curve

- I. Arduino and Picaxe
- II. Raspberry Pi, and Beaglebone Black
- III. Linux, Python and Ham Applications
- IV. Next-generation Arduino+Linux products



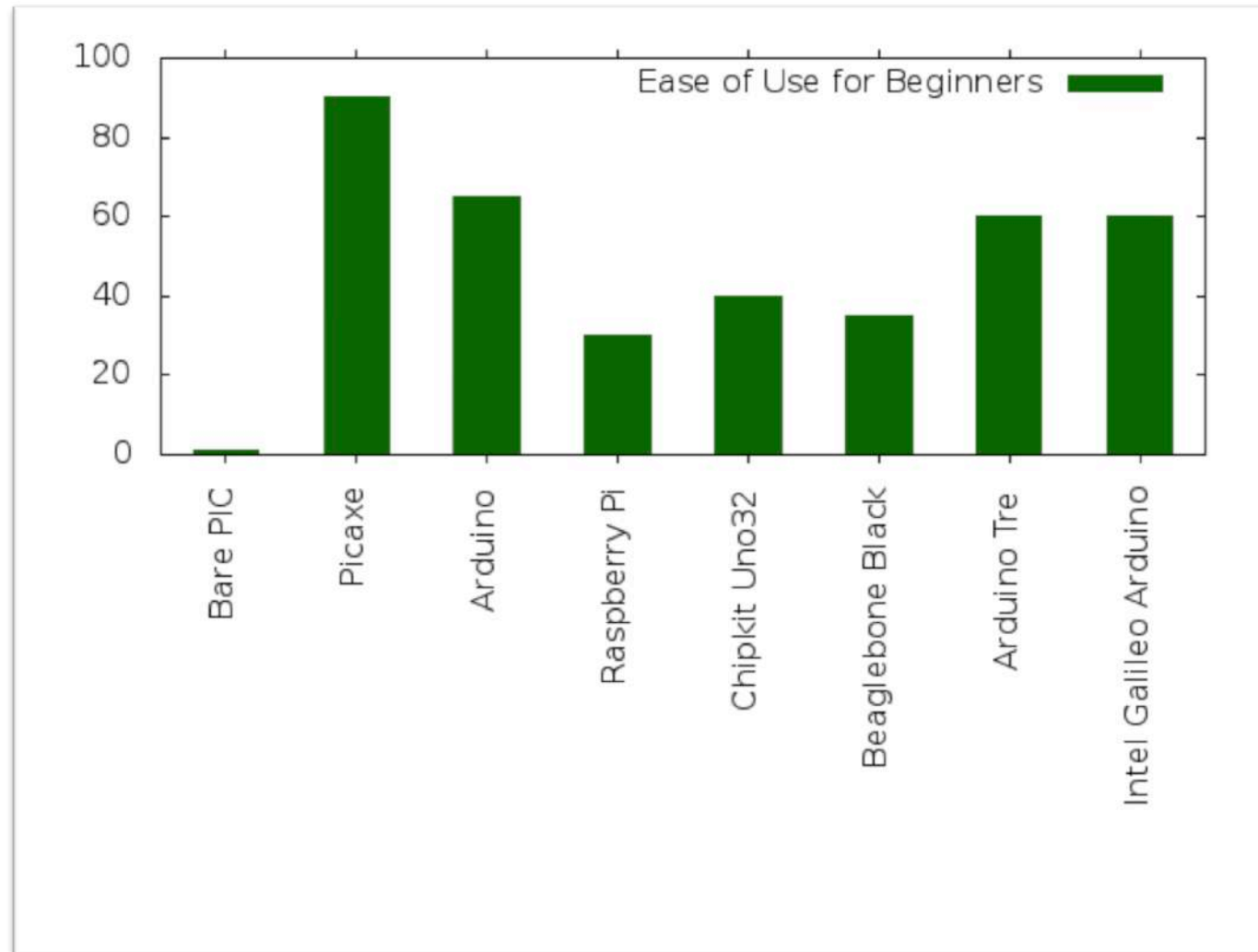
# Points along the Curve: History and Future

Systems vs.  
Performance

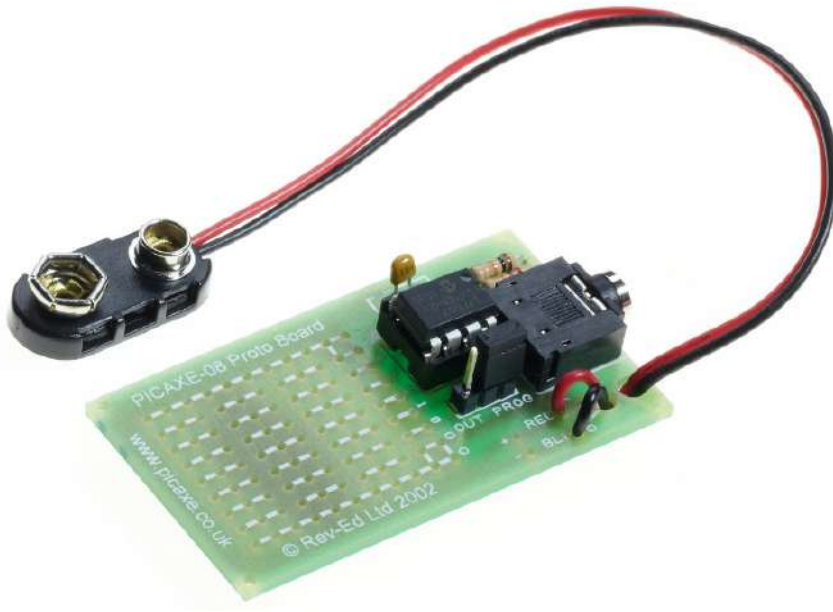


# Points along the Curve: History and Future

Systems vs.  
Ease of Use



# I. Picaxe is a Gentle Onramp



```
' Simple RGB/CMY fader for PICAXE-08m
' Uses Radio Shack 276-0028 5mm common-anode RGB LED
' Use 3 1.5V batteries for supply
' Hook LED long lead to V+
' Hook Other pins to DIP pins 3, 4, and 5 each through a 330 ohm resistor.
```

```
symbol green = 1
symbol blue = 2
symbol red = 4
```

```
symbol i = b4
symbol aa = b2
symbol bb = b3
```

```
main:
    gosub alloff

    aa = red
    gosub rgbramp

    aa = green
    gosub rgbramp

    aa = blue
    gosub rgbramp

    aa = blue
    bb = green
    gosub cmyramp

    aa = red
    bb = blue
    gosub cmyramp

    aa = red
    bb = green
    gosub cmyramp

    goto main

rgbramp:
    high red
    high blue
    high green
    for i=255 to 0 step -4
        pwm aa,i,1
    next i
    for i = 0 to 255 step 4
        pwm aa,i,1
    next i
    return
```



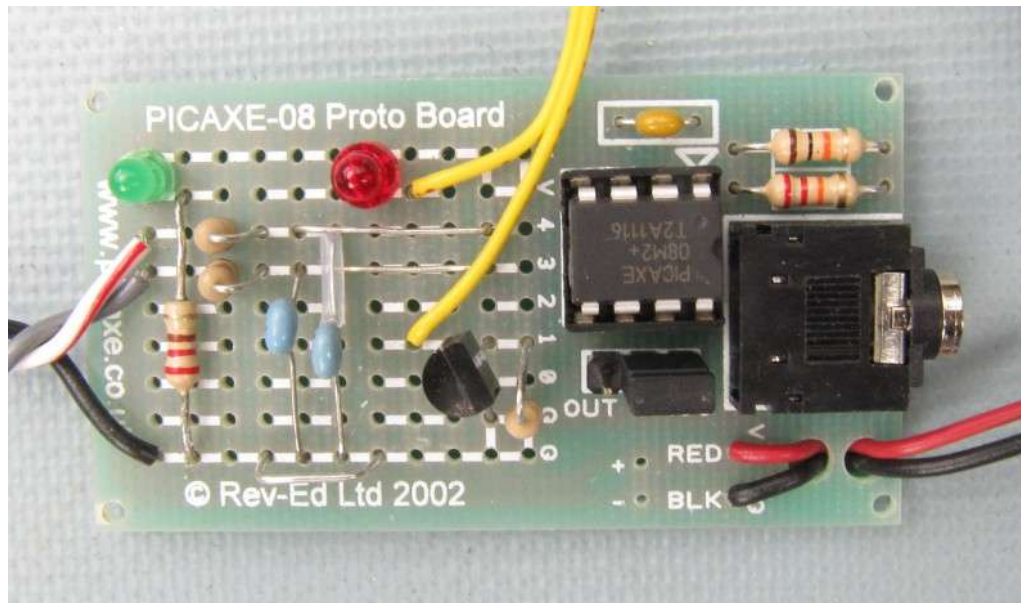
# I. Picaxe is a Gentle Onramp

- Easy to get started
- Program in BASIC
- Lots of Projects  
<http://www.picaxe.com/Project-Gallery/>
- ... but, once projects start to grow, progress is harder and eventually stalls

# **I. Picaxe Example Projects**

# I. Picaxe Keyer (Rich Heinek AC7MA)

- Axekey
- <http://hamradioprojects.com/authors/ac7ma/+axekey>



# I. Picaxe Beacon (Bill Prats K6ACJ)

- Pharos
- <http://hamradioprojects.com/authors/k6acj/+pharos>



# I. Picaxe Solar Tracker (Bill Prats K6ACJ)

- Sunflower
- <http://hamradioprojects.com/authors/k6acj/+sunflower>



# I. Arduino

- Arduino was originally designed for artists, adopted by hackers/makers
- Wikipedia Entry has a good history
- **Arduino Uno best place to start for most hams**



Best in show



# I. Arduino Benefits

- Great community support
  - “Shields” (boards) and Software Libraries
  - Many Suppliers: Jameco, Adafruit, Sparkfun, SEEDStudio, eBay, Amazon, Radio Shack ...

## Google Image Search for "Arduino Shield"



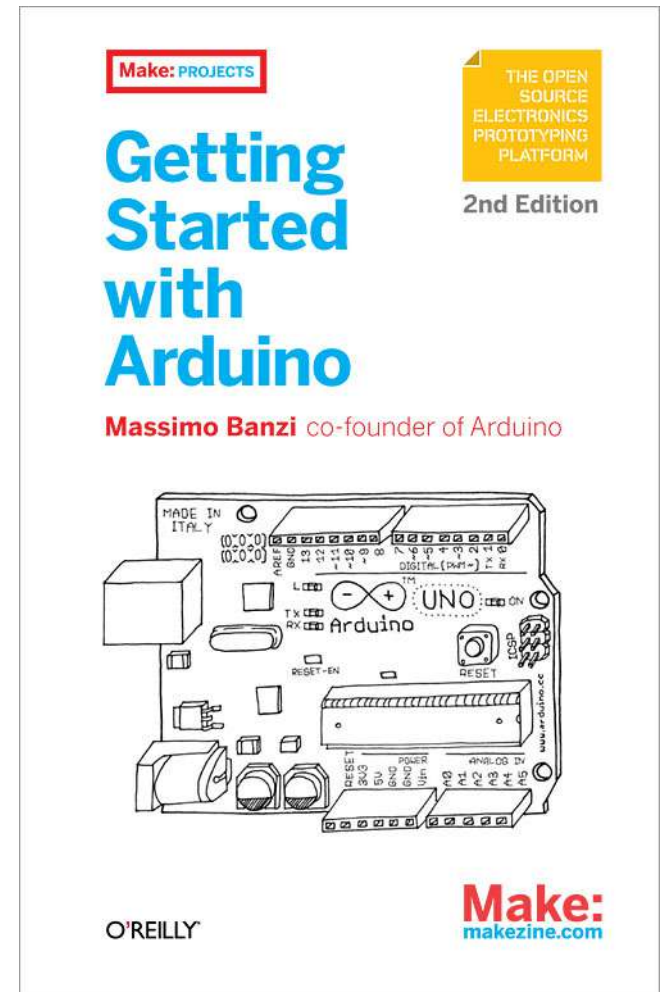
# I. Arduino Pro and Con

- Surprising power made affordable and easily accessible
  - IDE on Windows, Mac, Linux
- Electronically robust
  - Hard to “let the smoke out”
  - 5V, 3.3V
- Good control at electronics/hardware level
  - DAC, ADC present but somewhat weak
- High-level programming language (C++) made easy to use
- Major Disadvantage:
  - Ability to deal with high data rates maxes out early
  - Poor audio, video, wired/wireless networking



# I. Getting Started with Arduino

- **Ham Radio for Arduino and Picaxe** includes easy starter projects
- If you want a gentler introduction try the book **Getting Started with Arduino**
- Make Magazine is always a good bet
  - as is the Maker Faire
  - same time as Dayton Hamvention ;-(



<http://shop.oreilly.com/product/0636920021414.do>

# I. Other Arduino-related Devices



- There are dozens – see the Hardware chapter of **Ham Radio for Arduino and Picaxe**
- Visit websites such as Kickstarter, Indiegogo, Makezine, and retailers such as Jameco, Adafruit, and Sparkfun and others

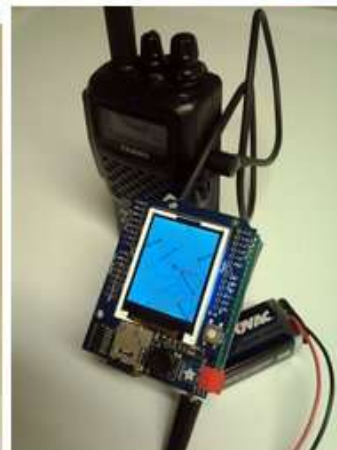
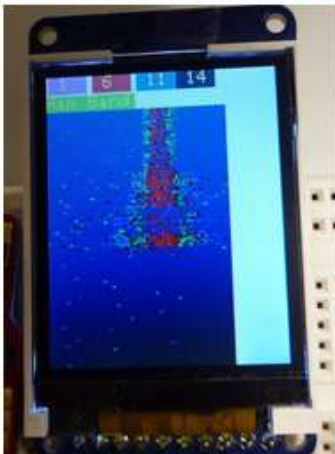
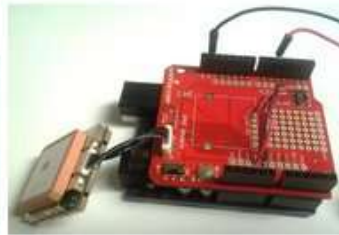
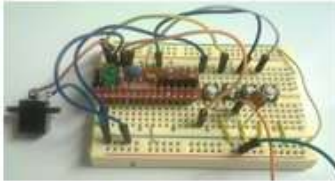
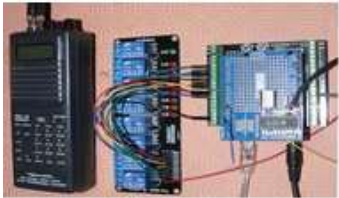
# I. Example Projects: Arduino (The Web)

- Google Image Search for “*arduino ham radio projects*” shows a huge wealth of activity





# I. Arduino Projects from *Ham Radio for Arduino and PICAXE*



# I. Arduino Projects from *Ham Radio for Arduino and PICAXE*

- **Airgate:** APRS IGate
- **QRSS-ATTiny:** QRSS Transmitter
- **MM-Shield:** QRSS and other modes Transmitter Shield
- **Thermic:** Tube VFO Temperature and Stability Monitor
- **Time-Out:** HT Talk Timer
- **Hermes:** APRS Messenger
- **Timber:** APRS Data Logger  
Sweeper: RF Antenna
- **Buddy:** Grid Square Annunciator for Microwave Rovers
- **Cascata:** Hand-held Audio Waterfall
- **Dozen:** SSTV Decoder and interface to SSTV Module
- **Marinus:** APRS Map Display
- **Nanokeyer:** CW Keyer
- **Swamper:** 2.4 GHz Spectrum Analyzer
- **SWR Analyzer**

# I. Arduino Project: Marinus, WA5ZNU

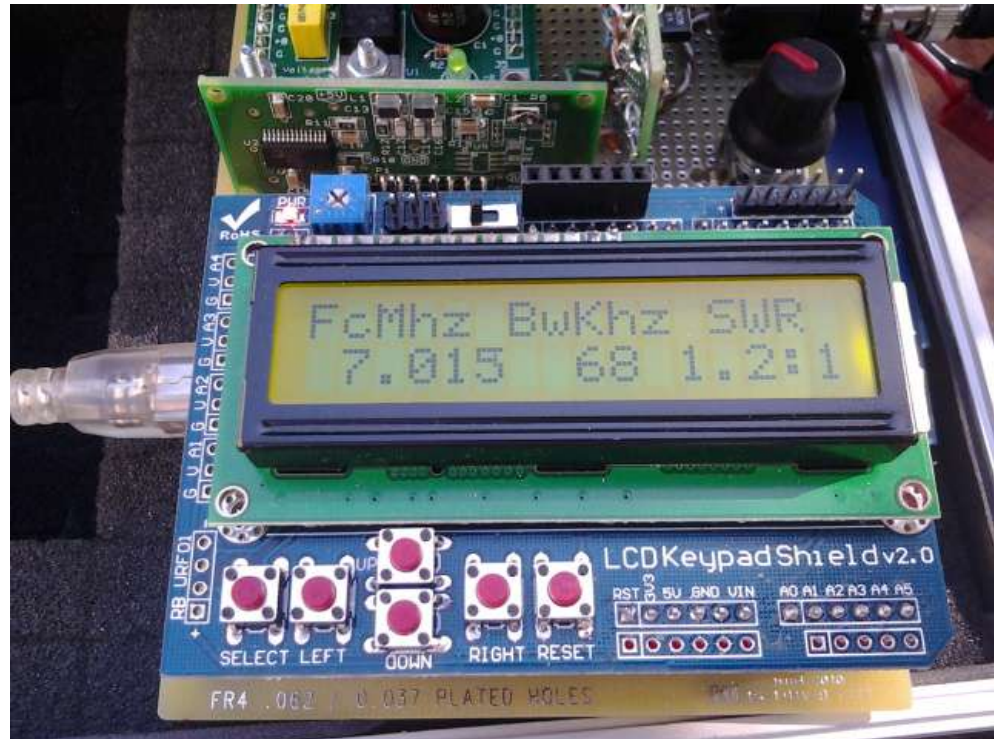
- Live APRS MAP display on color LCD panel
- From “Ham Radio for Arduino and Picaxe”
- Good mix of RF, modes, and display technology
- APRS, demodulation done on shield, map processing done on desktop as well





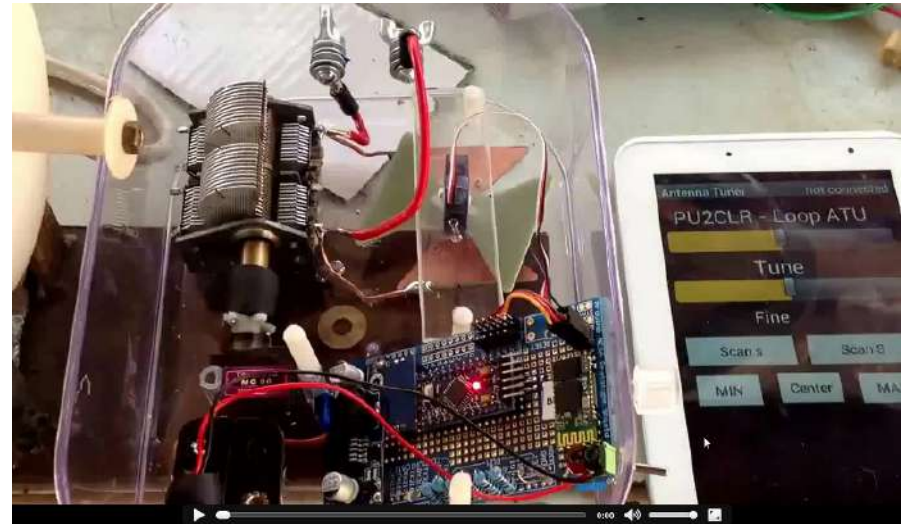
# I. Arduino Project: Sweeper, Alan W6AKB

- SWR-based Antenna Analyzer with DDS and character display LCD
- From “Ham Radio for Arduino and Picaxe”
- Focus on minimal coding support to improve an existing RF technology
- DDS used from NJRQP project; small amount of RF engineering (antenna bridge) and easy display
- Leaves open room for more work by builder
  - color LCD graph
  - Text-To-Speech output for Handi-Hams
- See also K6BEZ [http://www.hamstack.com/project\\_antenna\\_analyzer.html](http://www.hamstack.com/project_antenna_analyzer.html)



# I. Arduino Project: Antenna Tuner with Bluetooth to Android Tablet

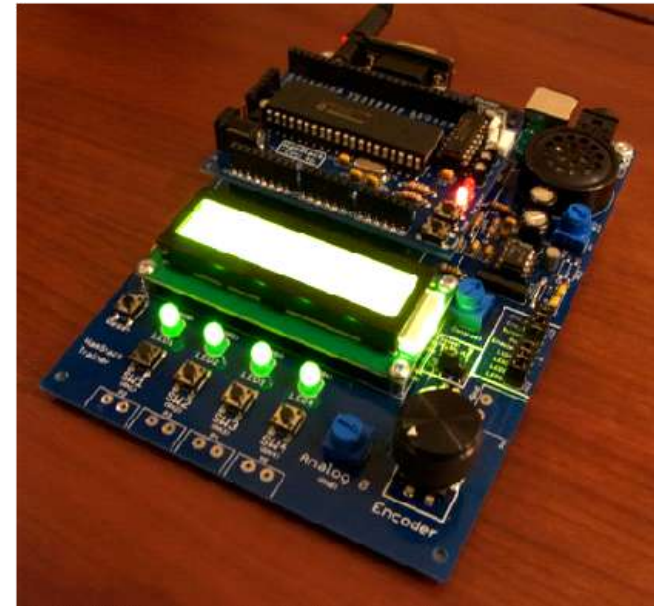
- Ricardo PU2CLR
- Antenna Tuner with Bluetooth to Android Tablet
- For Magnetic Loop - remote is an asset.
- Solves a ham RF problem
- Balanced skills combining electro-mechanics, Arduino, Bluetooth, and Android
- [Watch PU2CLR video on youtube](#)





# I. Chipkit: Microchip's PIC Meets the Arduino

- From Microchip with MIPS 32-bit CPU and Arduino form factor
- About 4-5x speed of Arduino
- <http://hackaday.com/2011/05/27/chipkit-uno32-first-impressions-and-benchmarks/>
- <http://dangerousprototypes.com/2011/05/31/chipkit-conference-call-yes-its-all-open-source/>
- Support of Arduino shields by Microchip for its industrial customers
- Basis of the HamStack project from Sierra Radio Systems
  - <http://www.hamstack.com>



# I. Chipkit: Ten Tec Rebel

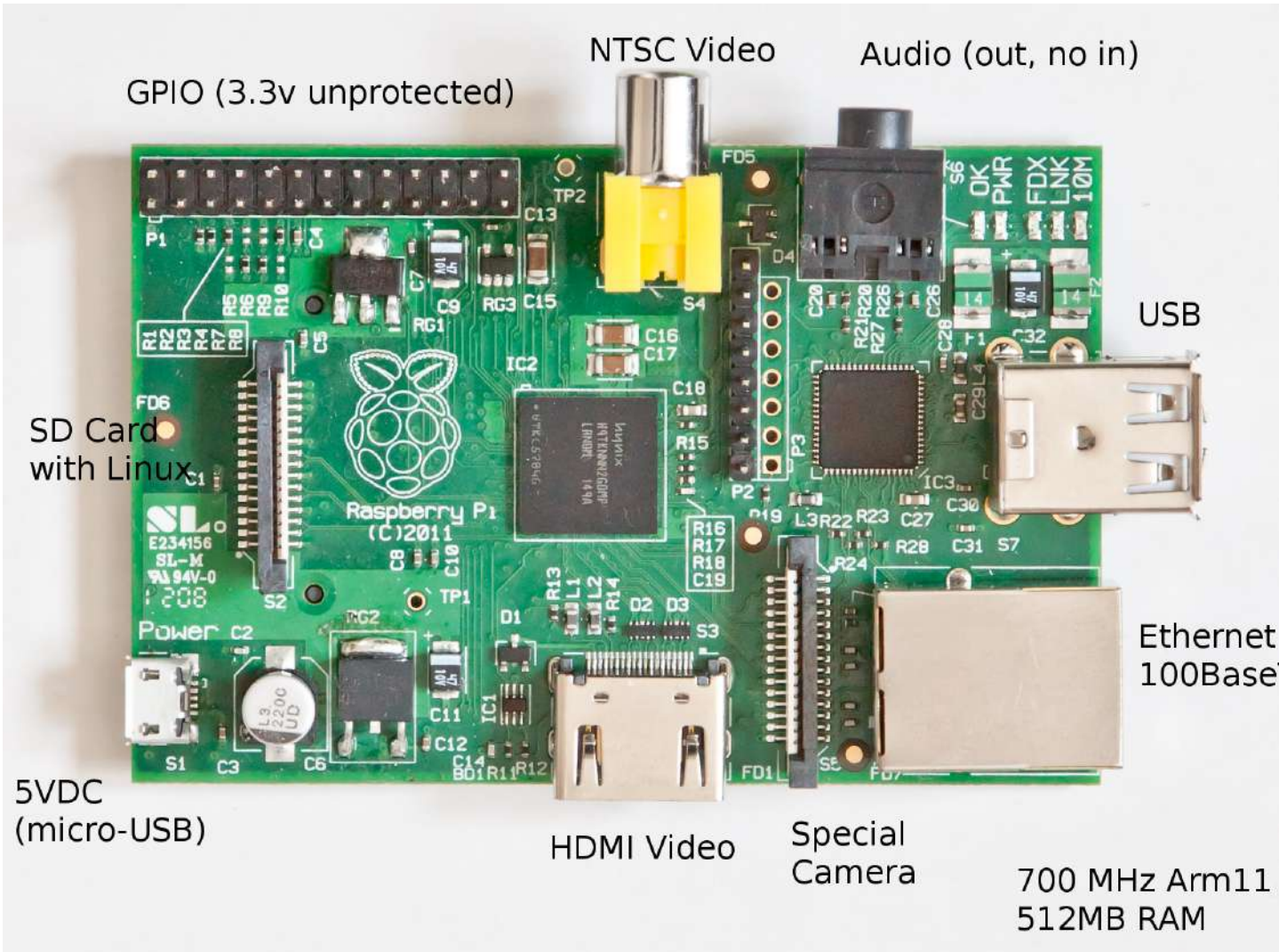
- Diligent chipKIT Uno32 is the basis of Tentec Rebel
- hardware/software open sourced radio from Ten Tec



# Part II. More Power

- Raspberry Pi and Beaglebone Black are a huge step up in power
- They run Linux operating system...
- You can run the ham applications that you can run on laptops
  - digimode programs, logging, APRS, rotator, propagation, Ham VOIP, Ham Wifi...
- They run easy “scripted” programming languages such as Python, Ruby, Perl, and Lua
  - another step up in power
  - another step up access to community

## II. Raspberry Pi took the world by storm



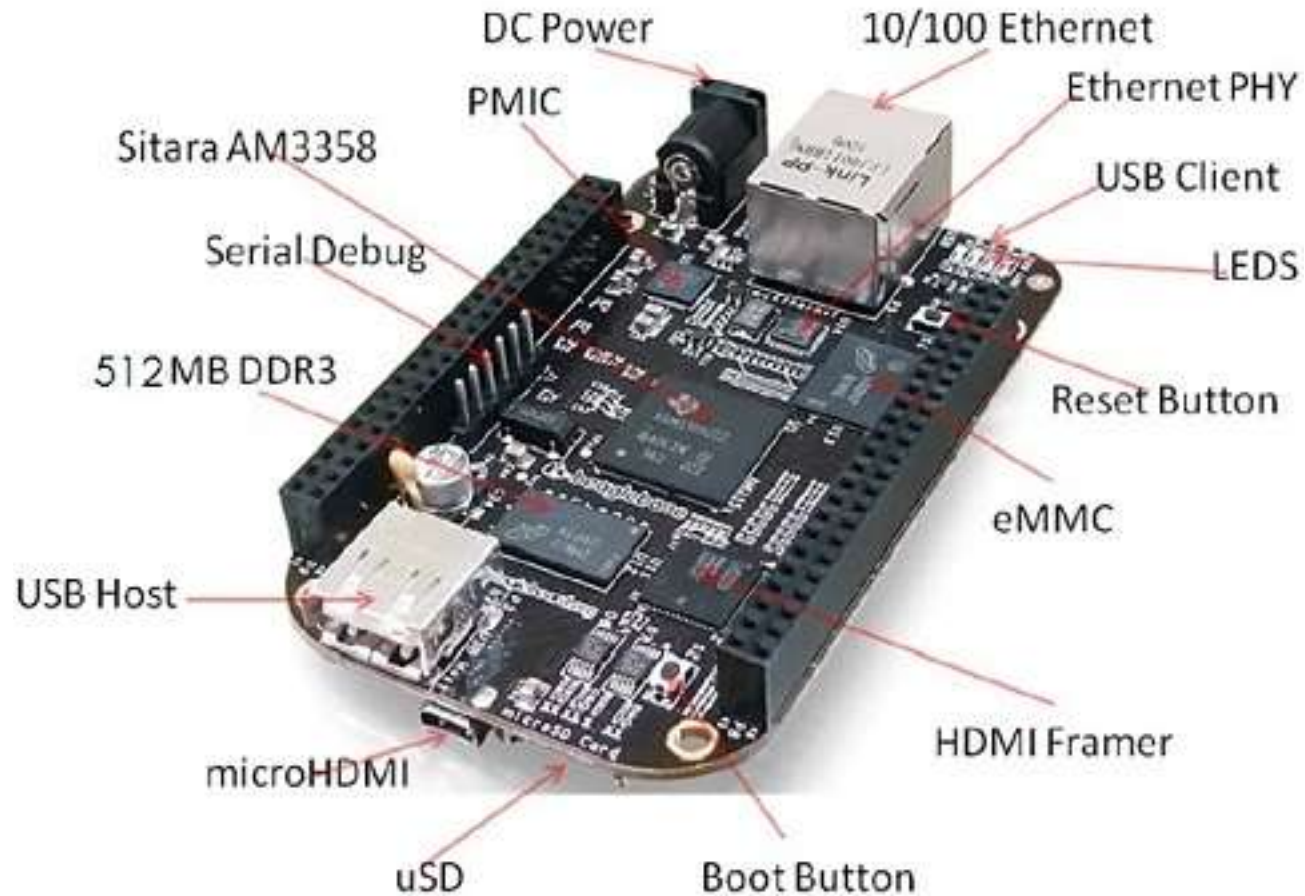
## II. Raspberry Pi Pros

- First inexpensive mass-marketed Linux board (700 MHz ARM11)
  - Millions sold, millions unused
- Pros:
  - faster and more RAM than a WRT54G (Linux) router
  - Many applications available
  - Higher-level languages (Python, Ruby, Lua, Java) all available
  - Runs modern web browsers (Chrome/Chromium)
- Add a display and keyboard for a laptop-like experience

## II. Raspberry Pi Cons

- Cons:
  - Speed sometimes too slow to use regular applications
  - Cost begins to add up, and performance is limiting
  - Electronics/hardware level interfacing quite limited and fussy

## II. Beaglebone Black



## II. Beaglebone Black

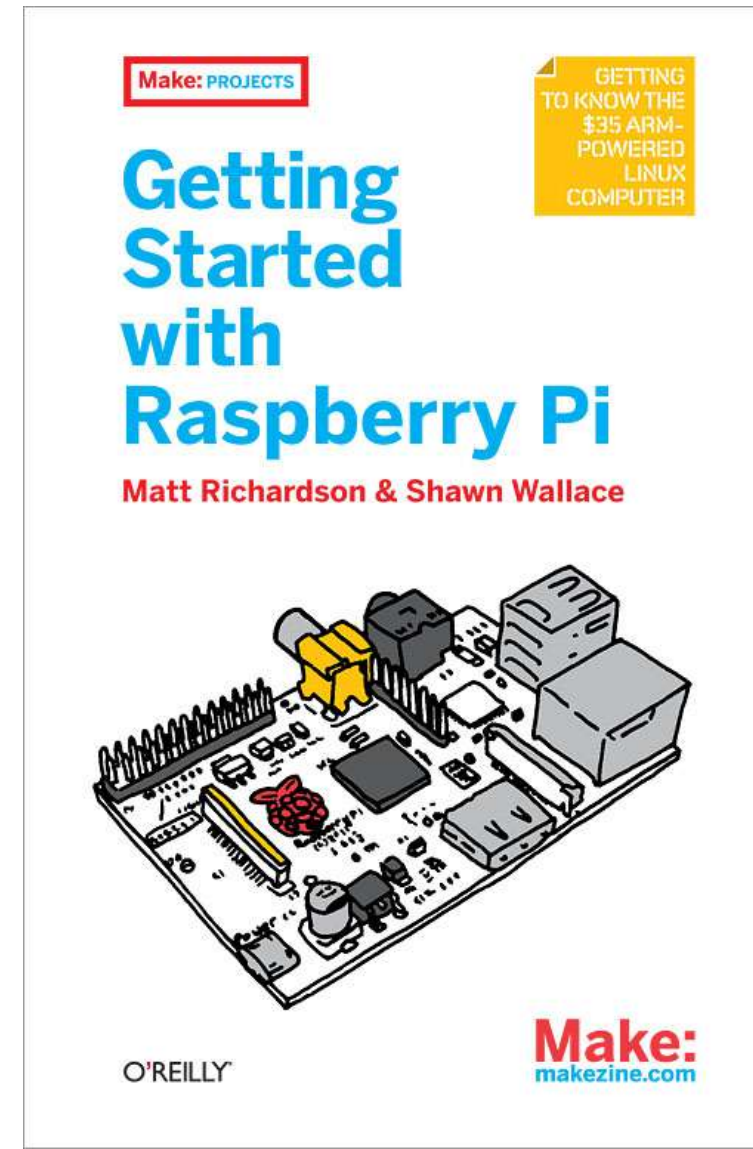
- Also a Linux system
- Faster than RPi: 1 GHz Cortex A8
- <http://beagleboard.org/Products/BeagleBone%20Black>
- Upcoming project: SDR receiver by Martin AA6E
  - an easily understood SDR in Python for your QRP-style tinkering
  - Same software runs on RPi but it's not quite fast enough
- Comparison with Raspberry Pi  
<http://makezine.com/2013/04/15/arduino-uno-vs-beaglebone-vs-raspberry-pi/>



## II. Getting Started with the Raspberry Pi

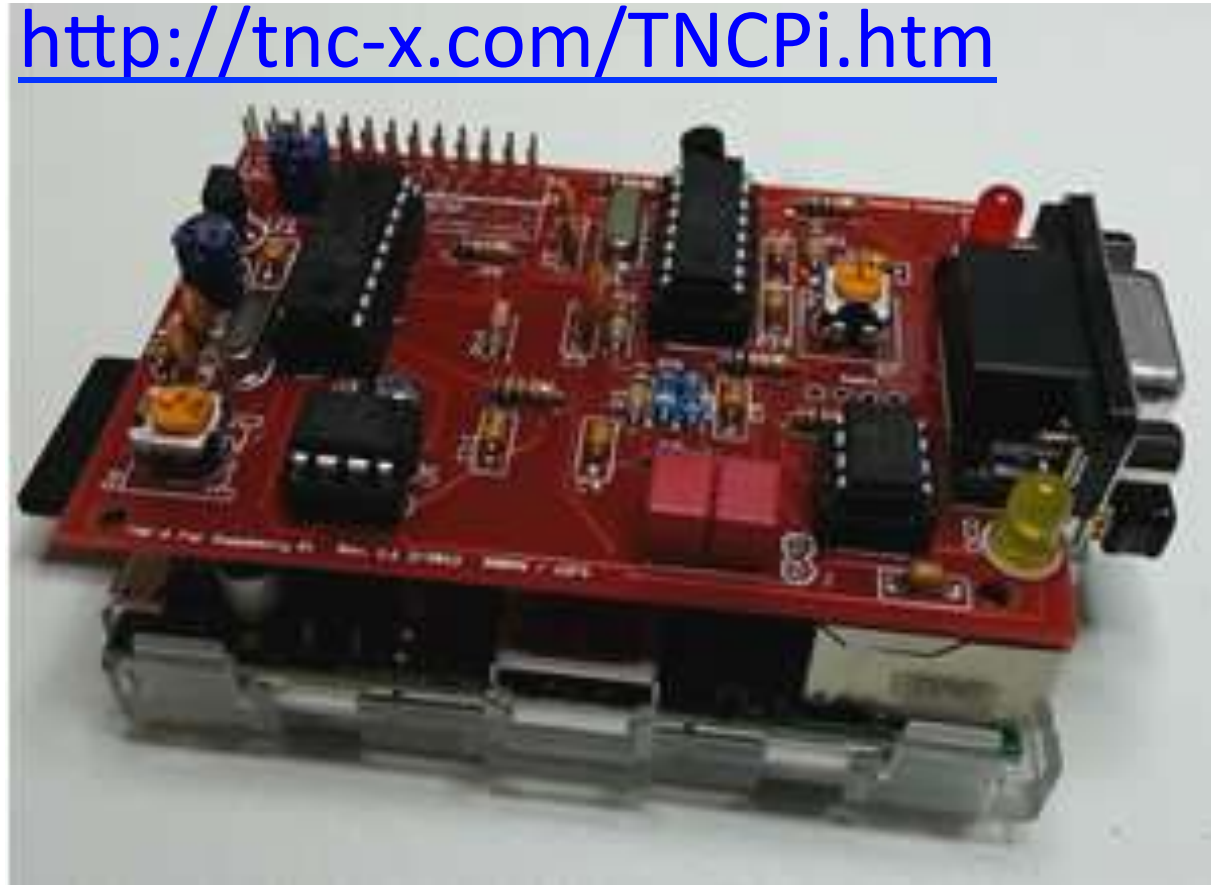
Many book available, but start with  
*Getting Started with Raspberry Pi*

<http://shop.oreilly.com/product/0636920023371.do>



## II. Raspberry Pi Projects

- APRS for Raspberry Pi
- RPi TNC board <http://tnc-x.com/TNCPi.htm>



## II. Side note: Compare with 2009 Project

- APRS for WRT54G OpenWRT
- [http://www.dimebank.com/cak/k6dbg/k6dbg\\_igate.html](http://www.dimebank.com/cak/k6dbg/k6dbg_igate.html)

Today's advantage:

- Less work
- Faster to implement
- Broader access to hardware
- More people can use it
- Faster



## II. Raspberry Pi SDR

- RPi plus RTL-SDR
  - Serves as server for Windows Client SDR program, Android, etc

Here is a [video of the SDR# connected to Raspberry Pi](#)



<http://zr6aic.blogspot.com/2013/02/setting-up-my-raspberry-pi-as-sdr-server.html>



## II. Raspberry Pi SSTV by HA5KDR Club

- This project uses a similar dedicated Raspberry Pi camera, but it produces JPEG files
- This project uses an SSTV-generator in Python
- C language version (faster) in open-source development
- <http://hackaday.com/2013/10/06/sstv-beacon-based-on-a-raspberry-pi/>
- <http://hsbp.org/rpi-sstv>



## II. Compare with Arduino Version

- Arduino version of this project in the **Ham Radio for Arduino and Picaxe** book
- Uses a dedicated SSTV Camera from Argent Data with embedded CPU
- Arduino just for command and control



# II. The Two Cultures: DIY and Operating?

- With this power comes the danger of the “Two Cultures” divide:
  - DIY/QRP/Homebrew (i.e., write your own code)
  - Operator (use the work of others)
- These new systems offer an open approach
  - one that invites experimentation and tinkering
  - yet one that is ready to support real-world use
- Key tools:
  - Linux
  - Python
  - Ham Applications
- As hams we should learn how our tools work and be ready to adapt them
  - Hams should be able to solve their own problems, and share solutions

# III. Learning Python

- Python is a powerful scripting programming language
  - Runs on desktop computers, Raspberry Pi, BBB, and next-generation Arduinos
- Learn Python to take advantage of the RPi and Beaglebone Black
  - General introduction to Python:
  - <http://www.pythonforrookies.org/lectureSlides.html>

# III. Learning Python (and JavaScript) on BeagleBone Black:

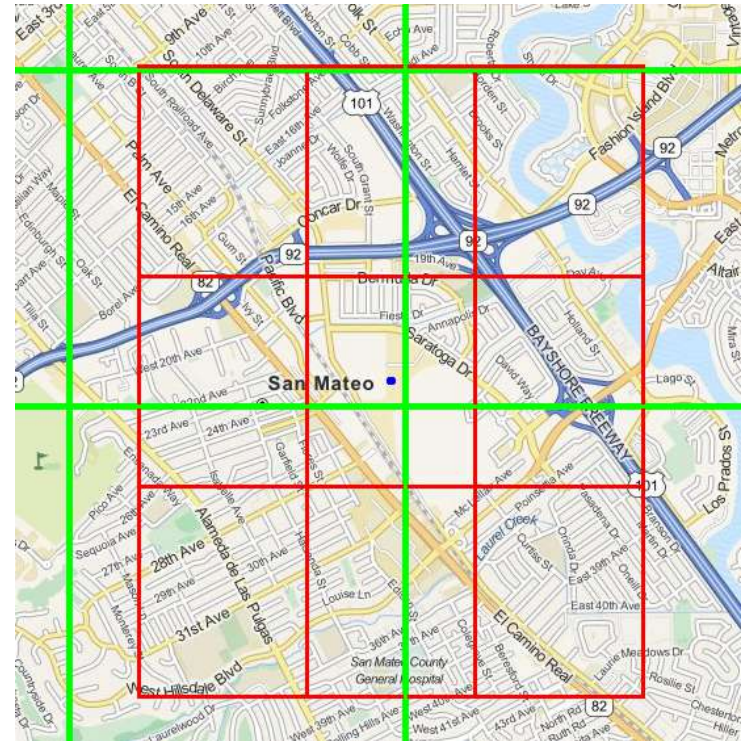
**Getting Started with BeagleBone:  
Linux-Powered Electronic  
Projects With Python and  
JavaScript**

<http://shop.oreilly.com/product/0636920028116.do>



# III. Sample Python Projects

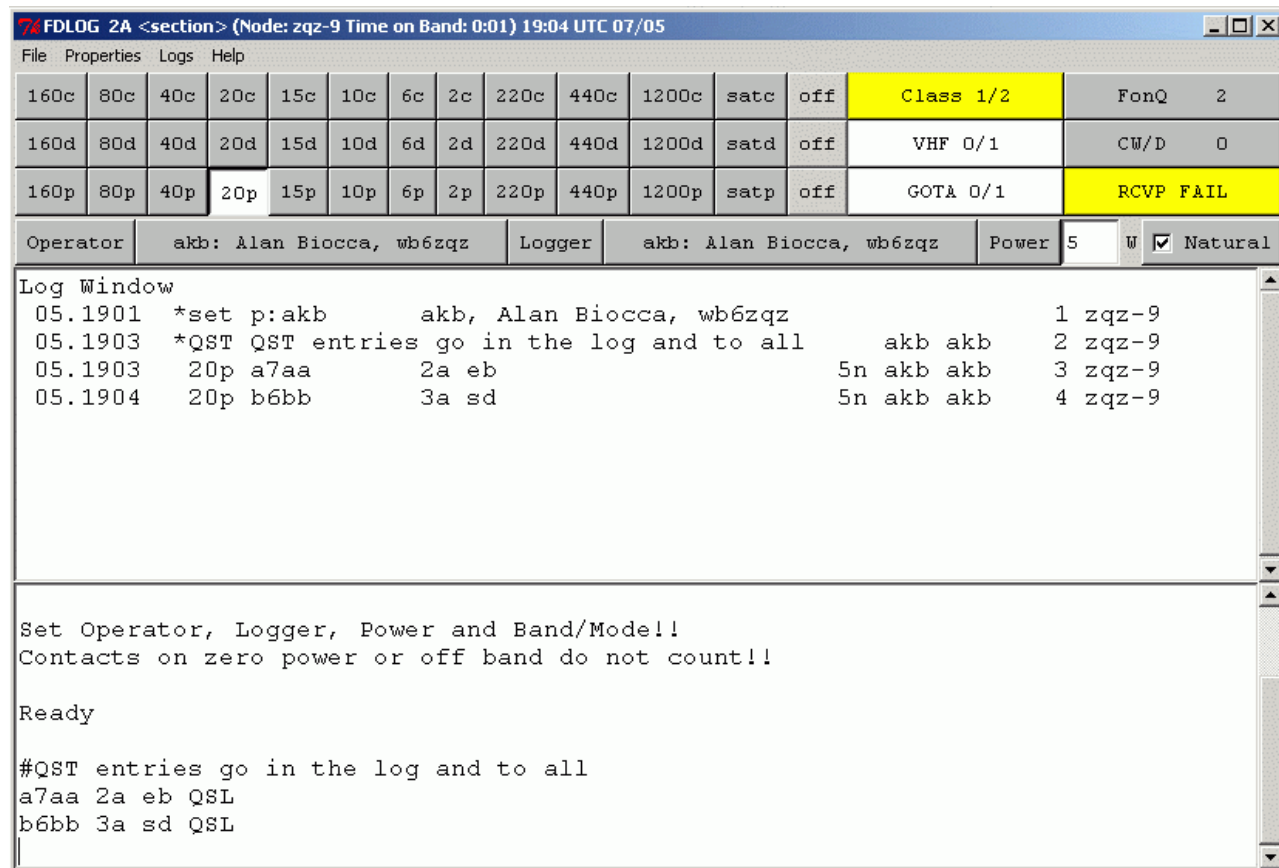
- Open Street Map Tile Generator for Marinus



<http://hamradioprojects.com/authors/wa5znu/+marinus/osm/>

# III. Sample Python Projects

- FDLog by W6AKB



# **IV. The Next-Generation**

- **Combining Arduino+Linux on the same device**
  - **Real-time programming and electronics compatibility of the Arduino**
  - **High-level programming, network, and software applications from Linux**



# IV. Arduino Yún

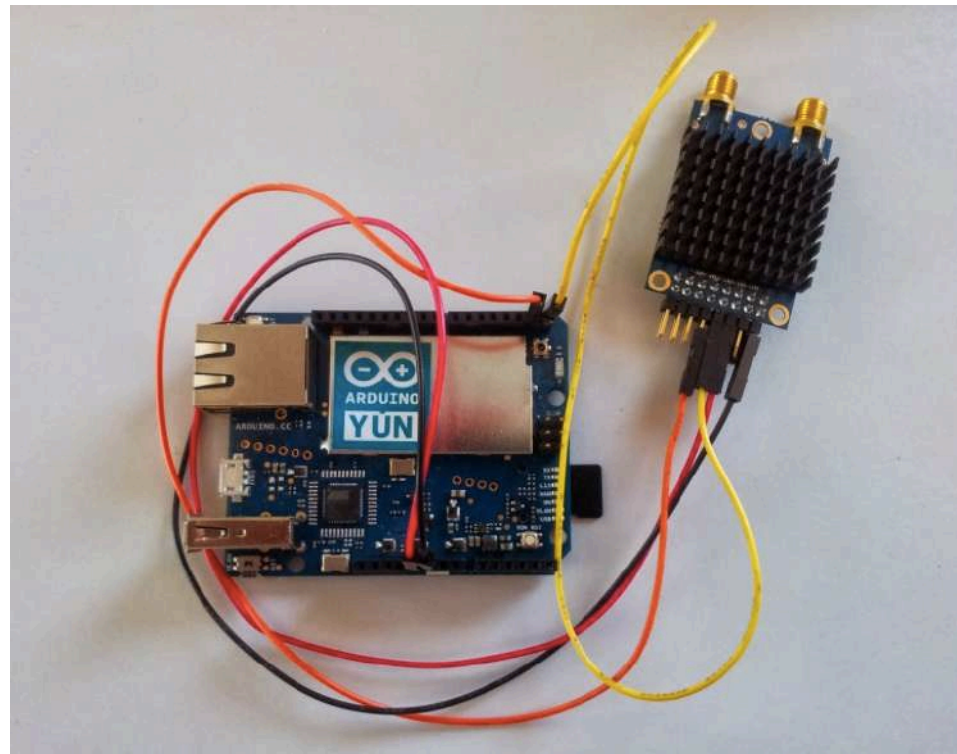
- Arduino Yún combines Arduino Leonardo and Atheros AR9331 CPU running Linux and OpenWRT
  - Same OS as the 2009 era K6DBG / WRT54G Project
- 802.11 and wired Ethernet
- <http://blog.arduino.cc/2013/09/27/getting-started-with-arduino-yun-video-tutorial/>
- <http://blog.arduino.cc/2013/05/18/welcome-arduino-yun-the-first-member-of-a-series-of-wifi-products-combining-arduino-with-linux/>
- [http://www.makershed.com/Arduino\\_Yun\\_p/mksp24.htm](http://www.makershed.com/Arduino_Yun_p/mksp24.htm)



Available Now!

# IV. Arduino Yún Mesh Networking Project

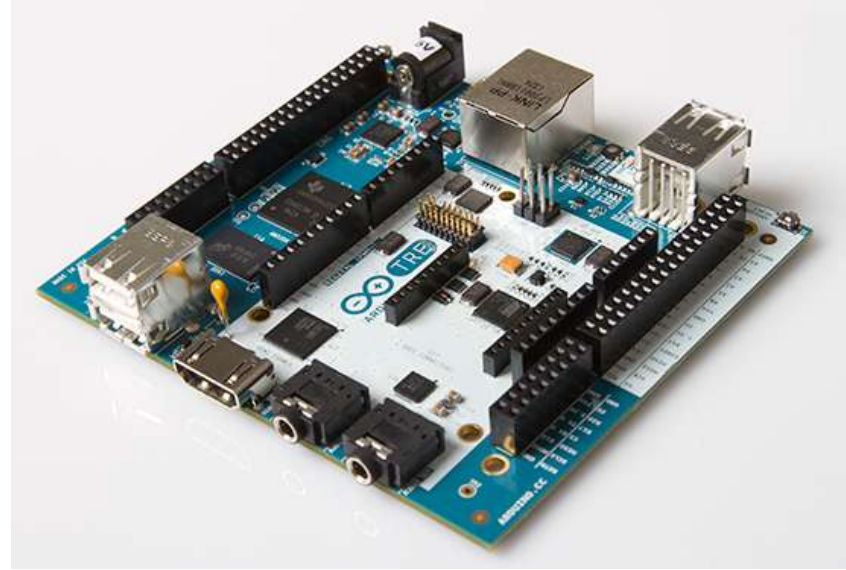
- Mesh Networking project combining WiFi and point-to-point UHF digital radio
- <http://blog.arduino.cc/2013/10/11/arduino-yun-as-a-possible-mesh-extender-platform/>



## IV. Arduino Tre

# Beaglebone Meets the Arduino, with help from TI and BeagleBord.org

- Same CPU as Beaglebone Black: 1 GHz Cortex A8
- Plus a full AVR-based Arduino
- Libraries help communication between Linux and Arduino
- Accepts existing Arduino shields
- <http://blog.arduino.cc/2013/10/03/a-sneak-preview-of-arduino-tre/>



Not yet shipping 11/2013

# IV. Arduino Intel Galileo



- Intel SoC Processor
  - a 32-bit Intel Pentium-class “System on a Chip”
  - 8MByte NOR flash
- Hardware and software pin-compatible with Arduino shields designed for the Uno R3 (Arduino 1.0 pinout.)
  - Digital pins, analog pins, etc.
  - 3.3v native but settable to 5V boards
  - Mini-PCI Express slot, 100Mb Ethernet, Micro-SD, RS-232, USB Host port, USB Client port
- Runs Linux programs and Arduino sketches at the same time
- <http://arduino.cc/en/ArduinoCertified/IntelGalileo> <http://www.intel.com/support/galileo/faq.htm>

Not yet Shipping 11/2013

# Summary

- There are different micro boards for different purposes
- Get involved in the DiY community and adapt their tools and techniques to ham radio – and vice versa
- There are dozens of other products and projects
- Consult this handy chart for the most popular systems in the DiY and Ham communities

| PICAXE          | Arduino              | chipKIT      | Raspberry Pi                       | Beagle Bone Black | Tre/Galileo | <u>Arduino Yún</u>                     |
|-----------------|----------------------|--------------|------------------------------------|-------------------|-------------|--|
| 555 Replacement | Electronics Projects | UI and Speed | Applications and Linux Programming | Ditto             | The Future? | Networked Electronics and Ham Projects |

# Thank you!

