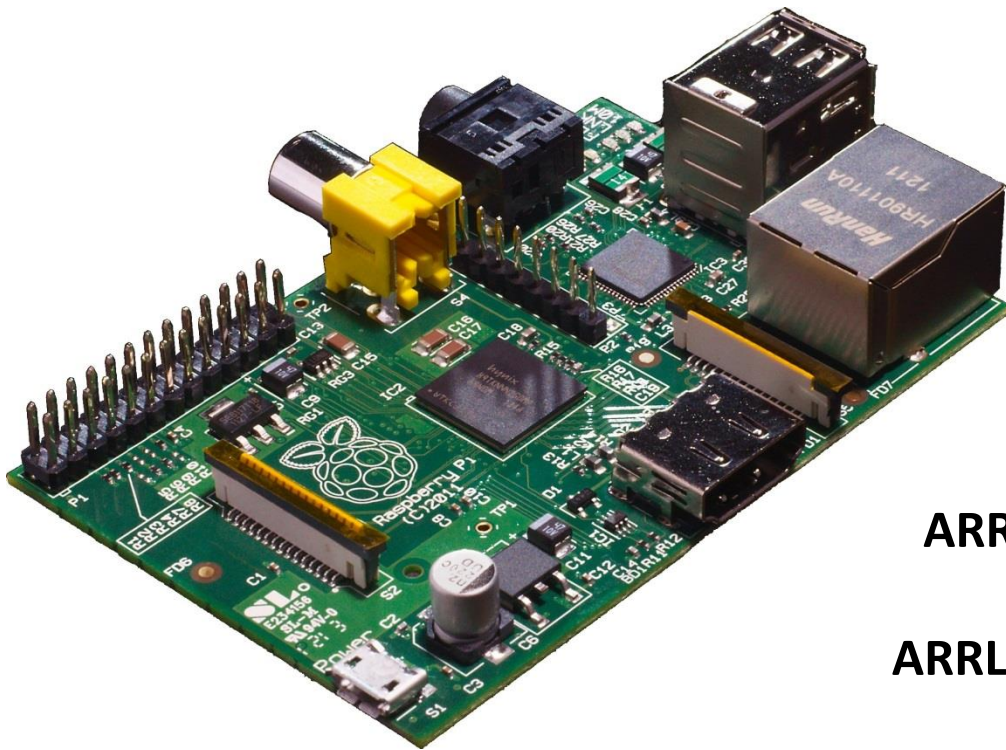# Raspberry Pi
A Low Cost Platform
For Amateur Radio Projects

Ed James, KA8JMW
ARRL NM Assistant Section Manager
Brian Mileshosky, N5ZGT
ARRL Rocky Mountain Division Director

Presentation to
2013 TechFest
**November 2nd , 2013**

ARRL
100 YEARS

Raspberry Pi (Wiki)

*"The **Raspberry Pi** is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools."*

"The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor"
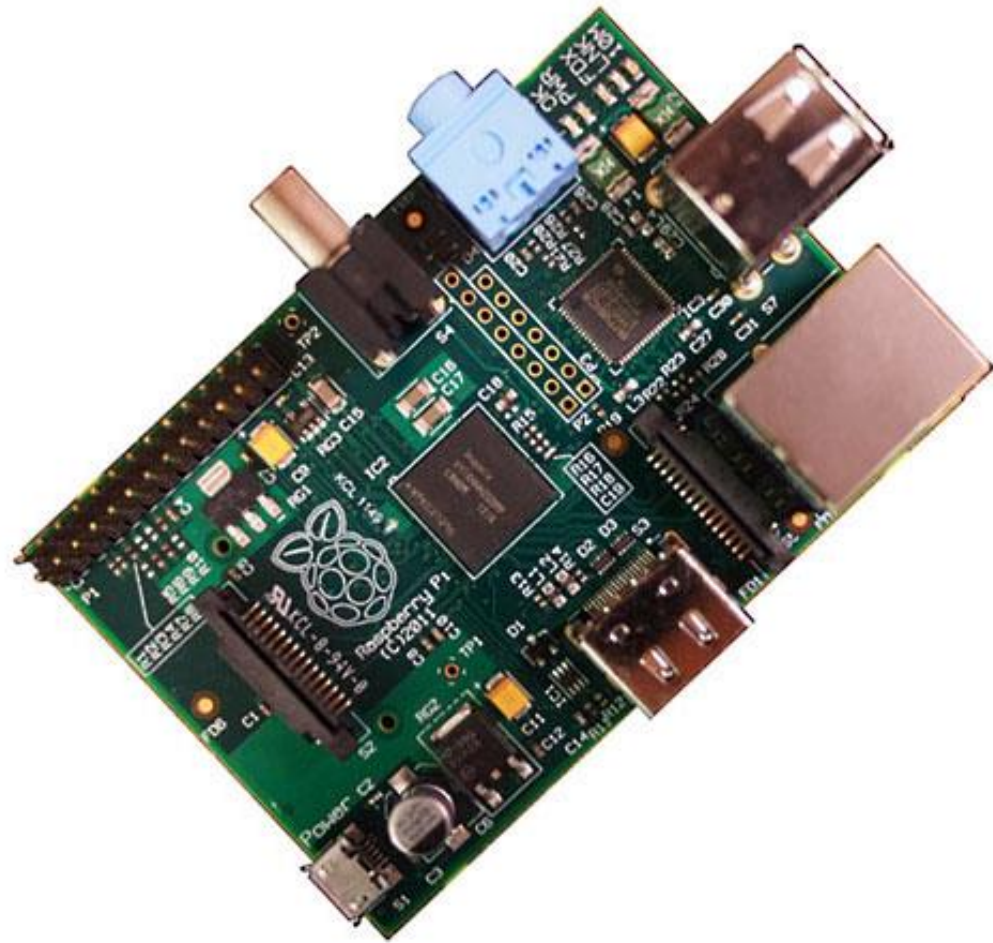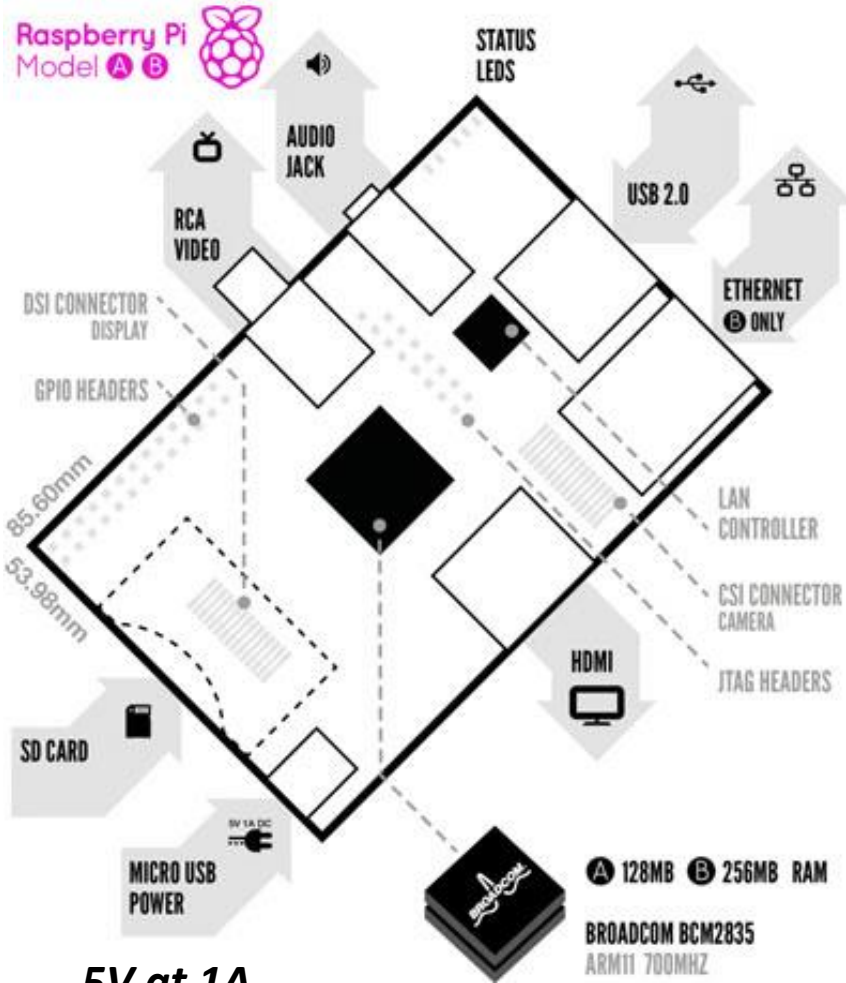
Two versions available:
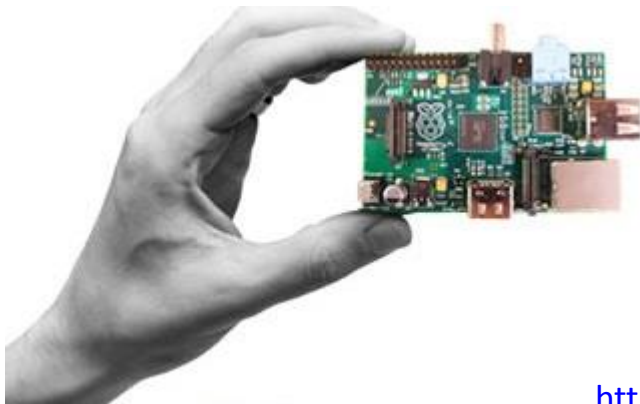
	RAM	USB	Ethernet	Cost
Model A	256MB	1	NO	$25
Model B	512MB	2	YES	$35

http://en.wikipedia.org/wiki/Raspberry_Pi

Raspberry Pi layout (Model B)

Raspberry Pi Model A B

TV / RCA VIDEO

AUDIO JACK

STATUS LEDS

USB 2.0

ETHERNET B ONLY

DSI CONNECTOR DISPLAY

GPIO HEADERS

85.60mm

53.98mm

LAN CONTROLLER

CSI CONNECTOR CAMERA

JTAG HEADERS

HDMI

SD CARD

MICRO USB POWER

5V at 1A

A 128MB   B 256MB   RAM

BROADCOM BCM2835
ARM11 700MHZ

3

Supported Operating Systems

Linux *(The Preferred Environment)*

    Raspbian, Debian GNU/Linux, Fedora, Arch Linux ARM

RISC OS

Unix:

    FreeBSD, NetBSD

Plan 9

Android 2.3 (Gingerbread), 4.0 (Ice Cream Sandwich)

Google Chrome OS

Firefox OS

DOS, 80486 200MHz, SVGA, SoundBlaster, COM1:
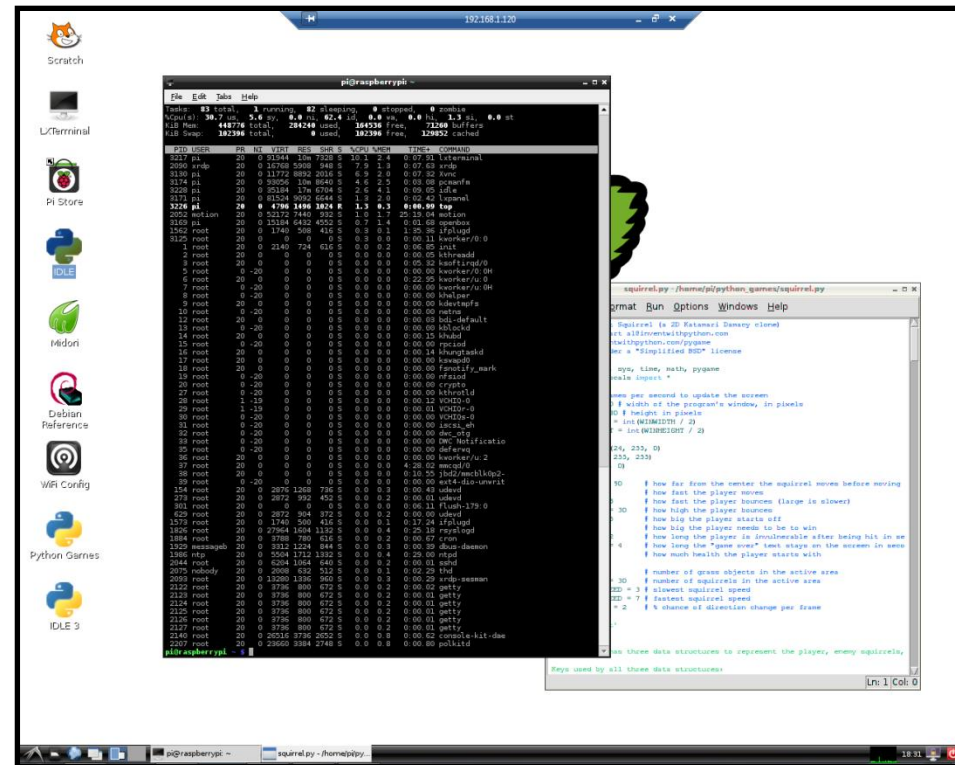
AROS, Amiga Research Operating System

…

And the list just keeps on growing.

http://en.wikipedia.org/wiki/Raspberry_Pi

Connecting with your RPi
The User Interface

- X-windows GUI
  - Keyboard, mouse, HDMI
  - Xrdp (headless)

- Command line
  - Serial Terminal
  - SSH user interface (headless)

Let's Dig in a little deeper
Raspberry Pi (RPi) General Purpose Input/Output (I/O)

- The RPi board has a 26-pin expansion header with 17 GPIO pins as well as +3.3 V, +5 V and GND supply lines.
- The default configuration provides 15 GPIO pins and a UART.
- The operating system also supports predefined alternate functions for some of the pins
    - I²C (Inter-Integrated Circuit) is a two wire communication bus developed by Philips, for chip to chip communication. Commonly used for connecting sensors and port expanders.
    - Serial Peripheral Interface (SPI) bus is a synchronous serial data bus designed by Motorola. Commonly used in high speed applications such as digital audio, digital signal processing and telecommunications.
    - UART, TXD and RXD
    - A Pulse Width Modulator (PWM)
- Operating system makes the hardware available to a variety of high level program languages including Python, C, Java, BASIC along with Perl and Bash shell scripts.
- Additional I/O pins are available via bit-banging and hacking

RPi GPIO Pinout
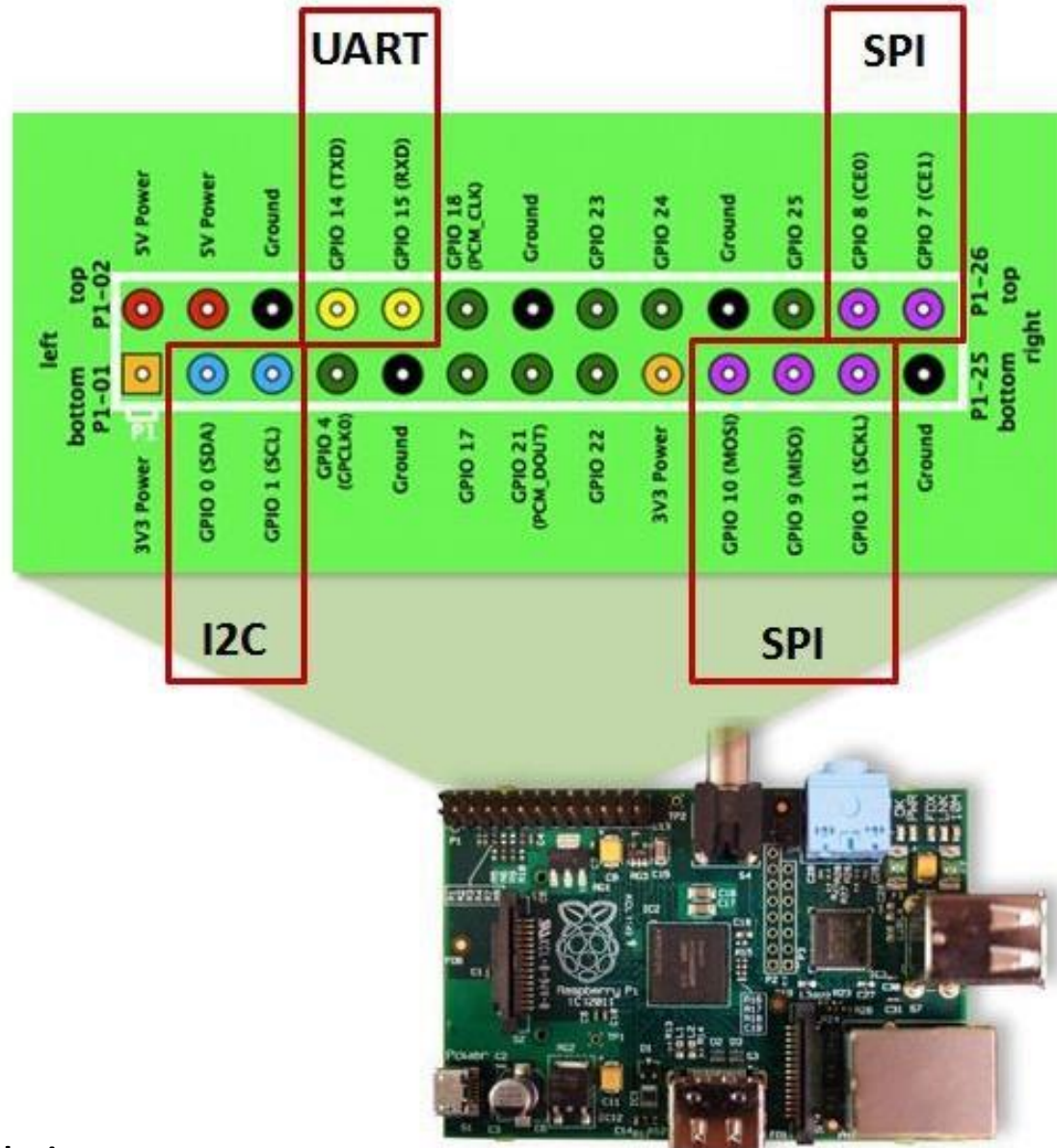
1. The RPi is a 3.3V device
2. The GPIO pins are unbuffered and unprotected, so if you short something out, you could fry your whole RPi, be careful!

What Can I Do With My RPi?

32 RPi low-cost "Supercomputer" Cluster

An Eclectic Mix of RPi Projects Projects

WiFi
Internet Radio Player

XBMC Media Player remote control

Cat Feeder

Event Countdown Clock

High Altitude Balloon Controller

Soil Moisture Monitor

Lighting Controller

Home Alarm System

Now, The Really Fun Stuff
Amateur Radio and the RPi

**piGate – an APRS iGate implementation using the Raspberry-Pi**

Software running on the Raspberry-Pi reads the audio signal coming into the sound-card, demodulates the signal, decodes the packet and then sends it to an APRS-IS server over the WiFi link

http://www.ultratechie.com/2012/10/pigate/
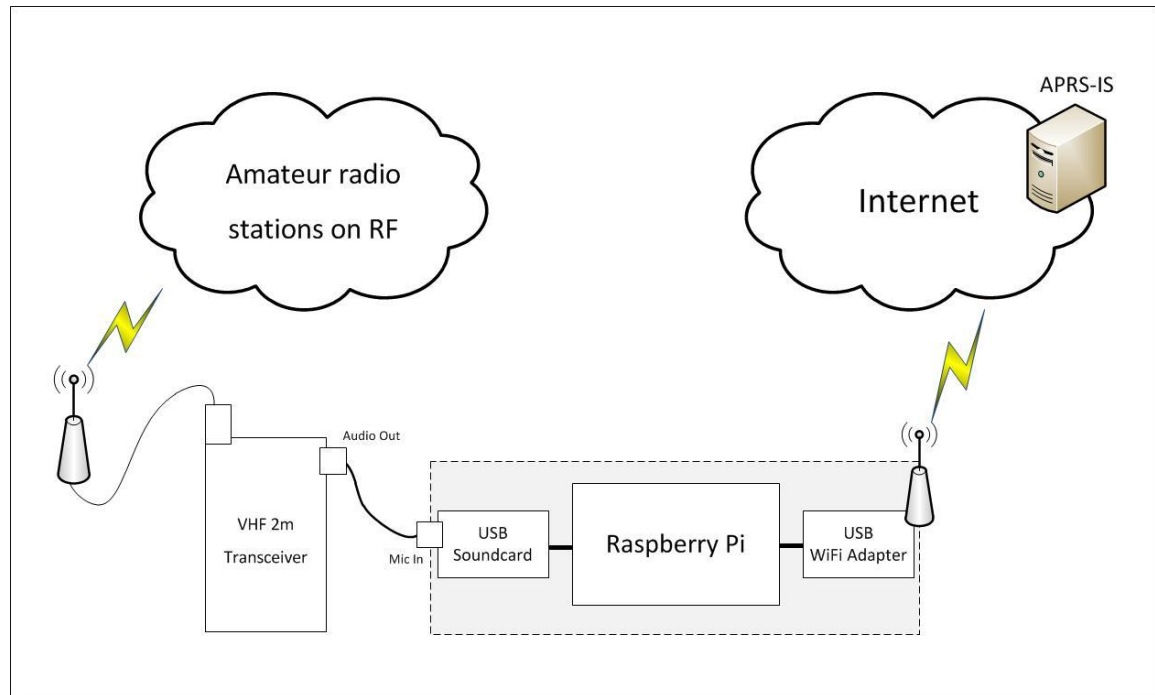
TNC-Pi RPi

TNC-Pi is a special version of TNC-X designed to interface directly with the Raspberry Pi computer. It can connect to the Pi either via the Pi's serial port, or via the I2C protocol. In the latter case, a single Pi can support multiple TNC-Pi's at the same time, since each TNC-Pi can be given a unique I2C address.
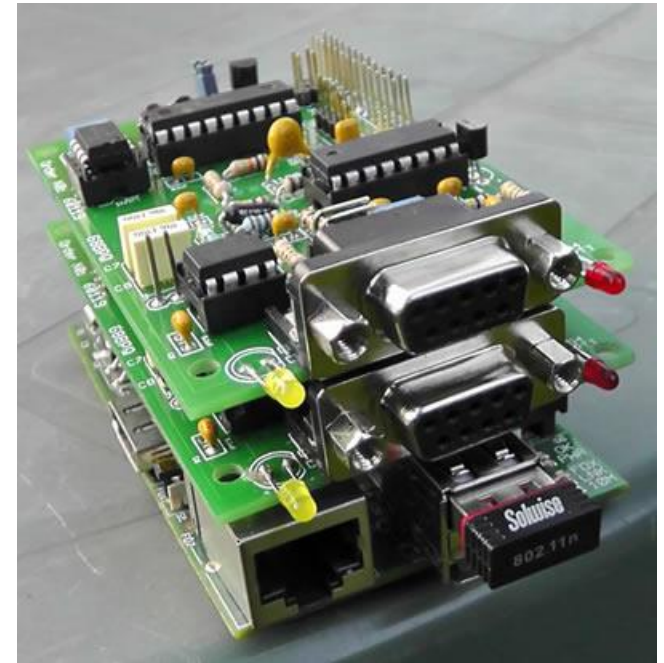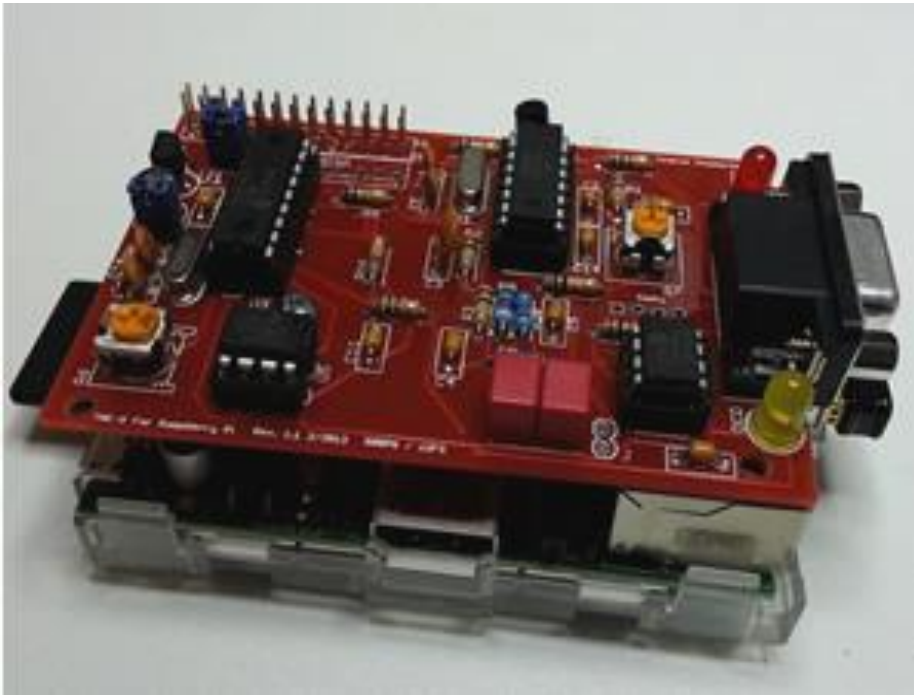
Run a pair of TNC-Pi's with a single RPi to create a dual frequency digipeater.

http://tnc-x.com/

D-Star DV Access Point Dongle & RPi

DVAP

5V power

Wi-Fi

SD card

RPi
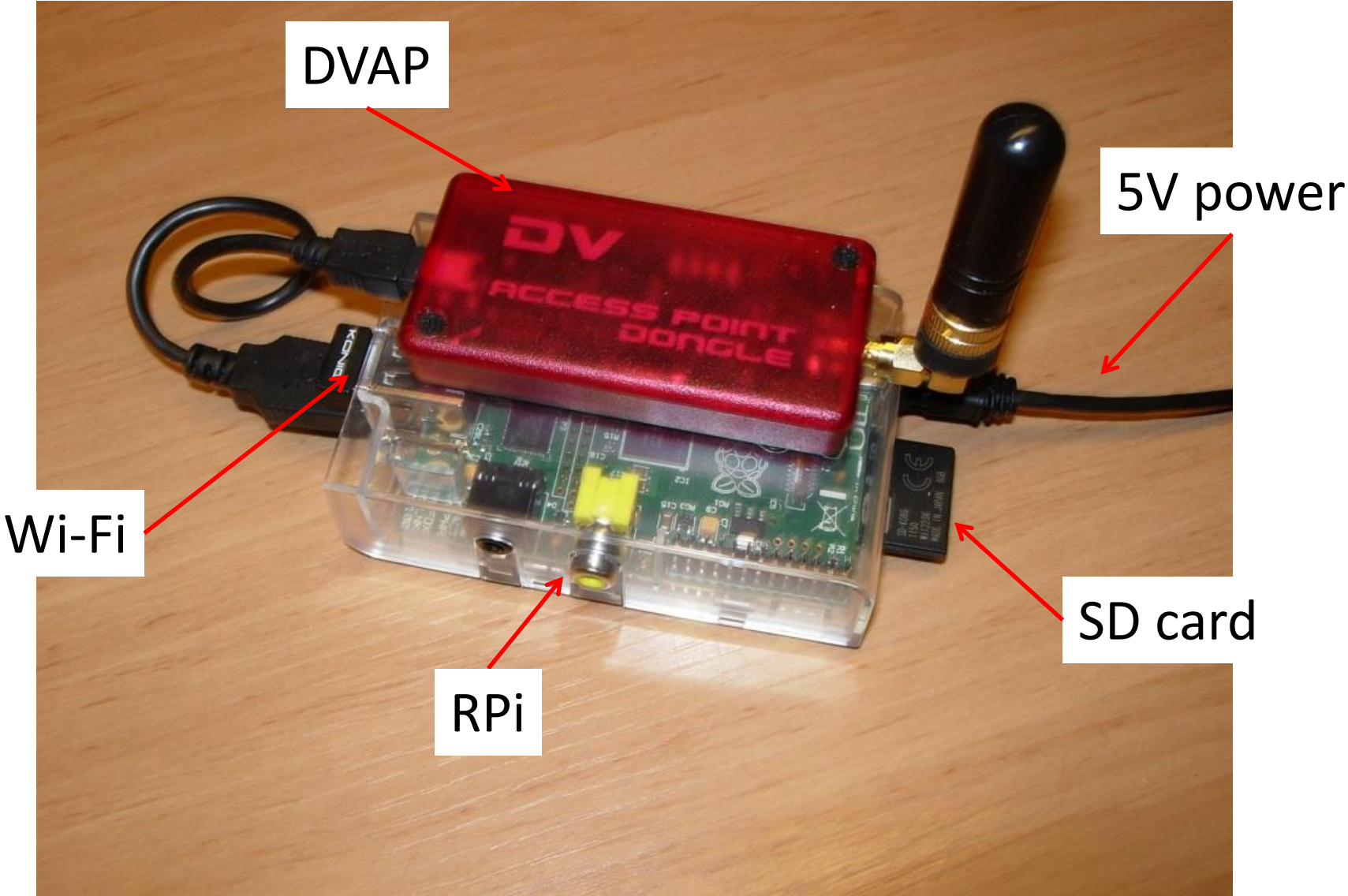
Creates a point of presence on the D-Star network

A Communications Tool For D-STAR

- D-RATS is a D-STAR communications tool that supports text chat, TCP/IP forwarding, file transfers, and can act as an e-mail gateway. There is also the ability to map user's positions using the D'PRS function of D-STAR. The application is written in Python/GTK and is cross-platform. It runs on Windows, Mac OS X, and Linux.
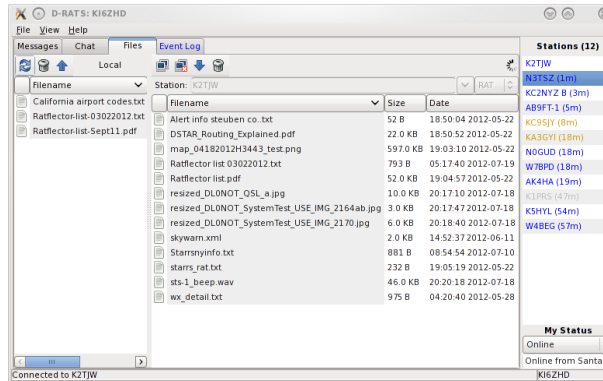- A Ratflector is a hub that allows multiple D-RATS users using either Ethernet or RF connections to communicate with each other.
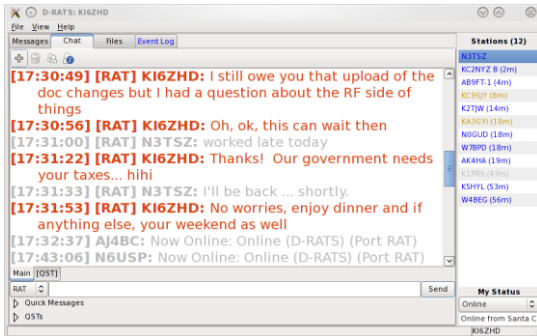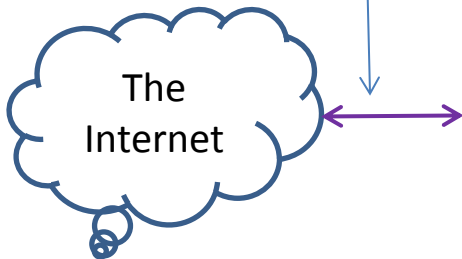
W5MPZ Ratflector

The Internet
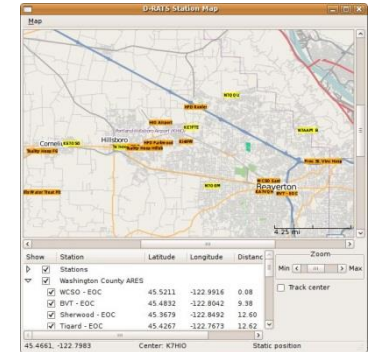
Ethernet

USB

Audio in/out PTT

Dell Optiplex 755 Running D-RATS ratflector software

Moencom Starboard GMSK modem

Yaesu FT-2600FM 9600 bps capable

A Communications Tool For D-STAR

W5MPZ ratflector (Rpi)

The Internet

Ethernet
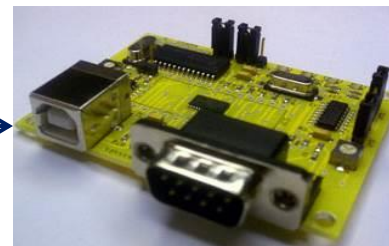
RPi
Running
D-RATS ratflector
software

USB

Moencom
Starboard
GMSK modem

Audio in/out
PTT

Yaesu FT-2600FM
9600 bps capable

GMSK modems for the RPi

- A RPi with either of these GMSK modems and a 9600bps capable narrowband FM radio to create a D-Star hotspot.
- With TWO radios and you get a D-Star repeater
  - Add an internet connection for a fully functioning D-Star gateway
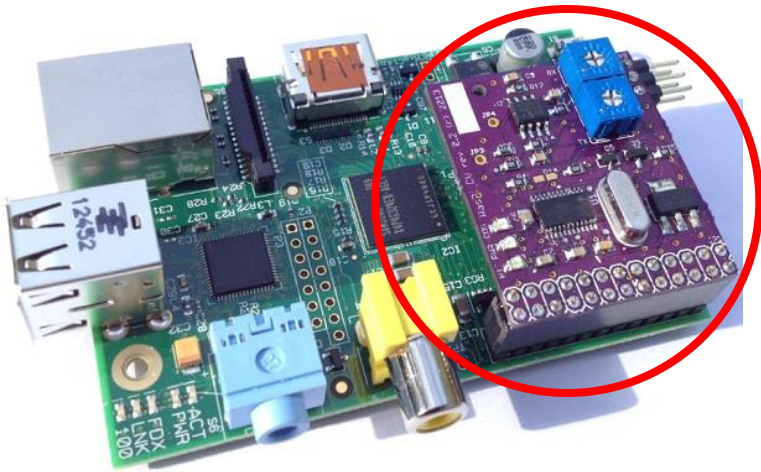
http://ki6zum.com/dstar/dv_overview.htm
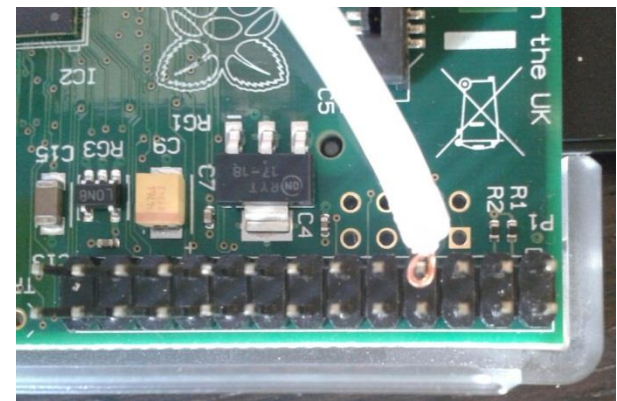
http://www.dutch-star.eu/
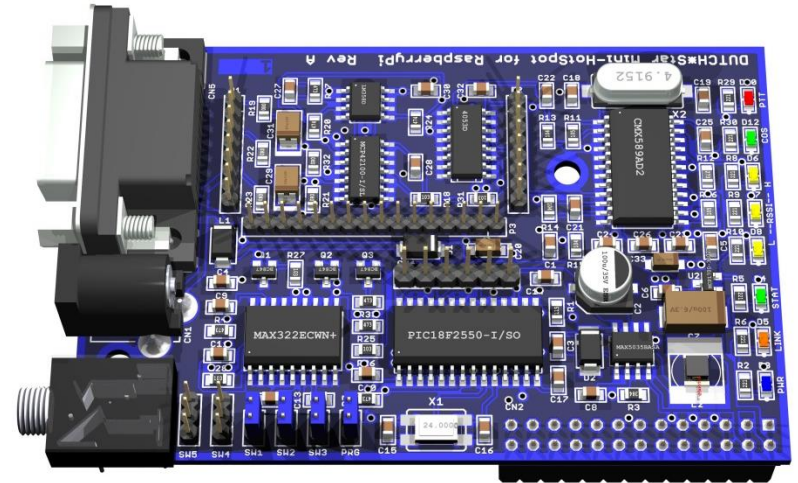
Turning the RPi into an FM Transmitter PiFM

- Using the existing hardware on the RPi that is intended to generate spread-spectrum clock signals to output FM RF.

- This means that all you need to do to turn the Raspberry-Pi into a FM Transmitter is to connect an antenna onto GPIO pin 4 and run the code.

http://www.icrobotics.co.uk/wiki/index.php/Turning_the_Raspberry_Pi_Into_an_FM_Transmitter
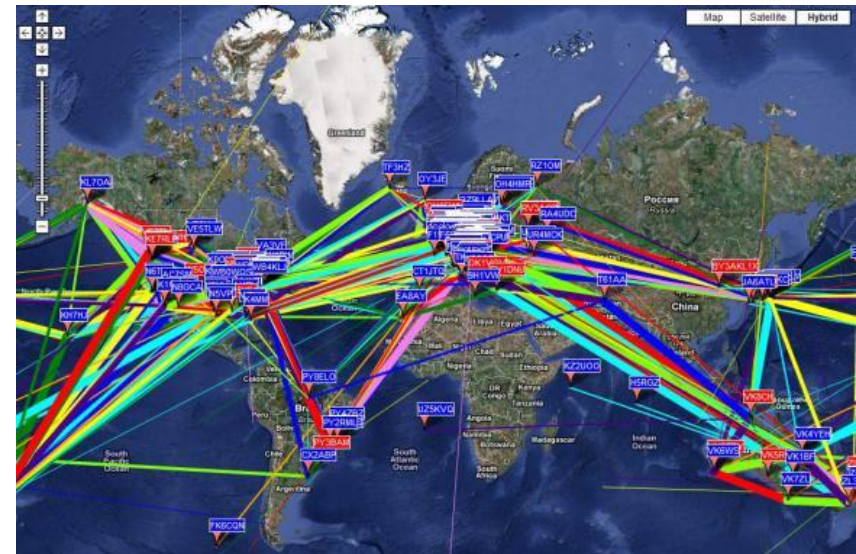
PiFM Demonstration

Carrier wave

Audio signal

Frequency modulated
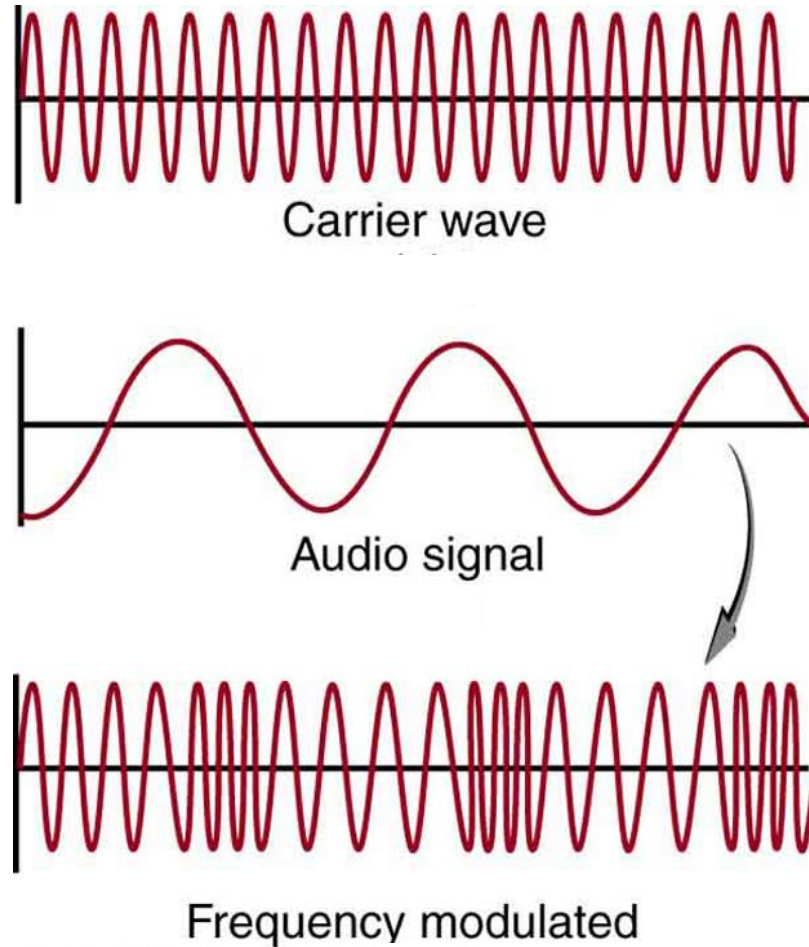
sudo ./pifm sound.wav 100.1

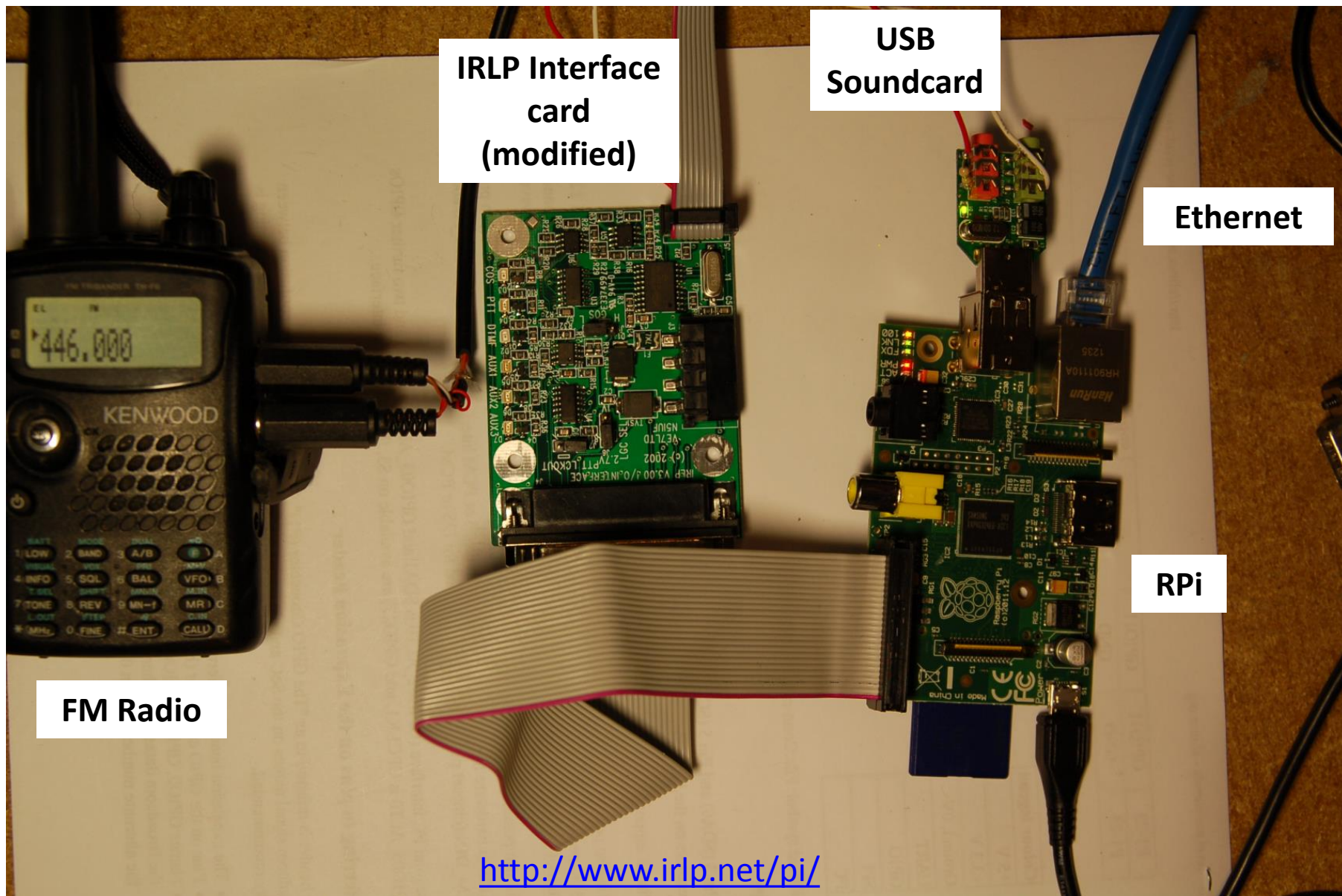# RPi LF/MF/HF/VHF WSPR Transmitter

- Weak Signal Propagation Reporter (WSPR).
- Used for weak-signal radio communication between amateur radio operators.
- Designed for sending and receiving low-power transmissions to test propagation paths on the MF and HF bands.
- WSPR implements a protocol designed for probing potential propagation paths with low-power transmissions.
- Transmissions carry a station's callsign, Maidenhead grid locator, and transmitter power in dBm.
- Stations with internet access can automatically upload their reception reports to a central database called WSPRnet, which includes a mapping facility.

- **With a little code**
  - **PiFM with a wrapper**
- **A low pass filter**
- **Your RPi is good to go**
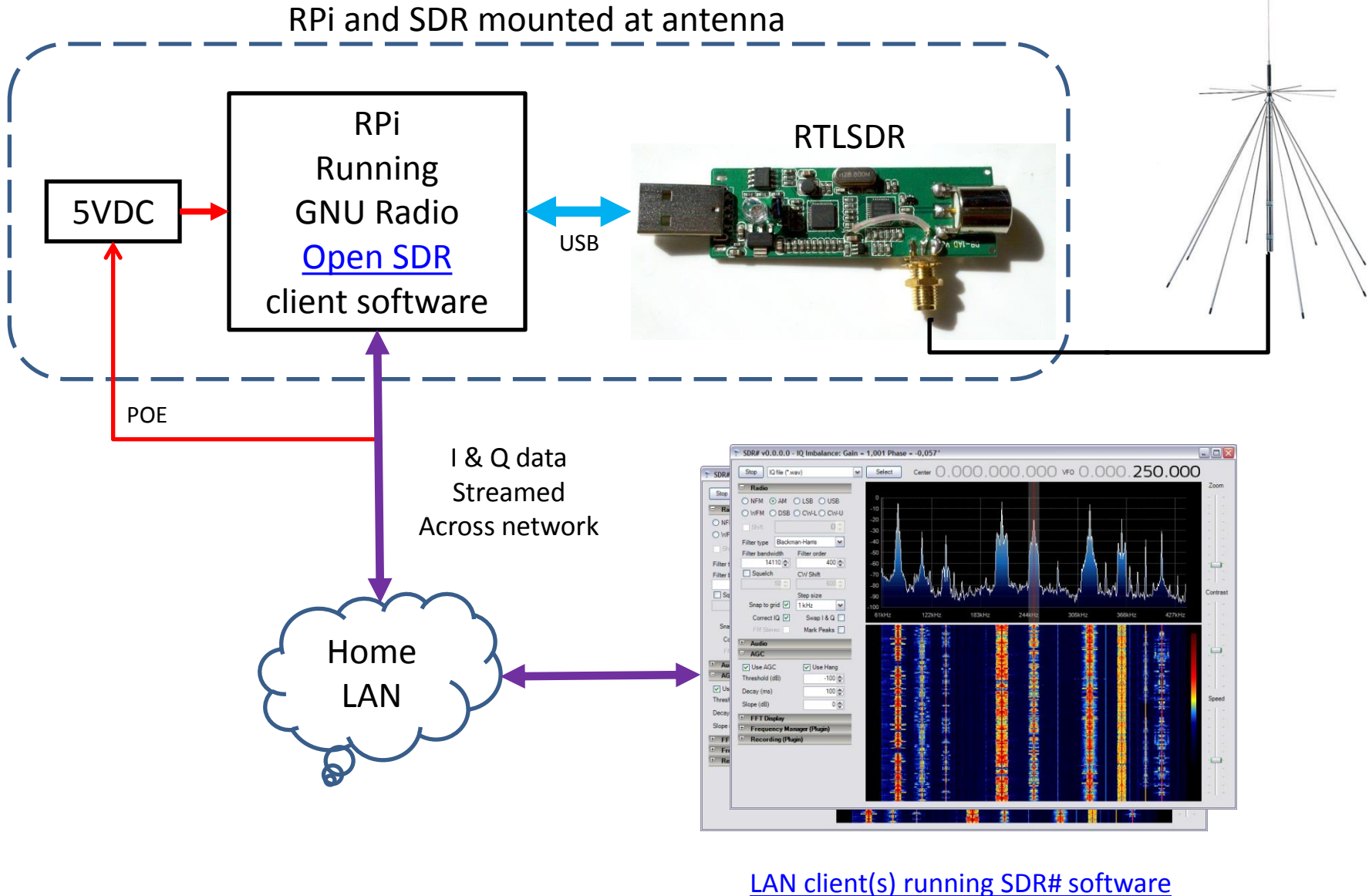 - **0 to 250MHz**
  - **+10dBm (10mw)**

https://github.com/threeme3/WsprryPi

PiIRLP (IRLP on a RPi)

FM Radio

IRLP Interface card (modified)

USB Soundcard

Ethernet

RPi

http://www.irlp.net/pi/

A Software Defined Radio Server

RPi and SDR mounted at antenna

5VDC

RPi
Running
GNU Radio
Open SDR
client software

USB

RTLSDR

POE

I & Q data
Streamed
Across network

Home
LAN

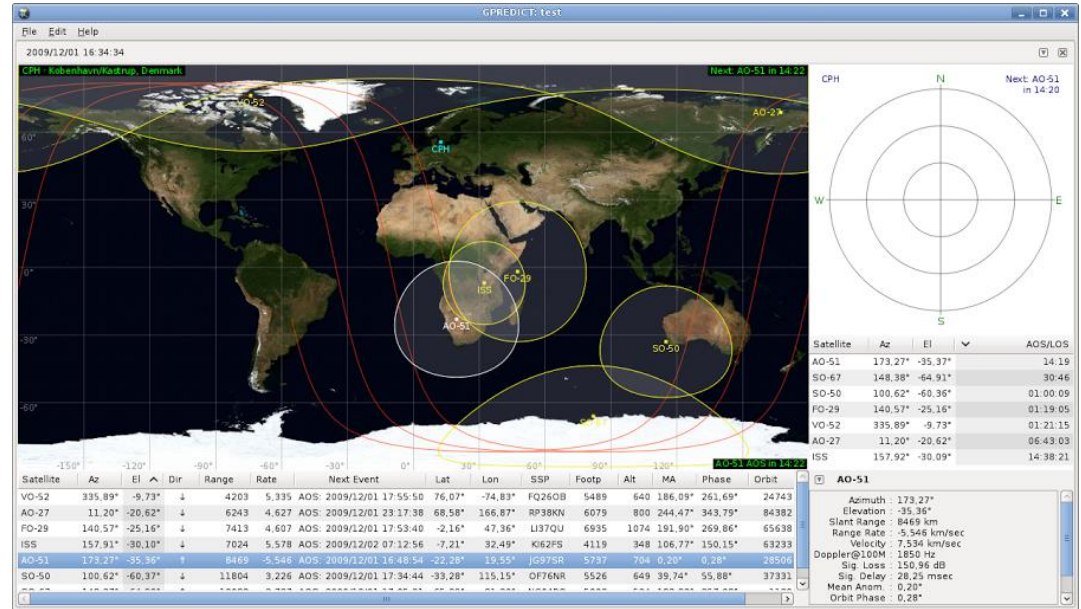LAN client(s) running SDR# software

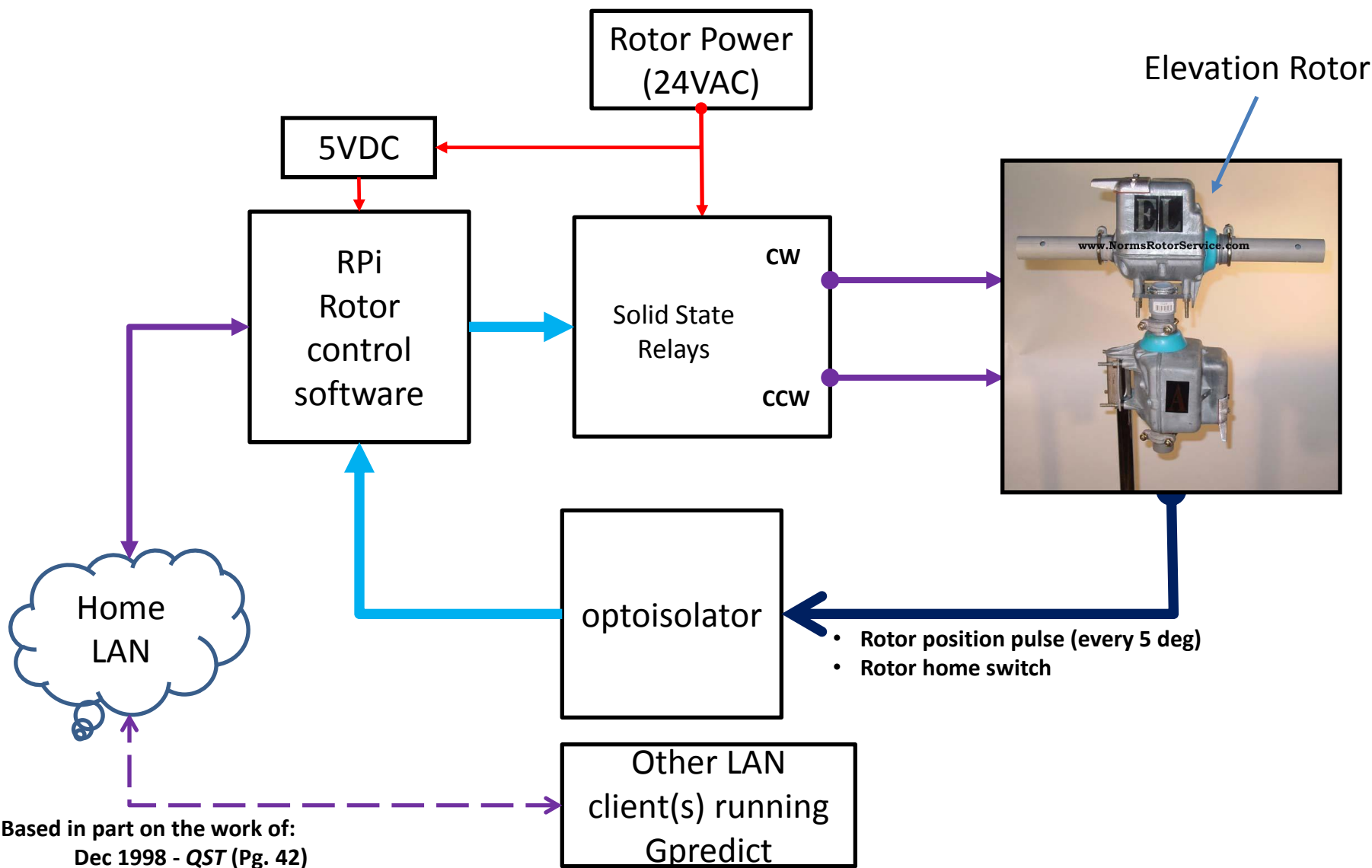# Satellite Tracking and Antenna Rotator Control
(a work in progess)

- [Gpredict](#) is free software that runs under Windows, Linux and Mac OS.
- Gpredict has the hooks in it for interfacing to antenna rotors
- Gpredict runs on the Raspberry Pi!
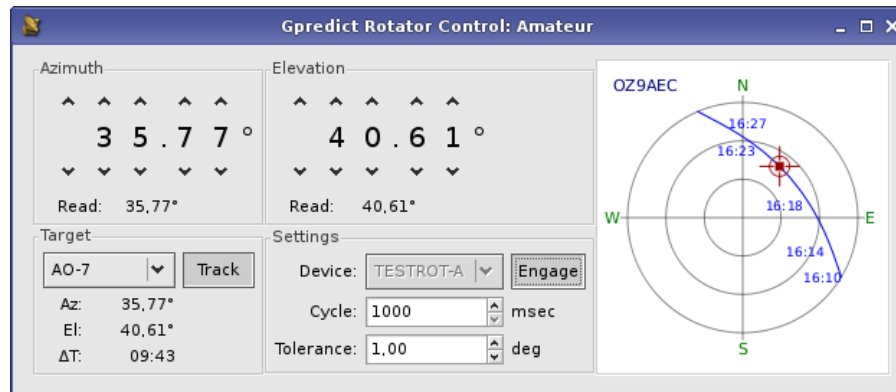
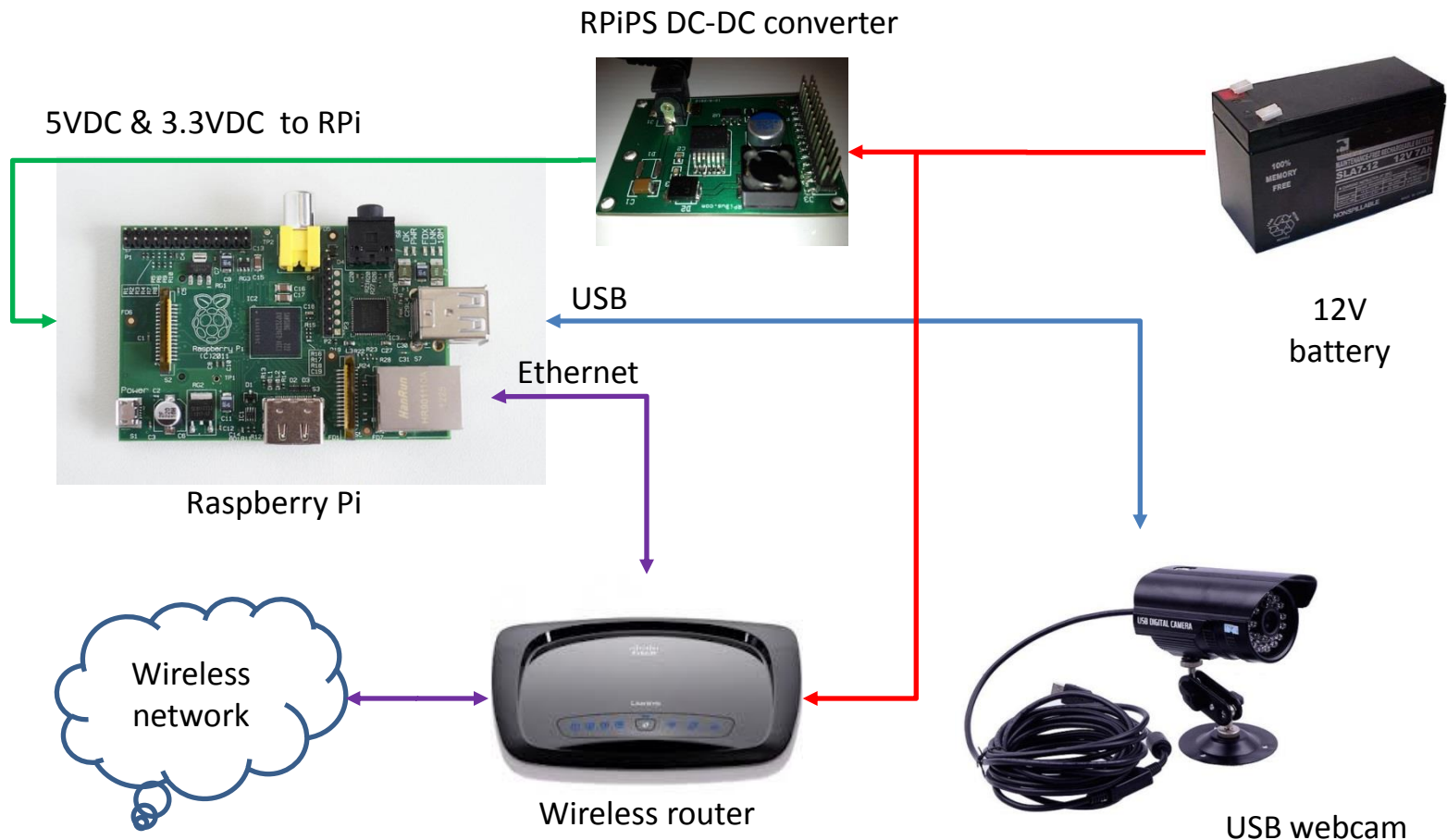# Satellite Tracking and Antenna Rotator Control (cont.)
(a work in progress)

Rotor Power (24VAC)

Elevation Rotor

5VDC

RPi Rotor control software

Solid State Relays

cw

ccw

Home LAN

optoisolator

- Rotor position pulse (every 5 deg)
- Rotor home switch

Other LAN client(s) running Gpredict

Based in part on the work of:
Dec 1998 - *QST* (Pg. 42)
**'An Inexpensive Az-El Rotator System'**
Koehler, Jim, VE5FP

Portable Webcam

- RPi running Motion software
- Software captures video whenever motion has been detected
- Captures a still frame every minute
- Streaming video available via Wifi

RPiPS DC-DC converter

5VDC & 3.3VDC to RPi

Raspberry Pi

USB

Ethernet

12V battery

Wireless network

Wireless router

USB webcam

Mount on a tripod for your next Hamfest, tailgate, Field day or club activity

# Portable Webcam W5MPZ
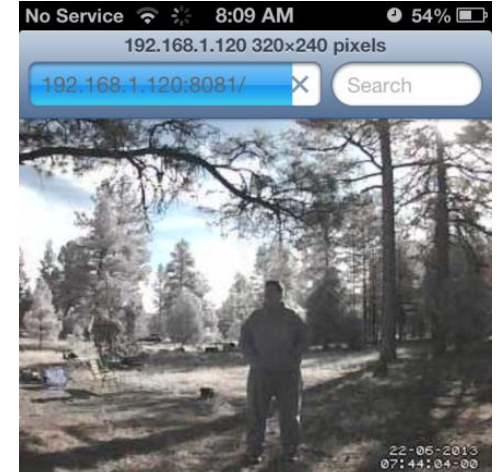
MESH Networking & RPi

- Use you RPi to create a MESH network node
- OLSR software runinng on the RPi
  - Configured as a MESH node
  - Able to perform other simultaneous tasks
    - Webcam server
    - Wireless sensor network node
    - Internet gateway
    - File server
    - D-RATS server/bridge
    - …
- With the RPi, MESH networking is no longer tied to out of production hardware or the 2.4GHz band (3.3, 5GHz)
- Limited only by your imagination and FCC part 97 regulations

https://github.com/urlgrey/hsmm-pi
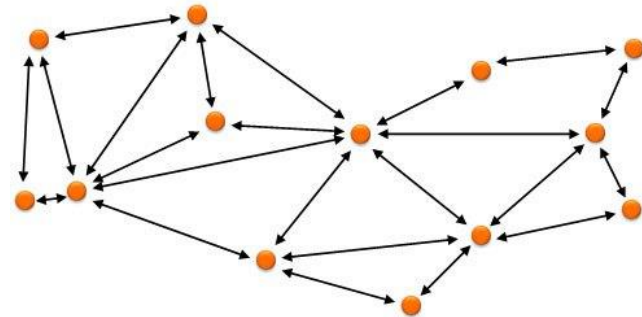
Third Party Prototype & I/O Boards for the RPi

Pi Face: Allows the RPi to control and sense physical devices such as lights, motors and sensors.

- Four momentary contact push switches
- Four LEDs.
- Two 10-A relays
- 8 general purpose open-collector outputs
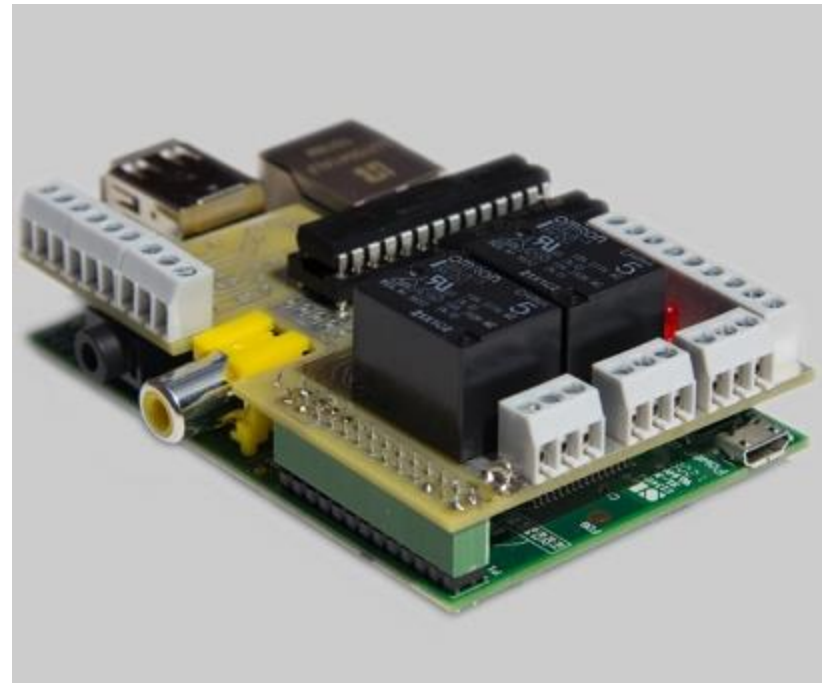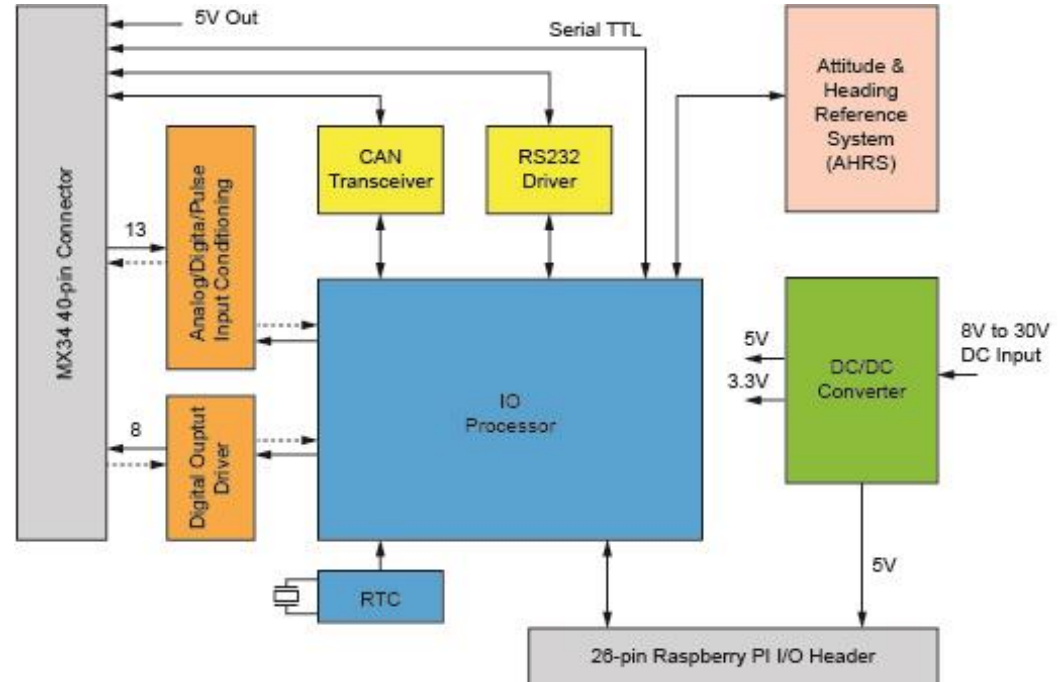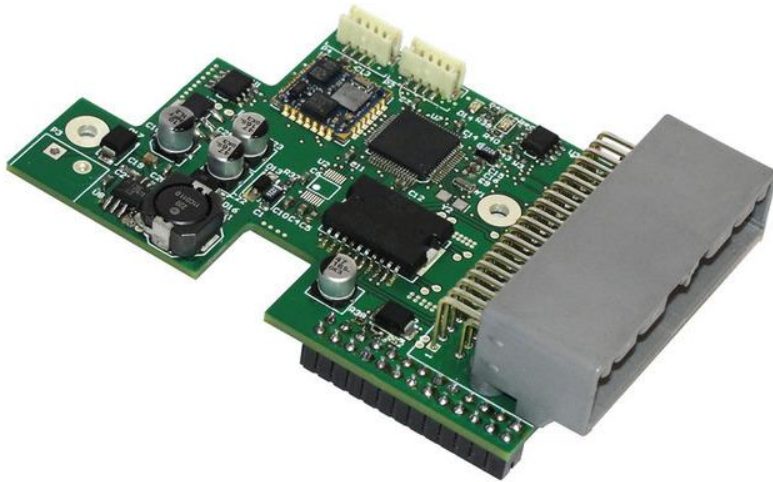

'Pi Face' Digital I/O board atop a RPi

'Com Pi' board atop a RPi

Com Pi :
- RS232 Serial port
- I²C serial bus

RIO (Raspberry IO)

- I/O and power supply card for Raspberry PI.
- 13 Ana/Digital/Pulse Inputs
- 2 Ana Outs
- 8 Digital 1A Outs
- RS232
- RS485
- CAN
- Optional 3 AXIS AHRS
- Connects via the SPI buss

Powering your RPi

Raspberry Pi Power Supply (RPiPS)

- 8-30VDC input
- 5V at 3A
- 3.3V at 800mA
- $35
- http://rpips.com/
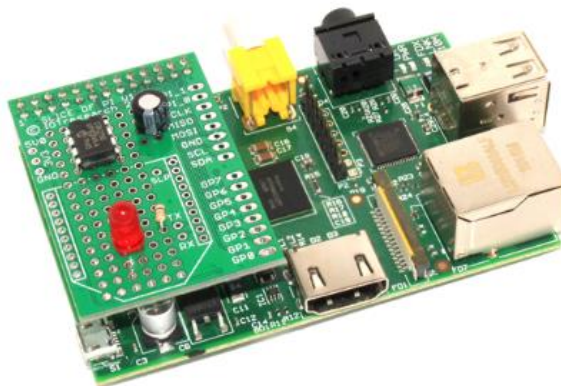
Echidna 6.5V – 24V

- Power switch.
- Reset button
- $18
- https://geekroo.com/products/352

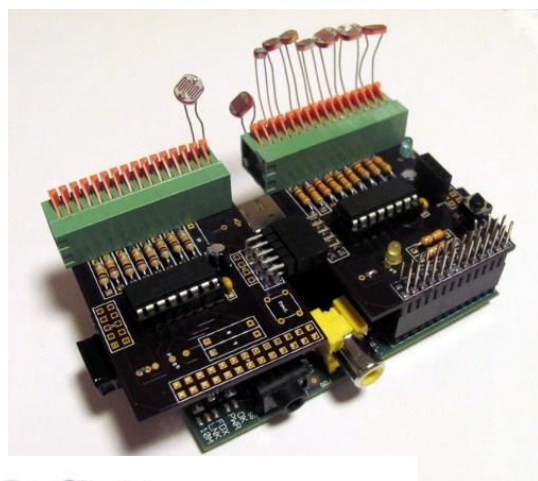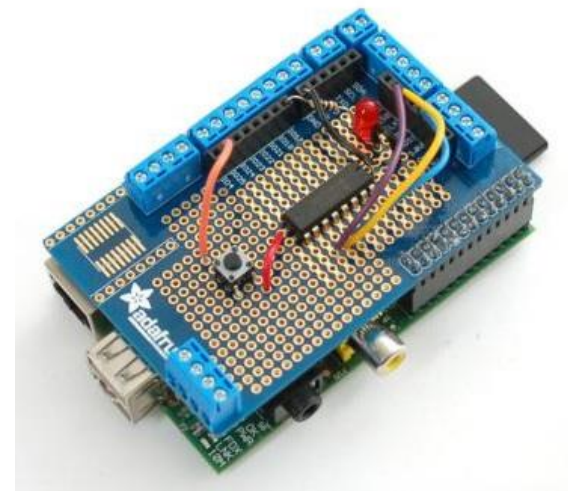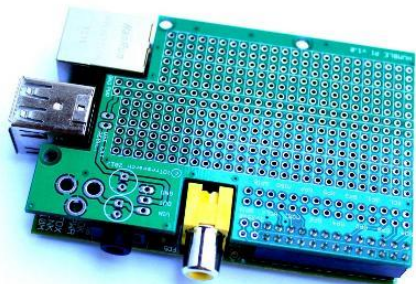## Echidna (Premium)

- 6.5V – 24V
- Power switch.
- Reset button
- Serial port
- Two voltage or current digital meters
- $35
- https://geekroo.com/products/526

And Many More…

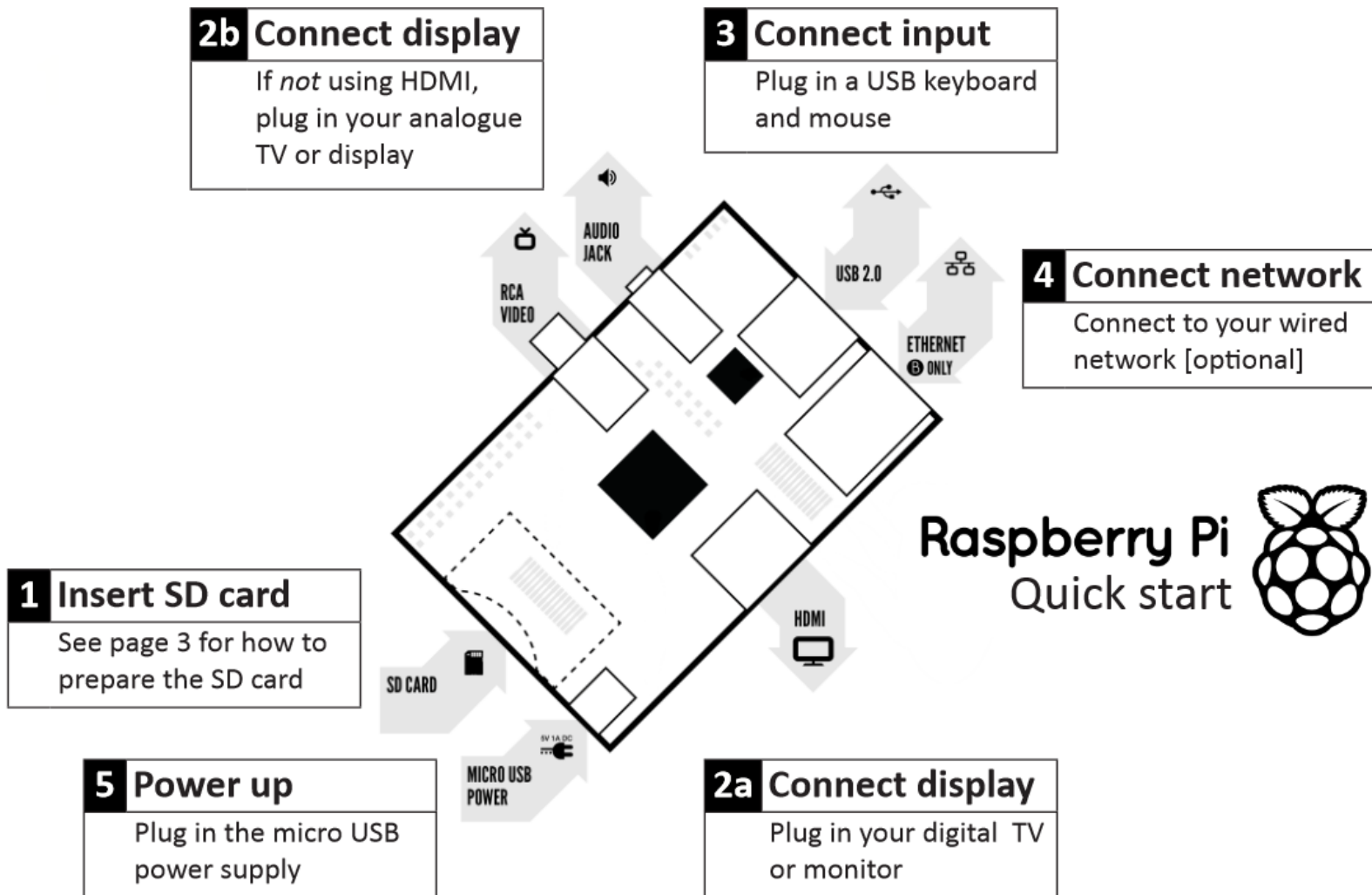*Over 140 different boards and counting!*
http://elinux.org/RPi_Expansion_Boards

Setting up your RPI

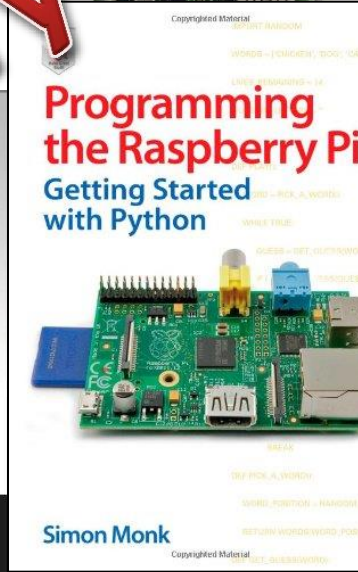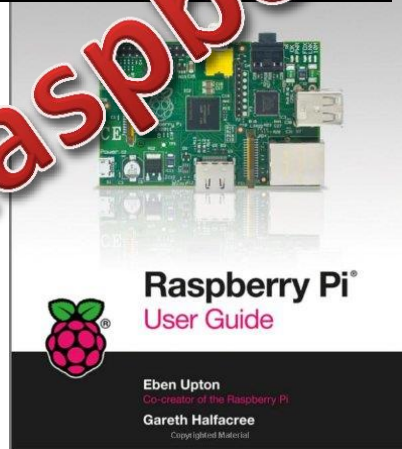## It's almost this easy

Rpi Setup Quick Start

2b Connect display
If *not* using HDMI, plug in your analogue TV or display

3 Connect input
Plug in a USB keyboard and mouse

4 Connect network
Connect to your wired network [optional]

1 Insert SD card
See page 3 for how to prepare the SD card

5 Power up
Plug in the micro USB power supply

2a Connect display
Plug in your digital TV or monitor

Raspberry Pi
Quick start

AUDIO JACK
RCA VIDEO
USB 2.0
ETHERNET B ONLY
HDMI
SD CARD
MICRO USB POWER
5V 1A DC

http://www.raspberrypi.org/quick-start-guide

Raspberry Pi Cookbooks

Additional Resources

http://www.raspberrypi.org

Raspberry Pi Amateur Radio Yahoo Group

http://groups.yahoo.com/group/Raspberry_Pi_4-Ham_RADIO/

Raspberry Connect

http://www.raspberryconnect.com/raspbian-packages-list/item/71-raspbian-hamradio

Discussion/Questions?

Speaker Bio

Ed James, KA8JMW of Albuquerque, NM is originally from Canton, OH where he was licensed over thirty five years ago. Since then, Ed has savored from the broad palette that amateur radio offers. Activities have included the design and fabrication of various projects from DC to daylight, QRP, net operations, traffic handling, rag chewing, contesting, DX, transmitter hunting, Search and Rescue, public service, satellites, EME and as an elmer to many a new ham. The thrill of that first QSO hasn't diminished. He has over 29 years of service as an electrical engineer leading space based and defense projects at Sandia National Laboratories. Ed, his wife Carol and their five daughters are all active amateur radio operators. Ed is an Assistant Section Manager for the ARRL New Mexico Section and can be reached via email at ka8jmw@arrl.net

Speaker Bio

Brian Mileshosky N5ZGT was first licensed at the age of 12 in 1992. Twenty one years later, ham radio is just as exciting now as it was when that highly anticipated envelope from the FCC with his ticket arrived in the mail. Brian is active on the air between 80 meters and 10 GHz, chasing DX, contesting, experimenting with novel technologies, assisting with public service communications, and mentoring new hams who seek the thrill of ham radio. Brian has served in numerous club and ham convention leadership positions and has sat on ARRL's Board since 2005, currently serving League members as Director of the Rocky Mountain Division (composed of the Colorado, New Mexico, Utah and Wyoming sections). Professionally, Brian is an RF/microwave engineer engaged in research and development of RF systems and applications from UHF through 30 GHz. Brain can be reached via email n5zgt@arrl.net