

# Application of Linux Single Board Computers to Amateur Radio

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<http://www.prinmath.com/ham/talks/>

# Talk Outline

- **Why Linux SBCs**
- **Getting Started**
- **BPQ Packet/RMS Gateway/APRS iGate**
- **AllStarLink Repeater**
- **Control and Monitoring**
- **SDR**
- ***Don't freak out about the number of slides***

# Single Board Computers

- **Full Linux boxes (*today's topic*)**
  - Raspberry Pi
  - Beaglebone
- **Microcontrollers (*not covered*)**
  - Arduino
  - PICAXE
  - BASIC Stamp

# Why Linux SBCs?

- **Runs a full Linux OS**
- **Usable stand alone computer or server**
- **Built in connectivity**
  - **Ethernet networking**
  - **USB and serial**
  - **General purpose IO**
- **Low power (5V 1A)**
- **Expandable using daughter boards**
- **Inexpensive (\$50 for a working system)**

# SBC Pros and Cons

- **Pros**

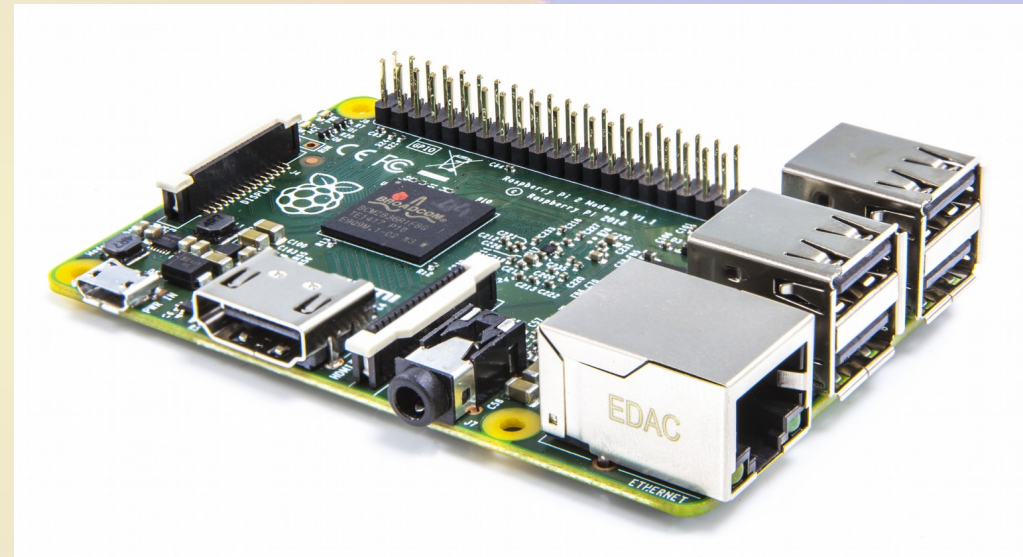
- **Inexpensive**
- **No moving parts**
- **5V power**
- **Expandable**

- **Cons**

- **SD cards corrupted by bad power**
- **SD card is not a great hard disk**

# Raspberry Pi

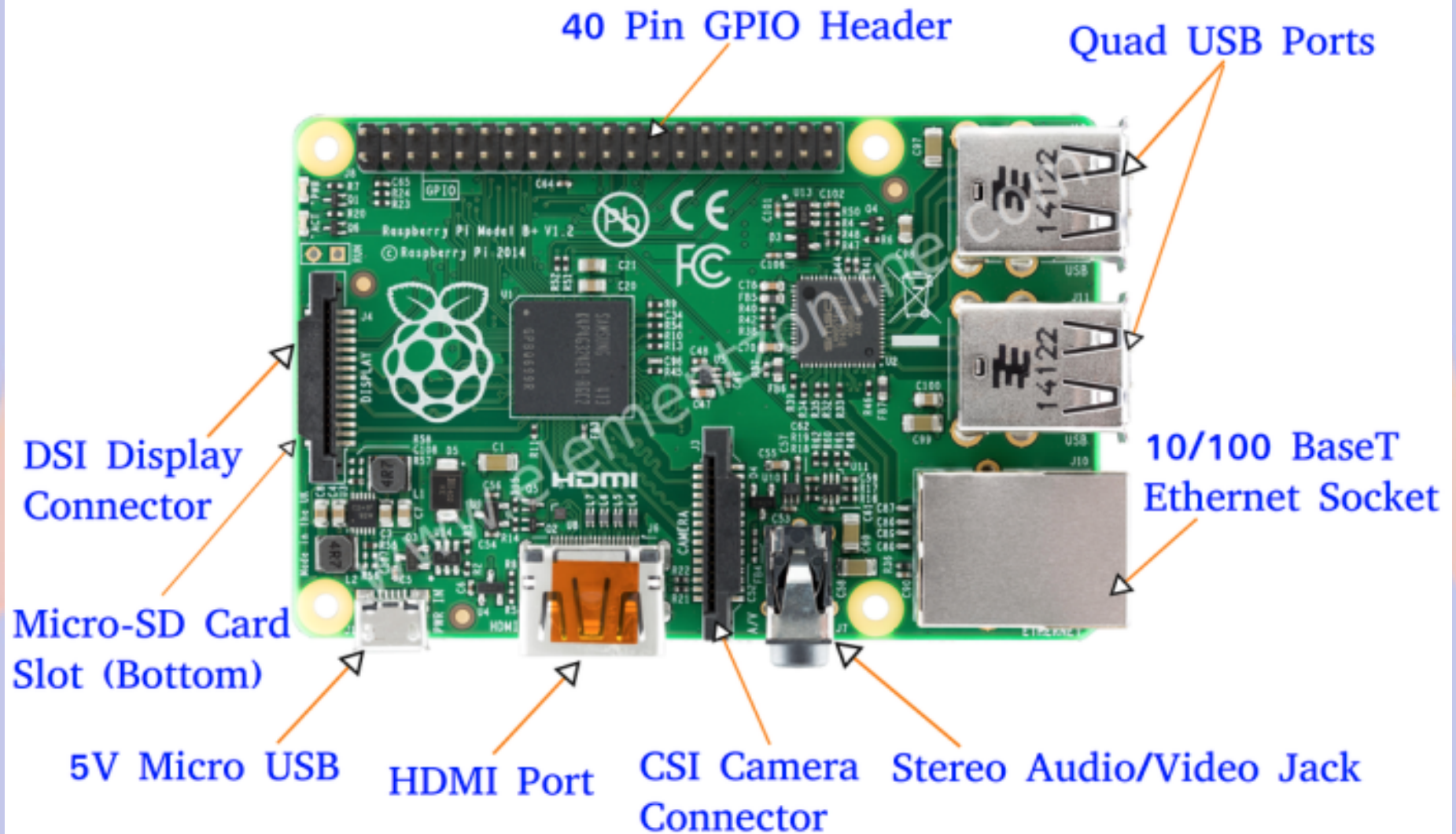
- **Most Popular**
- **Best supported**
- **rPi3 most powerful**
- **Lots of USB ports**
- **Lots of daughterboards**
- **No analog inputs**
- **\$35 plus SD card**



# Raspberry Pi models

- **Raspberry Pi**
  - **A/A+ 700 MHz CPU & 256MB SDRAM, 1xUSB**
  - **B 700 MHz CPU & 512MB SDRAM, 2xUSB, Ethernet**
  - **B+ 700 MHz CPU & 512MB SDRAM, 4xUSB, Ethernet**
  - **2B 900 MHz Quad A7 & 1GB SDRAM, 4xUSB, Ethernet**
  - **3B 1.2GHz Quad 64bit & 1GB SDRAM, 4xUSB, Ethernet**
- **Compute Module**
  - **700MHz CPU & 512MB SDRAM**
- **Zero**
  - **1GHz CPU & 512MB SDRAM**

# Raspberry Pi 2B





# Beagle Bone

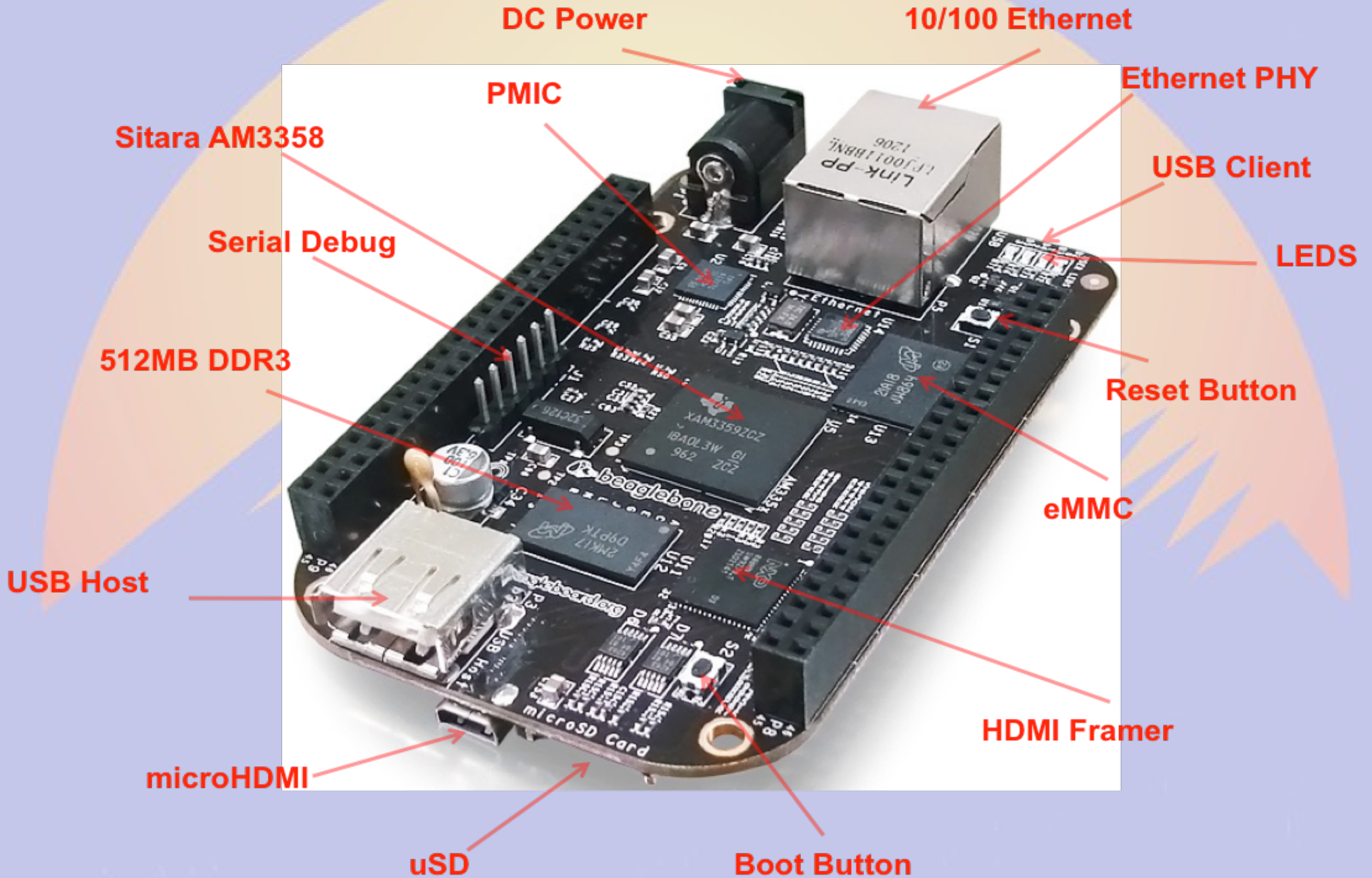
- Less well supported
- Onboard eMMC
- Power & Reset buttons
- More GPIO pins
- 8 analog inputs
- \$50 street price



# Beaglebone Models

- **White**
  - Original 720 MHz A8
- **Black**
  - Most Popular 1GHz A8
- **Green**
  - Same CPU as Black
  - No barrel power, two Grove connectors
- **Industrial**
  - Black with extended temperature range

# Beagle Bone Black



# Other Linux SBCs

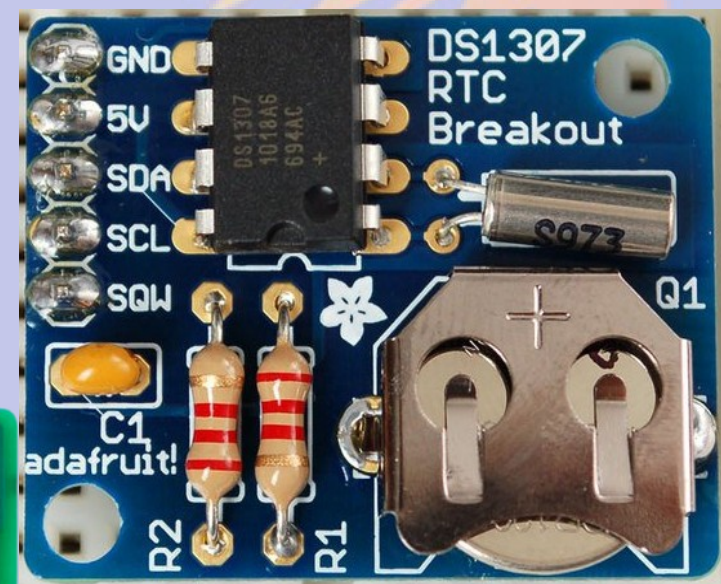
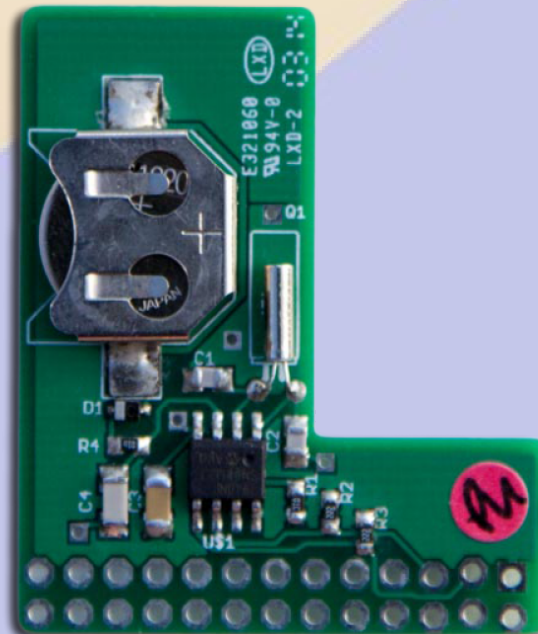
- **Examples**
  - Intel Edison
  - VoCore
  - Odroid
- **Less well supported**
- **Fewer peripherals**
- **Sometimes better performance**
- **Mostly higher priced**

# Power and Storage

- **Runs on 5V DC**
  - Needs clean power
  - Draws 0.5-1.0 A without daughter boards
- **Micro SD card storage**
  - Finite life
  - Marginal performance
  - Bad power kills SD

# Must Have Accessories

- **Micro SD card**
  - **Faster is better**
    - Class 10
    - UHS 1
    - UHS 3
  - **At least 4GB**
    - 16GB is ample
- **Real time clock**
  - PiFace Shim RTC
  - Adafruit DS1307
  - Needed if no network (NTP)



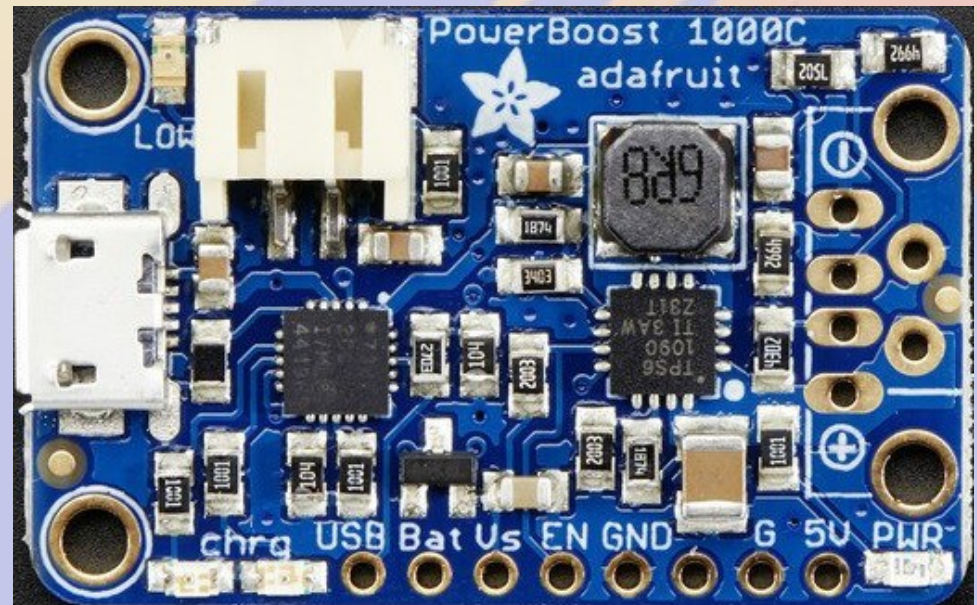
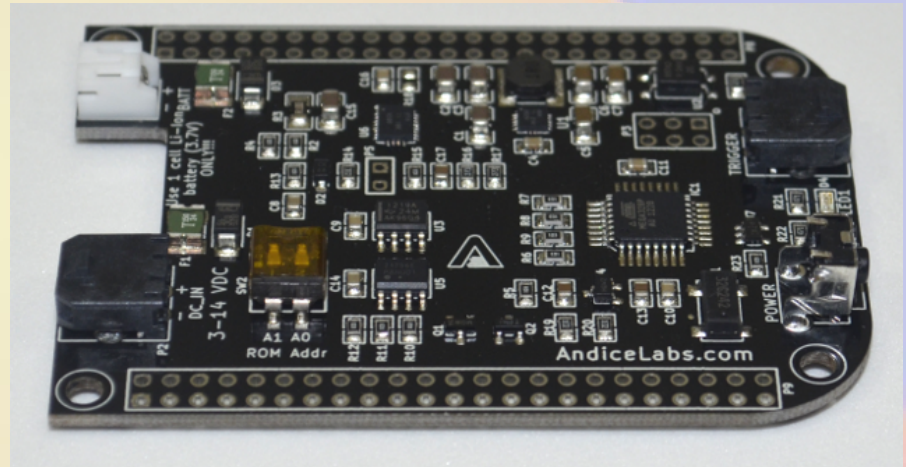
# Nice to have

- Official Raspberry 7" Touchscreen



# Power Control

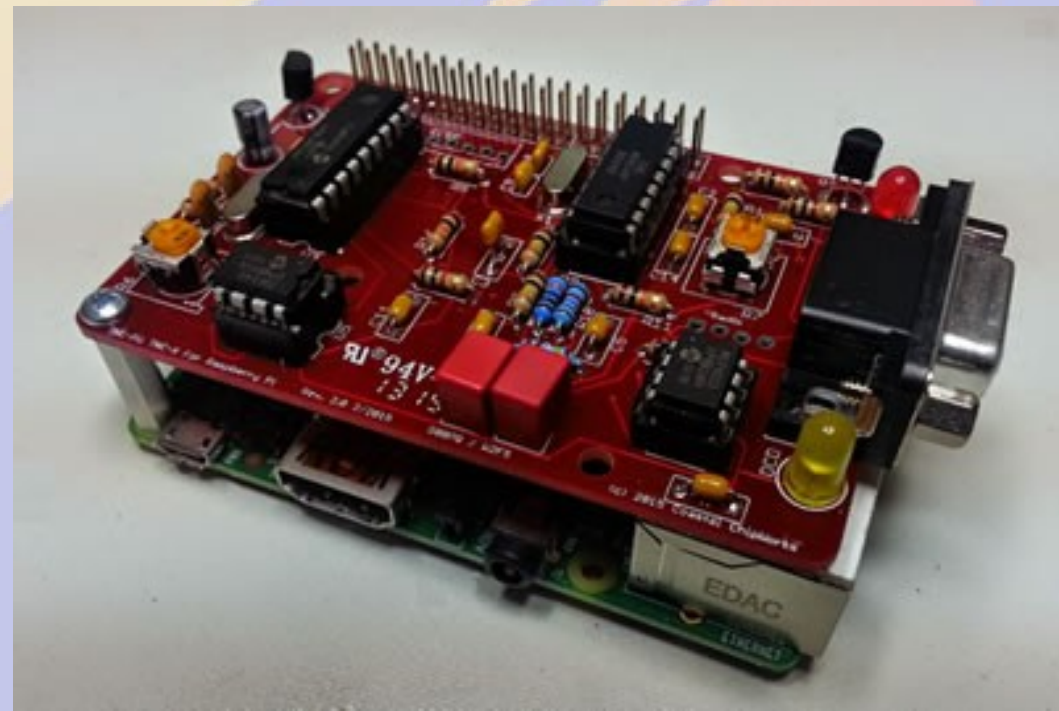
- Andice Labs Powercape
- Adafruit Powerboost 1000C
- Charges and boosts 4V from LIPO battery





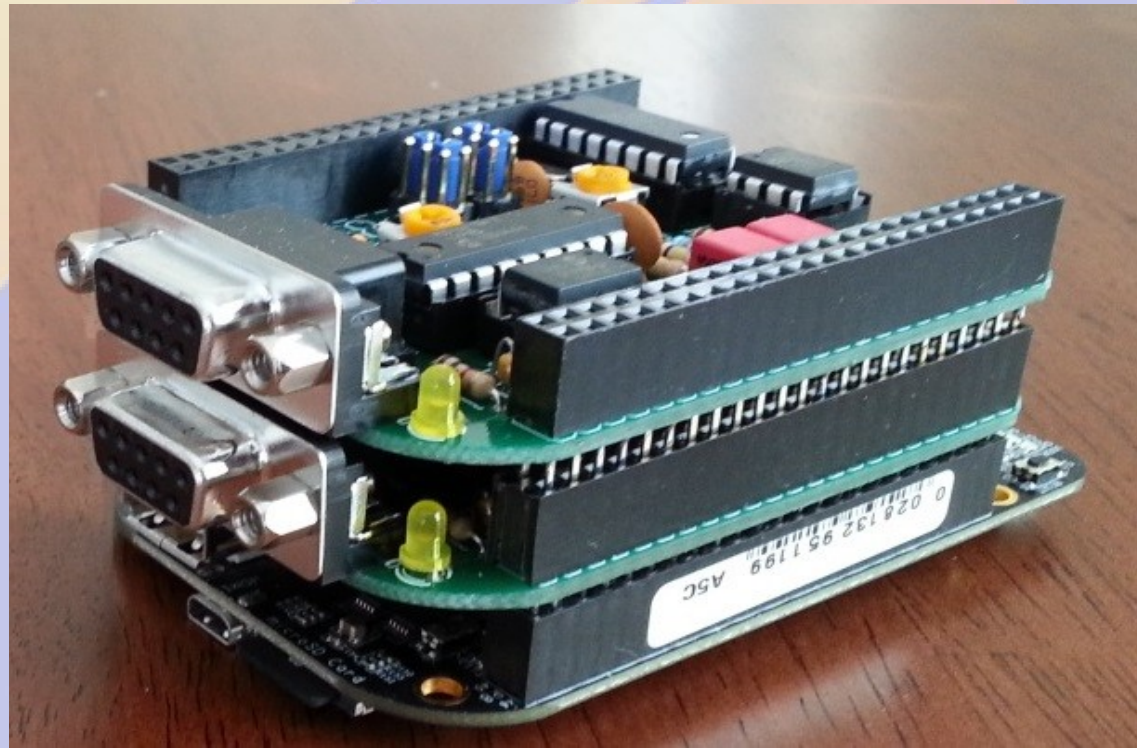
# TNC-X/Pi/Black


- Designed by John Hansen W2FS
- Based on PIC Microcontroller
- MX614 Bell 202 modem chip
- KISS interface
  - Serial
  - USB
  - I2C



# Why the BB/TNC-Black?

- **BBB has 5 serial ports**
- **Mechanically stable stacked capes**
- **Powercape battery backup**
- **Lots of pins for site monitoring**
- **50% more expensive**



A stylized sun with a yellow-to-orange gradient, partially obscured by a blue horizon line. The sun has several sharp rays extending downwards. The background is a solid light blue color.

# **Part 1**

# **Getting Started on the Raspberry Pi**

# rPi Materials

- **Raspberry Pi 2B or 3B**
- **Micro SD card**
- **5V 1A power supply**
- **USB A to micro USB B cable**
- **Ethernet cable**
- **Direct connection**
  - **Monitor or TV**
  - **HDMI cable**
  - **USB keyboard and mouse**

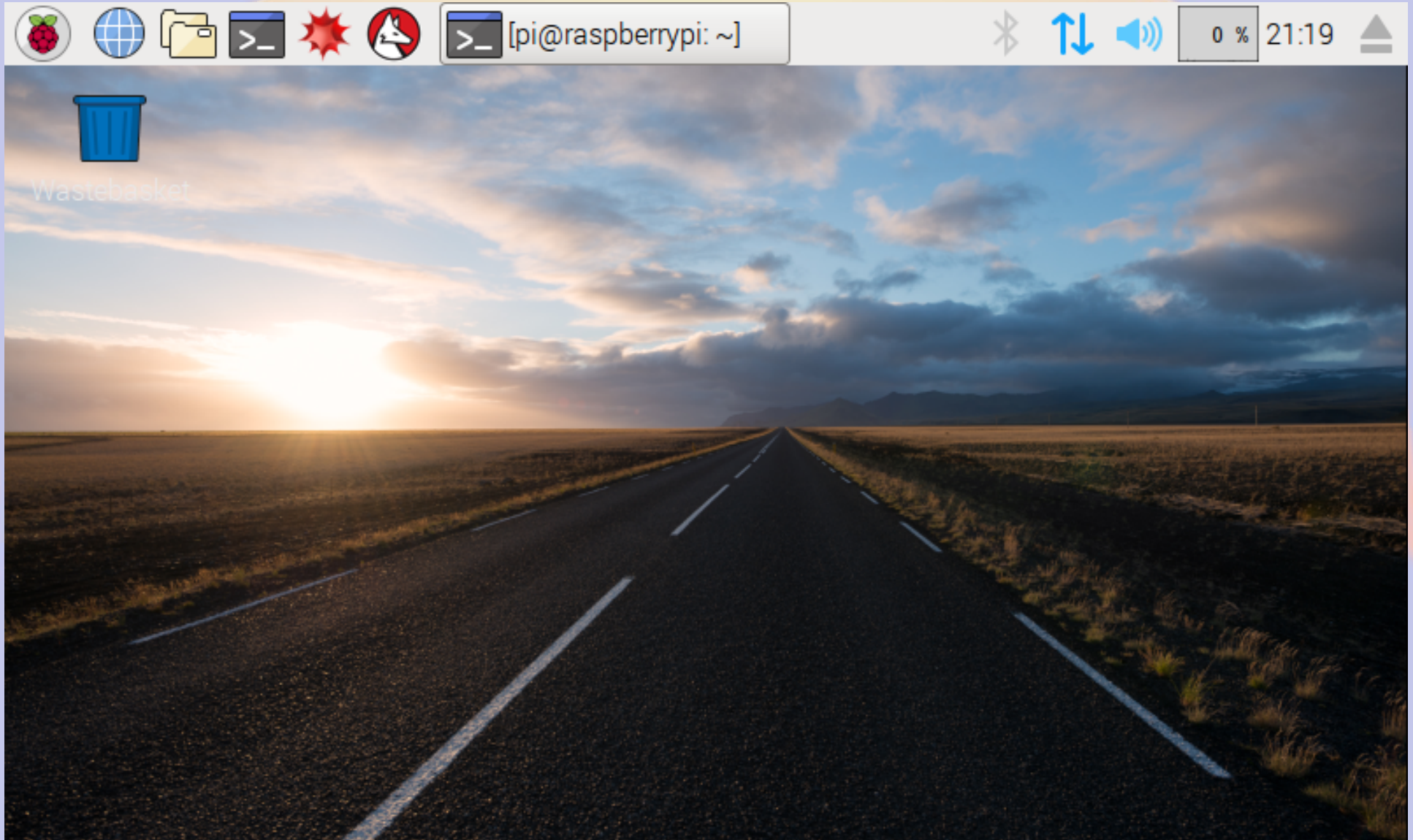
# Raspberry OS Choices

- <https://www.raspberrypi.org/downloads/>
- **Debian derivatives are most popular**
  - **Raspbian (Official Supported OS)**
  - **Alternatives are**
    - **NOOBS (New Out Of the Box Software)**
    - **Ubuntu Mate (Ubuntu Desktop)**
    - **Windows 10 IOT (a.k.a. YGBSM)**
    - *several others, some not Linux based*
- **Debian 8 (Jessie) adopts systemd**
  - **This changes how system programs are run**
    - **No more */etc/init.d/XXX* and */etc/inittab***
    - **Control programs with *systemctl***

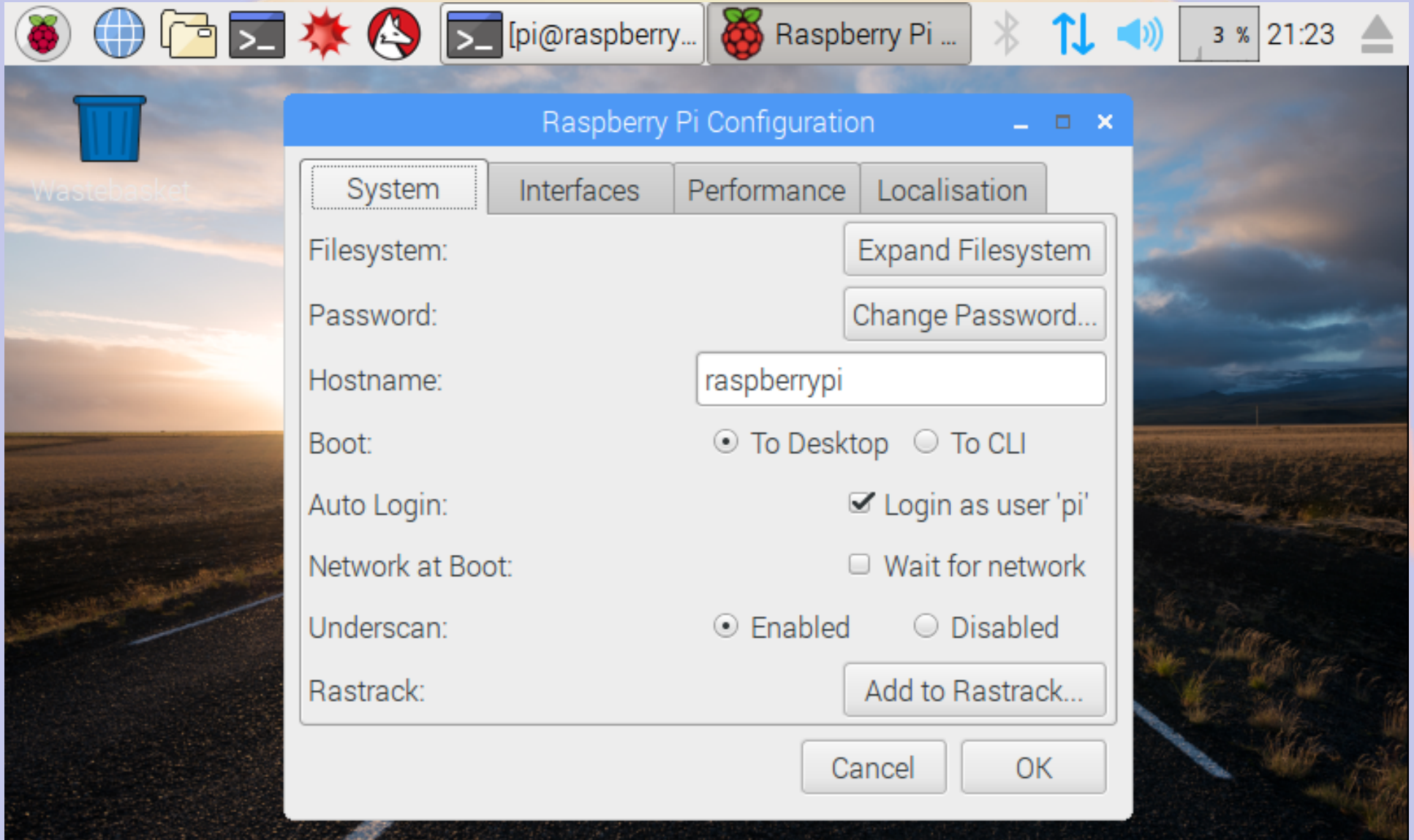
# Burning the Image

- **Unzip image**
  - `2016-09-23-raspbian-jesse.img`
- **Linux or OSX command line**
  - `dd if=2016-09-23-raspbian-jesse.img of=/dev/mmcblk0`
  - `sync;sync`
- **Windows**
  - Download Win32DiskImager
  - Select image file name
  - Select SD card drive letter
  - Click *Write*

# First boot with Pixel



# Raspberry > Preferences > Raspberry Pi Configuration





# Remote Access

- Do `ifconfig` from the keyboard
- Look for hostname *raspberrypi*
  - Assign a reserved IP address and add DNS
- Advantages of using `ssh`
  - Can access the device from anywhere
  - Automatic logins using `authorized_keys`
  - Text based menus work great remotely

# Configuring rPi

- **Plug in keyboard, mouse and screen**
  - Menu > Preferences > rPi Configuration
- **Plug in ethernet cable and locate the IP address**
  - Default hostname is *raspberrypi*
  - ssh **pi@XXX.XXX.XXX.XXX**
    - password raspberry

# Running raspi-config

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
willem@bashful: ~$ ssh pi@192.168.11.114  
pi@192.168.11.114's password:  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Sat May 7 18:09:16 2016 from 192.168.11.126  
pi@raspberrypi: ~$ sudo raspi-config
```

# Expand file system

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
1 Expand Filesystem          Ensures that all of the SD card s  
2 Change User Password      Change password for the default u  
3 Boot Options              Choose whether to boot into a des  
4 Wait for Network at Boot  Choose whether to wait for networ  
5 Internationalisation Options Set up language and regional sett  
6 Enable Camera             Enable this Pi to work with the R  
7 Add to Rastrack           Add this Pi to the online Raspber  
8 Overclock                 Configure overclocking for your P  
9 Advanced Options         Configure advanced settings  
0 About raspi-config        Information about this configurat  
  
                <Select>                <Finish>
```

# Change the Password

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
1 Expand Filesystem          Ensures that all of the SD card s  
2 Change User Password       Change password for the default u  
3 Boot Options               Choose whether to boot into a des  
4 Wait for Network at Boot   Choose whether to wait for networ  
5 Internationalisation Options Set up language and regional sett  
6 Enable Camera              Enable this Pi to work with the R  
7 Add to Rastrack            Add this Pi to the online Raspber  
8 Overclock                  Configure overclocking for your P  
9 Advanced Options           Configure advanced settings  
0 About raspi-config         Information about this configurat  
  
                <Select>                <Finish>
```

# Set timezone 1

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
1 Expand Filesystem          Ensures that all of the SD card s  
2 Change User Password       Change password for the default u  
3 Boot Options                Choose whether to boot into a des  
4 Wait for Network at Boot    Choose whether to wait for networ  
5 Internationalisation Options Set up language and regional sett  
6 Enable Camera               Enable this Pi to work with the R  
7 Add to Rastrack             Add this Pi to the online Raspber  
8 Overclock                   Configure overclocking for your P  
9 Advanced Options           Configure advanced settings  
0 About raspi-config          Information about this configurat  
  
                <Select>                <Finish>
```

# Set timezone 2

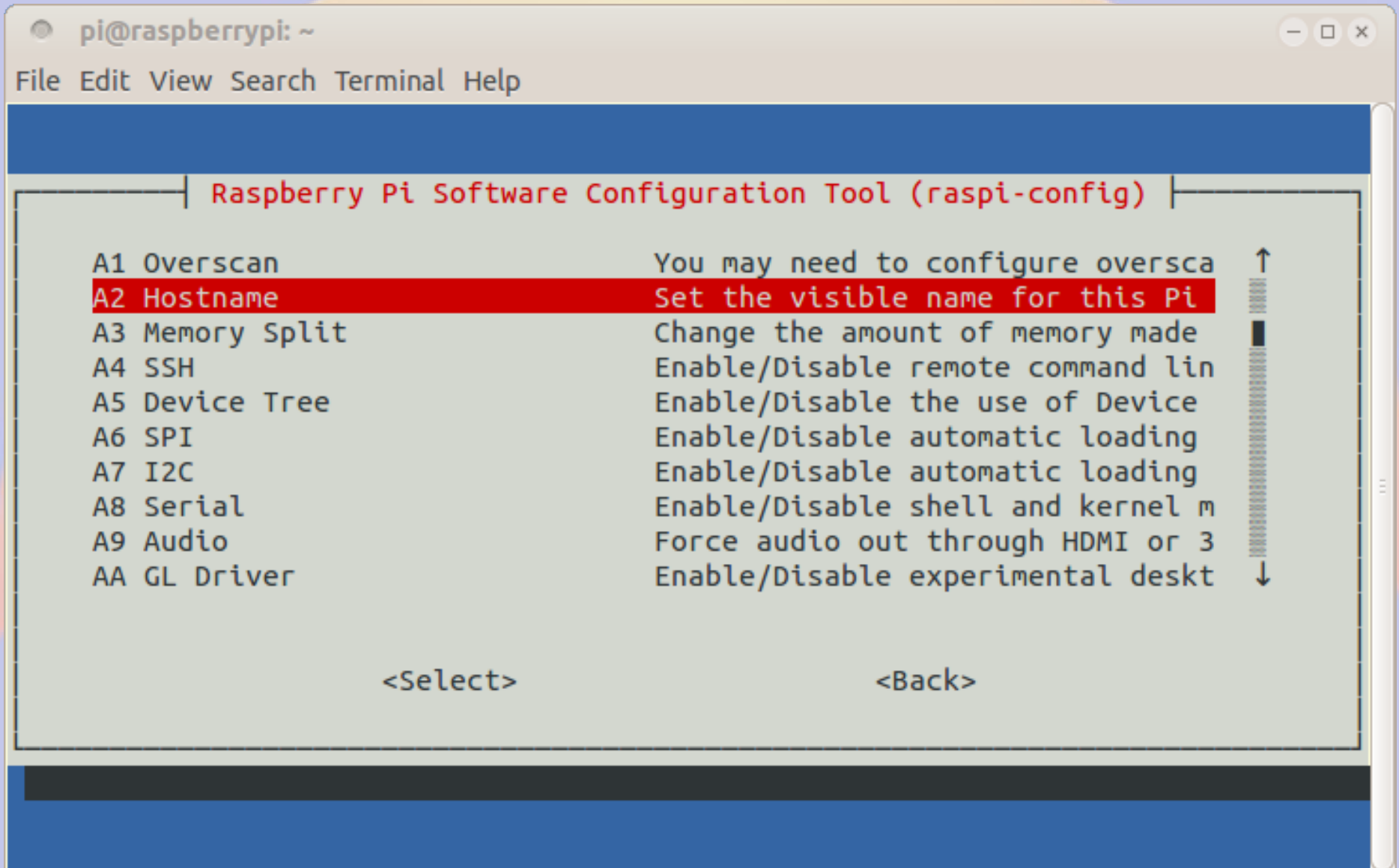
```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
I1 Change Locale          Set up language and regional sett  
I2 Change Timezone       Set up timezone to match your loc  
I3 Change Keyboard Layout Set the keyboard layout to match  
I4 Change Wi-fi Country  Set the legal channels used in yo  
  
<Select>                <Back>
```

# Advanced Options

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
1 Expand Filesystem          Ensures that all of the SD card s  
2 Change User Password       Change password for the default u  
3 Boot Options                Choose whether to boot into a des  
4 Wait for Network at Boot   Choose whether to wait for networ  
5 Internationalisation Options Set up language and regional sett  
6 Enable Camera              Enable this Pi to work with the R  
7 Add to Rastrack            Add this Pi to the online Raspber  
8 Overclock                  Configure overclocking for your P  
9 Advanced Options           Configure advanced settings  
0 About raspi-config         Information about this configurat  
  
                <Select>                <Finish>
```



# Set Hostname



# Disable serial login


```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
Raspberry Pi Software Configuration Tool (raspi-config)  
A1 Overscan You may need to configure oversca ↑  
A2 Hostname Set the visible name for this Pi  
A3 Memory Split Change the amount of memory made  
A4 SSH Enable/Disable remote command lin  
A5 Device Tree Enable/Disable the use of Device  
A6 SPI Enable/Disable automatic loading  
A7 I2C Enable/Disable automatic loading  
A8 Serial Enable/Disable shell and kernel m  
A9 Audio Force audio out through HDMI or 3  
AA GL Driver Enable/Disable experimental desk ↓  
  
<Select> <Back>
```

# Reboot and log in again

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
1 Expand Filesystem          Ensures that all of the SD card s  
2 Change User Password       Change password for the default u  
3 Boot Options               Choose whether to boot into a des  
4 Wait for Network at Boot   Choose whether to wait for networ  
5 Internationalisation Options Set up language and regional sett  
6 Enable Camera              Enable this Pi to work with the R  
7 Add to Rastrack            Add this Pi to the online Raspber  
8 Overclock                  Configure overclocking for your P  
9 Advanced Options           Configure advanced settings  
0 About raspi-config         Information about this configurat  
  
<Select>                    <Finish>
```

# Add user willem

```
pi@aid2: ~  
File Edit View Search Terminal Help  
pi@aid2:~$ sudo adduser willem  
Adding user `willem' ...  
Adding new group `willem' (1001) ...  
Adding new user `willem' (1001) with group `willem' ...  
Creating home directory `/home/willem' ...  
Copying files from `/etc/skel' ...  
Enter new UNIX password:  
Retype new UNIX password:  
passwd: password updated successfully  
Changing the user information for willem  
Enter the new value, or press ENTER for the default  
Full Name []: Willem AC0KQ  
Room Number []:  
Work Phone []:  
Home Phone []:  
Other []:  
Is the information correct? [Y/n]  
pi@aid2:~$ sudo adduser willem sudo  
Adding user `willem' to group `sudo' ...  
Adding user willem to group sudo  
Done.  
pi@aid2:~$
```



**Part 2**  
**BPQ BBS/RMS/iGate**

# What is BPQ?

- **NET/ROM compatible Packet Switch**
  - **Multiple ports**
    - **As many I2C or serial ports as you have available**
  - **Multiple protocols**
    - **Packet, Pactor, IP**
  - **Multiple functions**
    - **BBS, Chat, APRS**

# What can we use BPQ for?

- **AX25 (Packet) Access point**
- **Bulletin Board System (BBS)**
- **Radio Message Server (RMS)**
- **APRS Internet Gateway**
- **Application Gateway**

# BPQ Web Configuration

The screenshot shows a Mozilla Firefox browser window with the title "K0NTS's BPQ32 Web Server - Mozilla Firefox". The address bar displays "ctnpi:8080/Node/NodeIndex.html". The page content features a large heading "BPQ32 Node K0NTS" and a horizontal menu of navigation links. The browser's toolbar includes a search bar, star icon, and other standard navigation controls.

<a href="#">Routes</a>	<a href="#">Nodes</a>	<a href="#">Ports</a>	<a href="#">Links</a>	<a href="#">Users</a>	<a href="#">Stats</a>	<a href="#">Terminal</a>	<a href="#">Driver Windows</a>	<a href="#">Stream Status</a>	<a href="#">Mail Server Pages</a>	<a href="#">Chat Server Pages</a>	<a href="#">SYSOP Signin</a>	<a href="#">Edit Config</a>
------------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	--------------------------	--------------------------------	-------------------------------	-----------------------------------	-----------------------------------	------------------------------	-----------------------------



# BBS Message Page

Edit Messages - Chromium

Edit Messages

ctnpi:8080/Mail/Msgs?M000039592D06

## BPQ32 BBS K0NTS

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

**Filter**

From

To

Via

- [2504](#)
- [2503](#)
- [2498](#)
- [2497](#)
- [2494](#)
- [2493](#)
- [2492](#)
- [2491](#)
- [2486](#)
- [2485](#)
- [2483](#)
- [2482](#)
- [2481](#)

### Message 2555

From  Sent  Type

To  Received  Status

BID  Last Changed  Size

VIA

Title

Green = Sent, Yellow = Queued

K0NTS	RMS						
-------	-----	--	--	--	--	--	--

# Message Forwarding

Browser: Mozilla Firefox  
Page Title: Edit Forwarding  
URL: ctnpi:8080/Mail/FWD?M000038DD423A

## BPQ32 BBS K0NTS

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

**Max size to Send**  
99999

**Max Size to Receive**  
99999

**Max age for Bulls**  
365

**Warn if no route for P or T**

**Use Local Time**

**Aliases**

**Forwarding Config for RMS - 0 Messages Queued**

TO	AT	TIMES	Connect Script
RMS K0TER K6HTN N1IQI AL7N NX9K			RMS

Hierarchical Routes (Flood Bulls) HR (Personals and Directed Bulls)

--	--

BBS HA

Enable Forwarding  Interval  (Secs)

Request Reverse  Interval  (Secs)

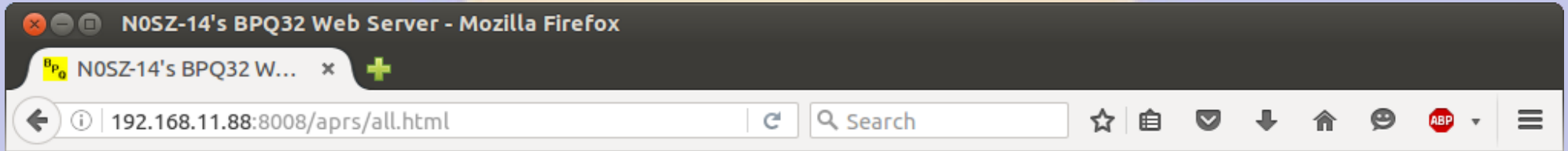
Send new messages without waiting for poll timer

FBB Max Block  Send Personal Mail Only

Allow Binary  Use B1 Protocol  Use B2 Protocol

Send ctrl/Z instead of /ex in text mode forwarding

# APRS Page



## N0SZ-14's BPQ32 APRS Web Server

### All Stations

(This page will automatically refresh every five minutes)

The following is a list of all the stations heard in the past 120 minutes, both on RF and on the internet.

There are 90 callsigns in the list, click a callsign to get an information page for that station.

<a href="#">Home</a>
<a href="#">All Stations</a>
<a href="#">RF Stations</a>
<a href="#">All WX Stations</a>
<a href="#">RF WX Stations</a>
<a href="#">All Mobile Stations</a>
<a href="#">RF Mobile Stations</a>
<a href="#">All Objects</a>
<a href="#">RF Objects</a>
<a href="#">Information</a>
<a href="#">Node Pages</a>

<a href="#">AC0VP-10</a>	<a href="#">AC0XW-1</a>	<a href="#">AC0YV-9</a>	<a href="#">AD0WB-B</a>	<a href="#">AE5VQ</a>	<a href="#">ALMGRE</a>	<a href="#">BVILLE</a>	<a href="#">K0BAN</a>
<a href="#">K0HEY-9</a>	<a href="#">K0JSC-1</a>	<a href="#">K0QED</a>	<a href="#">K0QED-10</a>	<a href="#">K0RTS-9</a>	<a href="#">K1DDN-4</a>	<a href="#">K7HRO-9</a>	<a href="#">K7RFW-9</a>
<a href="#">K7YE-3</a>	<a href="#">K8ZTT-9</a>	<a href="#">KB0JIT</a>	<a href="#">KB0USF</a>	<a href="#">KB9UZO-9</a>	<a href="#">KC0D</a>	<a href="#">KC0D-6</a>	<a href="#">KC0FAC-7</a>
<a href="#">KC0LAD-1</a>	<a href="#">KC0WUV</a>	<a href="#">KC6ETE-9</a>	<a href="#">KD0FPY-9</a>	<a href="#">KD0JZX-10</a>	<a href="#">KD0KVJ-15</a>	<a href="#">KD0LAC-10</a>	<a href="#">KD0SQA-4</a>
<a href="#">KD0SQA-9</a>	<a href="#">KE0GDJ-7</a>	<a href="#">KG4JAM</a>	<a href="#">KI4GYZ-1</a>	<a href="#">KJ0CFW-9</a>	<a href="#">KN0MAP-1</a>	<a href="#">KT0AM-9</a>	<a href="#">N0BN-1</a>
<a href="#">N0EB</a>	<a href="#">N0LNE</a>	<a href="#">N0OJ</a>	<a href="#">N0RUX-13</a>	<a href="#">N0SZ-14</a>	<a href="#">N0SZ-2</a>	<a href="#">N0WAR-9</a>	<a href="#">N0WGM-3</a>
<a href="#">N1GEP-1</a>	<a href="#">N2XGL-5</a>	<a href="#">N2XGL-9</a>	<a href="#">N3GPS</a>	<a href="#">N4ATA-7</a>	<a href="#">N4JJR-9</a>	<a href="#">N7GN-5</a>	<a href="#">N7MJ-9</a>
<a href="#">N7SOI-9</a>	<a href="#">NOADM</a>	<a href="#">SAG1</a>	<a href="#">W0AKO-B</a>	<a href="#">W0ARP</a>	<a href="#">W0BSP-10</a>	<a href="#">W0BSP-13</a>	<a href="#">W0CDS-A</a>
<a href="#">W0CDS-B</a>	<a href="#">W0CDS-C</a>	<a href="#">W0DPD-1</a>	<a href="#">W0JAW</a>	<a href="#">W0JAW-9</a>	<a href="#">W0JRL-15</a>	<a href="#">W0LRA-5</a>	<a href="#">W0QEY-5</a>
<a href="#">W0RDR-9</a>	<a href="#">W0UPS-5</a>	<a href="#">W8XAL-10</a>	<a href="#">W8XAL-9</a>	<a href="#">WA0GEH</a>	<a href="#">WA0TOG</a>	<a href="#">WA5VRL</a>	<a href="#">WA6IFI-3</a>
<a href="#">WB5PJB-B</a>	<a href="#">WB7GR-3</a>	<a href="#">WB7GR-9</a>	<a href="#">WD4IXD</a>	<a href="#">WD4IXD-10</a>	<a href="#">WQ8M-1</a>	<a href="#">WQ8M-9</a>	<a href="#">WR0AEN-B</a>
<a href="#">WR0AEN-D</a>	<a href="#">WY7ATH-2</a>						

# Stations Heard on RF

N0SZ-14's BPQ32 Web Server - Mozilla Firefox

N0SZ-14's BPQ32 W... x +

192.168.11.88:8008/aprs/allrf.html Search ☆ 📁 🛡️ ⬇️ 🏠 🗨️ ABP ☰

## N0SZ-14's BPQ32 APRS Web Server

### RF Stations

(This page will automatically refresh every five minutes)

The following is a list of all the stations heard on RF in the past 120 minutes.

\* after a callsign means that it was heard via a digi

The list only includes callsigns heard on RF, direct or via digipeaters.

It does not include callsigns heard on the internet, or heard as third-party RF traffic via IGATEs.

There are 47 callsigns in the list, click a callsign to get an information page for that station.

Callsign	Symbol	Location	Miles	Bearing	Last heard
<a href="#">ALMGRE*</a>	No. Digi	38°46.33'N 104°59.55'W	54.9	159	16:31:27
<a href="#">K0BAN*</a>	Truck	40°24.41'N 105°05.68'W	62.9	12	16:37:20
<a href="#">K0JSC-1*</a>	No. Digi	38°13.86'N 104°36.65'W	97.3	156	16:30:12
<a href="#">K0QED*</a>	Rec Veh'le	38°58.91'N 104°32.53'W	56.9	130	16:32:21
<a href="#">K0QED-10*</a>	No. Diam'd	38°59.87'N 104°38.52'W	52.1	133	15:55:59
<a href="#">K0RTS-9*</a>	Truck	39°17.25'N 103°30.01'W	100.0	99	15:57:58
<a href="#">K1DDN-4*</a>	Car	38°25.62'N 105°11.37'W	75.8	173	16:06:07
<a href="#">K7HRO-9*</a>	Truck	41°09.63'N 104°47.80'W	117.1	14	16:21:42
<a href="#">K7RFW-9*</a>	Van	41°33.88'N 106°08.23'W	147.3	344	16:39:01
<a href="#">K7YE-3*</a>	Truck	40°24.43'N 104°49.41'W	67.5	24	16:11:59
<a href="#">K8ZTT-9*</a>	Jeep	38°59.63'N 105°03.46'W	39.4	157	16:24:34

# Station Map

N0SZ-14's BPQ32 Web Server - Mozilla Firefox

N0SZ-14's BPQ32 W... x +

192.168.11.88:8008/aprs/find.cgi?call=N0SZ-2

Search

Home

All Stations

RF Stations

All WX Stations

RF WX Stations

All Mobile Stations

RF Mobile Stations

All Objects

RF Objects

Information

Node Pages

## N0SZ-14's BPQ32 APRS Web Server

(This page will automatically refresh every five minutes)

### Information about [N0SZ-2](#)

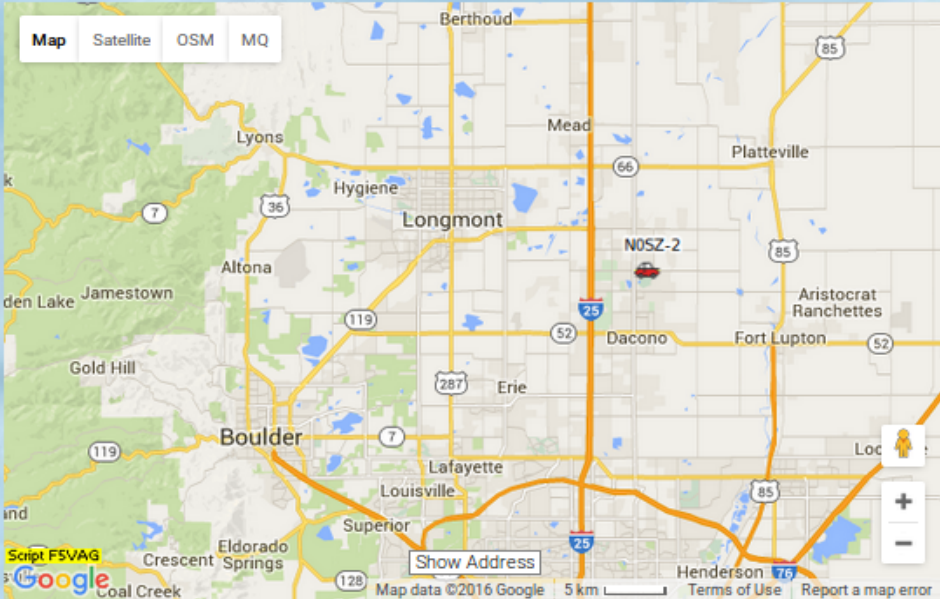
Click the callsign to look it up on qrz.com

Location: 40°07.91'N 104°55.75'W

The bearing from N0SZ-14 to N0SZ-2 is 028 degrees, the distance is 47.9 Miles

Last posit: APTT4,W0UPS-5,WIDE1,KC0D,WIDE2\*

Status: /TinyTrak4 Alpha  
Last heard 00:54:36 ago



Map Satellite OSM MQ

Script F5VAG

Google

Map data ©2016 Google 5 km Terms of Use Report a map error

# How does it work?

- **BPQ is a software program**
  - Runs on most computers
  - Somewhat complex configuration file
- **Connects to radio via Terminal Node Controller (TNC)**
  - Typically serial connection
- **Interconnects via IP**
- **Built-in BBS, iGate, Chat server, ...**

# rPi/BPQ vs. KPC3+ BBS

- **rPi/BPQ Pros**

- Lower cost (\$100)
- Much larger capacity (GB vs. kB)
- More ports (multiple RF, serial and IP)
- Sophisticated forwarding

- **rPi/BPQ Cons**

- Higher current draw
- Less tolerant of bad power

# Complaint: Hard to set up BPQ

- **BPQ is very sophisticated, and that necessarily adds complexity**
- **Solutions:**
  - **Use *bpq-config* to get started**
  - **Web interface for BBS etc.**
  - **Join a support group**
    - **Yahoo BPQ32**
    - **RMHAM**

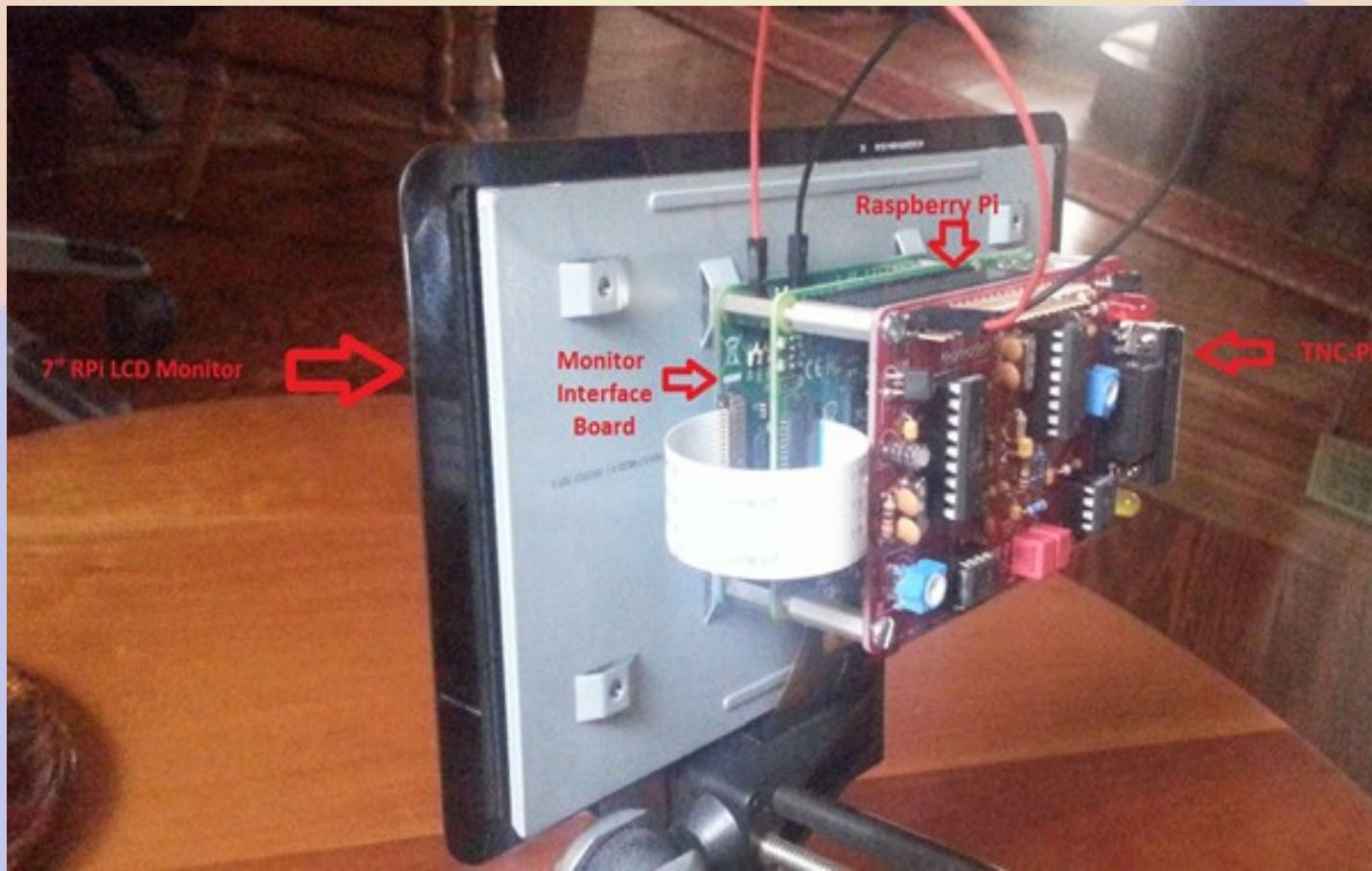


# Why so rPi and BBB centric?

- **BPQ is software – runs anywhere**
  - **Supported on Windows, OSX, Linux**
  - **Best run as a headless server**
- **rPi and BBB are**
  - **Inexpensive**
  - **Reliable Linux boxes**
  - **DC powered**
  - **TNC/Pi & TNC/Black daughter boards**
  - **All the cool kids have one**

# Why the rPi/TNC-Pi?

- Extremely well supported
- Complete package with screen



# Brief history of BPQ

- **Written by John Wiseman G8BPQ**
- **Originally called BPQCODE**
- **Became BPQ32 in late 90s**
- **Ported to OSX/Linux in 2000s**
- **Ported to Raspberry Pi/TNC-PI and Beagle Bone Black/TNC-Black**

# Building the TNC kit

- **It takes a few hours to build**
  - Quality soldering iron time
  - Simple, excellent instructions
- **Test it**
  - Check voltages, insert ICs
  - LEDs should flash on power up
  - Configure OS and BPQ
- **John W2FS provides outstanding after-sales support**

# Selecting a Username

- **Default user name**
  - Raspberry Pi = pi
  - Beaglebone Black = debian
- **The default user name is good for BPQ and similar programs with multiple users**
- **Create a login for each user**
- **Create subdirectories for programs like BPQ which will clutter the home directory**

# Quick Start

<http://www.primmath.com/ham/howto/quickstart/>

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
willem@bashful:~$ ssh pi@192.168.11.113
pi@192.168.11.113's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Mon Nov 28 20:38:33 2016
pi@bpqpi:~ $ mkdir BPQ
pi@bpqpi:~ $ cd BPQ
pi@bpqpi:~/BPQ $ wget -q http://www.primmath.com/ham/bpq-config
pi@bpqpi:~/BPQ $ chmod a+x bpq-config
pi@bpqpi:~/BPQ $ sudo ./bpq-config
```

# bpq-config installs programs

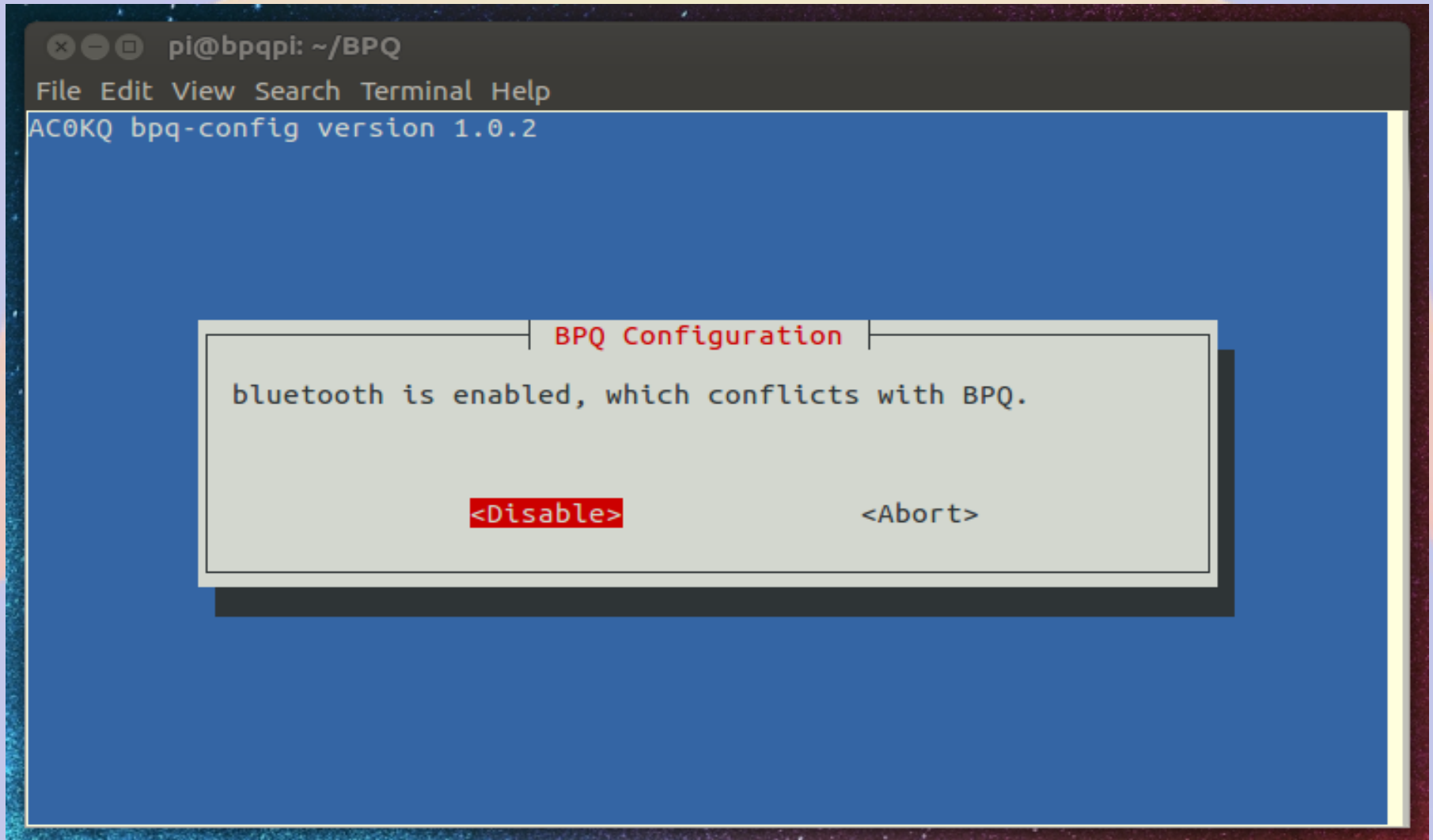
```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

**BPQ Configuration**

telnet and minicom and lsof is not installed.  
Select Install to install, or Quit to install them  
yourself.

**<Install>**                      <Quit>

# bpq-config resolves conflicts



The image shows a terminal window with a dark blue background. At the top, the window title is "pi@bpqpi: ~/BPQ". Below the title bar is a menu bar with "File Edit View Search Terminal Help". The terminal output shows "AC0KQ bpq-config version 1.0.2". A dialog box is centered on the screen with a light green background and a black border. The dialog title is "BPQ Configuration" in red. The main text in the dialog is "bluetooth is enabled, which conflicts with BPQ." Below the text are two options: "<Disable>" in red and "<Abort>" in black.

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

**BPQ Configuration**

bluetooth is enabled, which conflicts with BPQ.

**<Disable>**                      <Abort>



# Quick Start

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

**BPQ Configuration**

This appears to be a fresh install of BPQ.

If you are new to BPQ we recommend that you do Quick Install which will download BPQ, build an initial configuration and start BPQ.

You can then run bpq-config again to modify this configuration.

**<Quick Install>**                      <Expert Install>

# Fill the required fields

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

**Quick Start Configuration**

Set Parameter

Node Callsign	K0NTS
Owner Acronym	CTN
Owner Name	Colorado Traffic Net
Grid Square	DM79gr
Frequency	145050
Username	willem
Password	XyZ123

<Set> **<Finish>**

# Write Configuration

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

bpq-config save

```
Wrote bpq32.cfg
Wrote linmail.cfg
Wrote BPQBBSUsers.dat
Wrote /lib/systemd/system/bpq.service
Wrote /etc/minicom/minirc.bpq
Wrote minicombpq
Wrote /usr/local/bin/bterm
```

<ok>

# Start BPQ

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

**Quick Start**

BPQ started.

Connect to it with a web browser as  
  http://192.168.11.113 :8008/  
or  
  telnet 192.168.11.113 8010

If that works enable it to start on boot.

**<Continue>**                      <Abort Quick Start>

# Options after Startig BPQ

```
pi@bpqpi: ~/BPQ
File Edit View Search Terminal Help
AC0KQ bpq-config version 1.0.2
```

**Installation Steps**

Select next step

- 1 Download BPQ
- 2 Configure BPQ**
- 3 Restart BPQ
- 4 Stop BPQ
- 5 Disable BPQ start at boot
- 6 About bpq-config

<Select>      **<Finish>**

# Browse to BPQ node port 8008

(if you configured a different port, use it instead)



# BPQ Ports

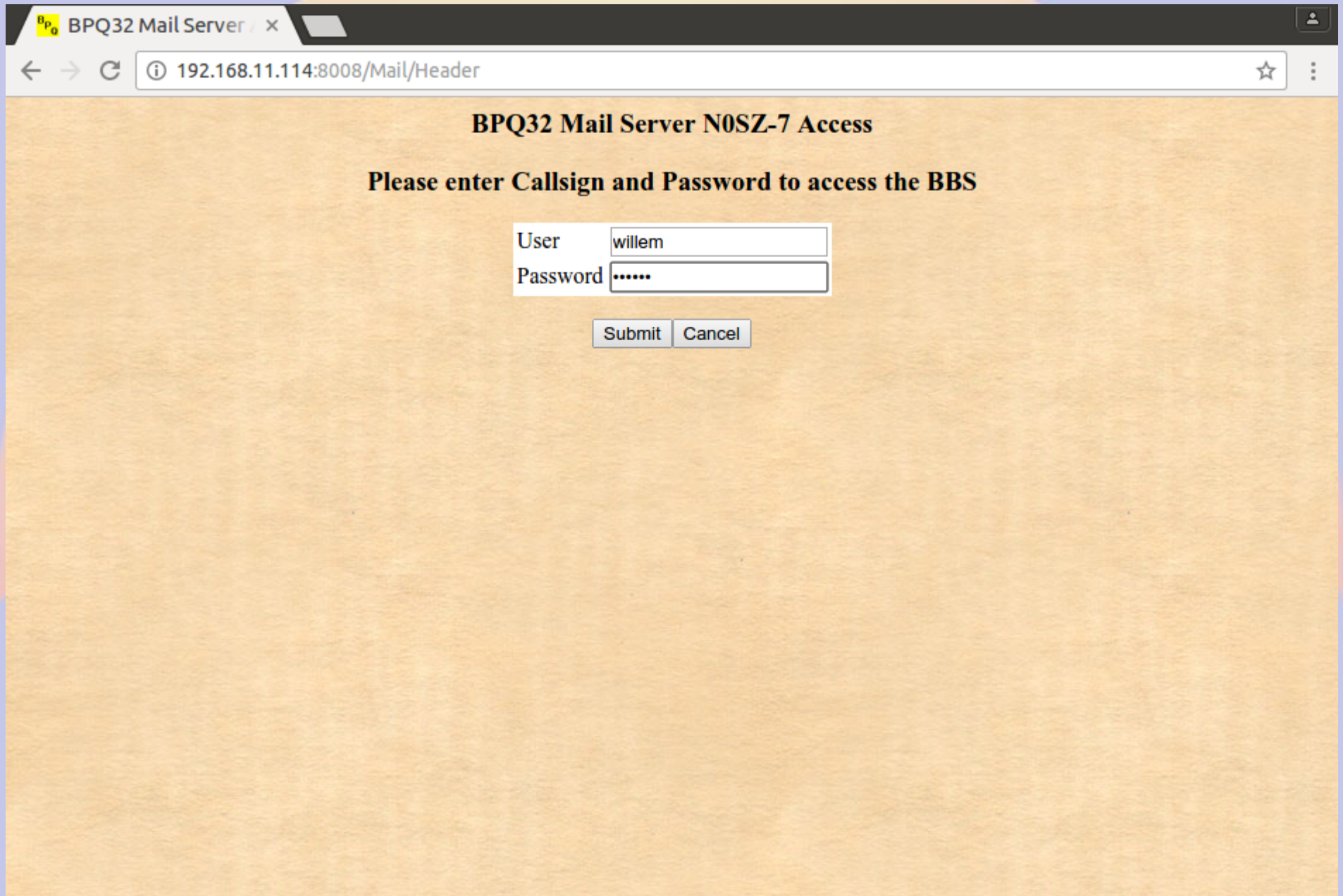
BPQ32 Node N0SZ-7

[Routes](#) [Nodes](#) [Ports](#) [Links](#) [Users](#) [Stats](#) [Terminal](#) [Driver Windows](#) [Stream Status](#) [Mail Server Pages](#) [SYSOP Signin](#) [Edit Config](#)

## Ports

Port	Driver	ID	Beacons
1	<a href="#">ASYNC</a>	145.050 MHz 1200 bps	<a href="#">Beacons</a>
2	TELNET	Telnet Server	
3	<a href="#">BPQAXIP</a>	AX/IP/UDP	<a href="#">Beacons</a>

# Click *Mail Server Pages*



BPQ32 Mail Server / x

192.168.11.114:8008/Mail/Header

**BPQ32 Mail Server N0SZ-7 Access**

**Please enter Callsign and Password to access the BBS**

User

Password



# BBS Configuration

(bpq-config set most of these in linmail.cfg)

bpq Main Configuration x

192.168.11.114:8008/Mail/Conf?M000077442E50

## BPQ32 BBS N0SZ

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

### Main Configuration

#### BBS Params

BBS Call  SYSOP Call

H Route   Redirect msgs to BBS Call to SYSOP Call

BBS APPL No  Streams

Send System Msgs to SYSOP Call  
 Refuse Bulls  
 Enable FBB UI System  
Send Mail For Beacons every  Minutes

Don't Hold Messages From New Users  
 Don't Request Name  
 Don't Request Home BBS  
 Allow users to kill T messages  
 Forward Messages to BBS Call

POP3 Port  SMTP Port  NTPPort   Enable Remote Access  
AMPR Address   Send AMPR Mail to AMPR host

#### TSP Params

# BBS Users

(bpq-config added RMS and telnet users)

**BPQ32 BBS N0SZ**

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

[AC0KQ](#)  
[N0SZ](#)  
[RMS](#)  
[W0VG](#)

### Update User AC0KQ

<input type="checkbox"/> BBS	<input type="checkbox"/> Permit Email
<input type="checkbox"/> PMS	<input type="checkbox"/> RMS Express User
<input checked="" type="checkbox"/> SYSOP	<input type="checkbox"/> Poll RMS
<input type="checkbox"/> Expert	For SSID's <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<input type="checkbox"/> Excluded	<input type="checkbox"/> Hold Messages
<input type="checkbox"/> Include SYSOP msgs in LM	<input type="checkbox"/> Don't add @winlink.org
<input checked="" type="checkbox"/> Allow Sending Bulls	<input type="checkbox"/> NTS MPS

Connects In 0      Msgs in 0      Rejects In 0  
Connects Out 0      Msgs Out 0      Rejects Out 0  
Bytes In 0      Last Connect 01-Jan 00:00Z  
Bytes Out 0      Last Listed 0

Name   
Password  CMS Pass   
QTH  ZIP   
Home BBS

# User RMS is WinLink2000

BPQ Edit Users x

192.168.11.114:8008/Mail/Users?M000077442E50

**BPQ32 BBS N0SZ**

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

[AC0KQ](#)  
[N0SZ](#)  
[RMS](#)  
[W0VG](#)

### Update User RMS

BBS

PMS

SYSOP

Expert

Excluded

Include SYSOP msgs in LM

Allow Sending Bulls

Permit Email

RMS Express User

Poll RMS

For SSID's

Hold Messages

Don't add @winlink.org

NTS MPS

Connects In 0      Msgs in 0      Rejects In 0  
Connects Out 0      Msgs Out 0      Rejects Out 0  
Bytes In 0      Last Connect 01-Jan 00:00Z  
Bytes Out 0      Last Listed 0

Name

Password  CMS Pass

QTH  ZIP

Home BBS

# Forwarding to Winlink is Enabled

BPQ32 BBS N0SZ

[Status](#) [Configuration](#) [Users](#) [Messages](#) **Forwarding** [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

Max size to Send: 100000  
Max Size to Receive: 100000  
Max age for Bulls: 60  
Warn if no route for P or T:   
Use Local Time:   
Aliases:   
Update

[N0SZ](#)  
[RMS](#)

### Forwarding Config for RMS - 0 Messages Queued

TO	AT	TIMES	Connect Script
RMS			RMS

Hierarchical Routes (Flood Bulls) HR (Personals and Directed Bulls)

BBS HA:

Enable Forwarding  Interval: 3600 (Secs)  
Request Reverse  Interval: 3600 (Secs)  
Send new messages without waiting for poll timer   
FBB Max Block: 10000 Send Personal Mail Only   
Allow Binary  Use B1 Protocol  Use B2 Protocol   
Send ctrl/Z instead of /ex in text mode forwarding

Update Start Forwarding

# Connect out via RF

```
willem@bashful: ~  
File Edit View Search Terminal Help  
willem@bashful:~$ telnet 192.168.11.114 8010  
Trying 192.168.11.114...  
Connected to 192.168.11.114.  
Escape character is '^]'.  
user:chris  
password:  
  
AID2 BPQ32 Telnet Server  
Enter ? for list of commands  
  
c 1 K0NTS-1  
N0SZ} Connected to K0NTS-1  
[BPQ-6.0.12.35-IHJM$]  
Hello KD0ZYF. Latest Message is 2506, Last listed is 2506  
CTN BBS>  
b  
73 de CTN BBS  
*** Disconnected from Stream 1  
Connection closed by foreign host.  
willem@bashful:~$
```

# Connect in via RF (as AC0KQ)

```
willem@bashful: ~  
File Edit View Search Terminal Help  
  
cmd c N0SZ  
cmd:*** CONNECTED to N0SZ  
Welcome to the Aid Station 2 BPQ32 Node.  
N0SZ> BBS CONNECT BYE INFO NODES ROUTES PORTS USERS MHEARD  
info  
N0SZ} This is the BPQ32 Node for the Aid Station 2.  
Sysop KD0ZYF.  
Traffic left on this node will be forwarded  
using the National Traffic System.  
Type BBS to connect to the BBS.  
ports  
N0SZ} Ports  
 1 145.030 MHz 1200 bps  
 2 Telnet Server  
 3 AX/IP/UDP  
bbs  
N0SZ} Connected to BBS  
[BPQ-6.0.12.35-IHJM$]  
Hello AC0KQ. Latest Message is 2, Last listed is 2  
de N0SZ>  
b  
*** DISCONNECTED  
cmd: 
```

# Connect via RF to WinLink

```
willem@bashful: ~  
File Edit View Search Terminal Help  
cmd: c N0SZ-10  
cmd: *** CONNECTED to N0SZ-10  
Trying brentwood.winlink.org  
*** AC0KQ Connected to CMS  
[WL2K-3.2-B2FWIHJM$]  
;PQ: 72781840  
Brentwood CMS via N0SZ >  
lm  
Login [246]:  
Brentwood CMS via N0SZ >  
CR 067MRW  
Hello AC0KQ  
Brentwood CMS via N0SZ >  
lm  
2884_K0TER 2016/05/07 01:27 676 K0TER@winlink.org QTC 2  
3KYUXDSAP727 2016/05/02 15:51 889 K6HTN@winlink.org Re: QTC 1 K6HTN  
2882_K0TER 2016/05/04 16:40 1180 K0TER@winlink.org QTC 4  
6AQ9DQG3C59D 2016/05/04 18:30 1295 WA3QLW@winlink.org QTC 8  
2883_K0TER 2016/05/05 18:35 2281 K0TER@winlink.org QTC 7  
2868_K0TER 2016/05/03 17:26 2803 K0TER@winlink.org QTC 9  
2886_K0TER 2016/05/07 21:52 3103 K0TER@winlink.org QTC 10  
Brentwood CMS via N0SZ >  
b  
Disconnecting...  
*** DISCONNECTED  
cmd: 
```

# BBS Messages

Chromium Edit Messages - Chromium

Edit Messages

ctnpi:8080/Mail/Msgs?M000039592D06

## BPQ32 BBS K0NTS

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

**Filter**

From

To

Via

- [2504](#)
- [2503](#)
- [2498](#)
- [2497](#)
- [2494](#)
- [2493](#)
- [2492](#)
- [2491](#)
- [2486](#)
- [2485](#)
- [2483](#)
- [2482](#)
- [2481](#)

### Message 2555

From  Sent  Type

To  Received  Status

BID  Last Changed  Size

VIA

Title

Green = Sent, Yellow = Queued

K0NTS	RMS						
-------	-----	--	--	--	--	--	--



# General BBS Users

Chromium Edit Users - Chromium

ctnpi:8080/Mail/Users?M000039592D06

## BPQ32 BBS K0NTS

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[KB5YZB](#)  
[KC0JPO](#)  
[KC0ONP](#)  
[KC0WDN](#)  
[KC4YLV](#)  
[KD0CIM](#)  
[KD0CRX](#)  
[KD0DPX](#)  
[KD0FDS](#)  
[KD0GBX](#)  
[KD0KVJ](#)  
[KD0MSP](#)  
[KD0RML](#)  
[KD0RNF](#)  
[KD0RPH](#)  
[KD0SOO](#)  
[KD0SQA](#)  
[KD0WHB](#)  
[KD0WZK](#)  
[KD0YGO](#)  
[KD0ZYF](#)  
[KD8BQN](#)  
[KE0CRD](#)

### Update User KD0ZYF

<input type="checkbox"/> BBS	<input type="checkbox"/> Permit Email
<input type="checkbox"/> PMS	<input type="checkbox"/> RMS Express User
<input type="checkbox"/> SYSOP	<input type="checkbox"/> Poll RMS
<input type="checkbox"/> Expert	For SSID's <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<input type="checkbox"/> Excluded	<input type="checkbox"/> Hold Messages
<input type="checkbox"/> Include SYSOP msgs in LM	<input type="checkbox"/> Don't add @winlink.org
<input checked="" type="checkbox"/> Allow Sending Bulls	<input type="checkbox"/> NTS MPS

Connects In 6      Msgs in 0      Rejects In 0  
Connects Out 0      Msgs Out 0      Rejects Out 0  
Bytes In 0      Last Connect 08-May 20:12Z  
Bytes Out 0      Last Listed 2507

Name   
Password  CMS Pass   
QTH  ZIP   
Home BBS

# WinLink User Download

Edit Users - Chromium

Edit Users

ctnpi:8080/Mail/Users?M000039592D06

BPQ32 BBS K0NTS

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

[AA0QC](#)  
[AC0KQ](#)  
[AC0TG](#)  
[AC0VC](#)  
[AC9D](#)  
[AD0RX](#)  
[AI8Z](#)  
[K0KAI](#)  
[K0LAI](#)  
[K0MEL](#)  
[K0NTS](#)  
[K0SCH](#)  
[K0XK](#)  
[K6DHN](#)  
[K6XCQ](#)  
[KA0BSA](#)  
[KB0BSA](#)  
[KB1SGJ](#)  
[KB5YZB](#)  
[KC0JPO](#)  
[KC0ONP](#)  
[KC0WDN](#)  
[KC4YLV](#)  
[K000M](#)

### Update User AC0KQ

BBS  Permit Email  
 PMS  RMS Express User  
 SYSOP  Poll RMS  
 Expert For SSID's      
 Excluded  Hold Messages  
 Include SYSOP msgs in LM  Don't add @winlink.org  
 Allow Sending Bulls  NTS MPS

Connects In 9      Msgs in 42      Rejects In 0  
Connects Out 0      Msgs Out 1      Rejects Out 0  
Bytes In 10416      Last Connect 08-May 21:39Z  
Bytes Out 533      Last Listed 2514

Name   
Password   
QTH  ZIP   
Home BBS

# Forwarding BBS

Edit Users - Chromium

Edit Users

192.168.11.114:8080/Mail/Users?M0000399D835D

BPQ32 BBS N0SZ

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[AC0KO](#)  
[KB1SGJ](#)  
[KB5YZB](#)  
[KD0ZYF](#)  
[N0SZ](#)  
[RMS](#)

### Update User KB1SGJ

BBS  Permit Email  
 PMS  RMS Express User  
 SYSOP  Poll RMS  
 Expert For SSID's      
 Excluded  Hold Messages  
 Include SYSOP msgs in LM  Don't add @winlink.org  
 Allow Sending Bulls  NTS MPS

Connects In 0      Msgs in      0      Rejects In 0  
Connects Out 0      Msgs Out      0      Rejects Out 0  
Bytes In      0      Last Connect 01-Jan 00:00Z  
Bytes Out      0      Last Listed 0

Name   
Password  CMS Pass   
QTH  ZIP   
Home BBS

# Forwarded Users

Edit Forwarding - Chromium

Edit Forwarding

192.168.11.114:8080/Mail/FWD?M0000399D835D

BPQ32 BBS N0SZ

[Status](#) [Configuration](#) [Users](#) [Messages](#) [Forwarding](#) [Welcome Msgs & Prompts](#) [Housekeeping](#) [WP Update](#) [Node Menu](#)

Max size to Send  [KB1SGJ](#)

Max Size to Receive  [N0SZ](#)

Max age for Bulls  [RMS](#)

Warn if no route for P or T

Use Local Time

Aliases

Forwarding Config for KB1SGJ - 0 Messages Queued

TO	AT	TIMES	Connect Script
<input type="text" value="KB1SGJ&lt;br/&gt;KD0LDR"/>	<input type="text"/>	<input type="text" value="0000-1000"/>	<input type="text" value="C 1 KB1SGJ-1"/>

Hierarchical Routes (Flood Bulls) HR (Personals and Directed Bulls)

RBS HA

Enable Forwarding  Interval  (Secs)

Request Reverse  Interval  (Secs)

Send new messages without waiting for poll timer

FBB Max Block  Send Personal Mail Only

Allow Binary  Use B1 Protocol  Use B2 Protocol

Send ctrl/Z instead of /ex in text mode forwarding

# RF > N0SZ & AXIP > K0NTS-1

```
willem@bashful: ~  
File Edit View Search Terminal Help  
  
cmd:c N0SZ  
cmd:*** CONNECTED to N0SZ  
Welcome to the Aid Station 2 BPQ32 Node.  
N0SZ> BBS CONNECT BYE INFO NODES ROUTES PORTS USERS MHEARD  
ports  
N0SZ} Ports  
 1 145.030 MHz 1200 bps  
 2 Telnet Server  
 3 AX/IP/UDP  
c 3 K0NTS-1  
N0SZ} Connected to K0NTS-1  
[BPQ-6.0.12.35-IHJM$]  
CTN BBS>  
l  
No New Messages  
CTN BBS>  
b  
73 de CTN BBS  
*** DISCONNECTED  
cmd:  
cmd:  
cmd:  
cmd:
```

# Manual Configuration Steps

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

## Configuration Steps

Select next step

**1 Node Configuration**

2 Port configuration

3 Telnet users

4 AXIP Node Maps

5 Write Configuration

<Select>

<Finish>

# Node Configuration

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Node Configuration

Set Parameter

Node Callsign	N0SZ
Owner Acronym	RMH
Owner Name	Rocky Mountain Ham Radio
Grid Square	DM79hm
Telnet Port	8010
FBB Port	8011
HTTP Port	8008
AXIP Port	10093
AXIP AutoAdd	Yes
WinLink RMS	Yes

<Set> **<Finish>**

# Port Configuration

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Set Parameter		Configure port
	<b>Type</b>	
	Device Type	
	Device Number	
	Frequency	
	Digipeat	Yes
	Power	
	Height	
	Gain	
<Set>		<Finish>



# Port Type

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

		Type
of port		
<input checked="" type="checkbox"/>	Packet	
<input type="checkbox"/>	APRS	
<input type="checkbox"/>	APRS rx only	
<b>&lt;Select&gt;</b>		<Cancel>

# Device Type

(Devices description is board specific)

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

## Device Type

There is only one serial port numbered 0  
For multiple devices the I2C bus must be used  
I2C bus addresses are in decimal

- Serial
- I2C

<Select>

<Cancel>

# Device Number

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Device Number

Enter Device Number

There is only one serial port numbered 0

For multiple devices the I2C bus must be used

I2C bus addresses are in decimal

0

<Ok>

<Cancel>

# User Configuration

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Configure user	
Set Parameter	
Username	willem
Password	abc123
Callsign	AC0KQ
Application	NODE
SysOp	Yes
<Set>	<Finish>

# AXIP Map

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Configure map	
Set Parameter	
Callsign	K0NTS-1
Address	ctnpi.ac0kq.rmham
Port	10093
<Set>	<Finish>

# Setting up an iGate

- **This iGate setup is on a BeagleBone Black**
  - The only difference with an rPi is the serial port names in the Port section
- **The Node setup is the same as what was done previously**
  - Some but not all the parameters are relevant
- **Ports are mapped as Packet or APRS in port configuration**
  - You can have both Packet and APRS ports on the same BPQ node

# Enable iGate and set SSID, Symset, Symbol, Lat/Long

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Node Configuration

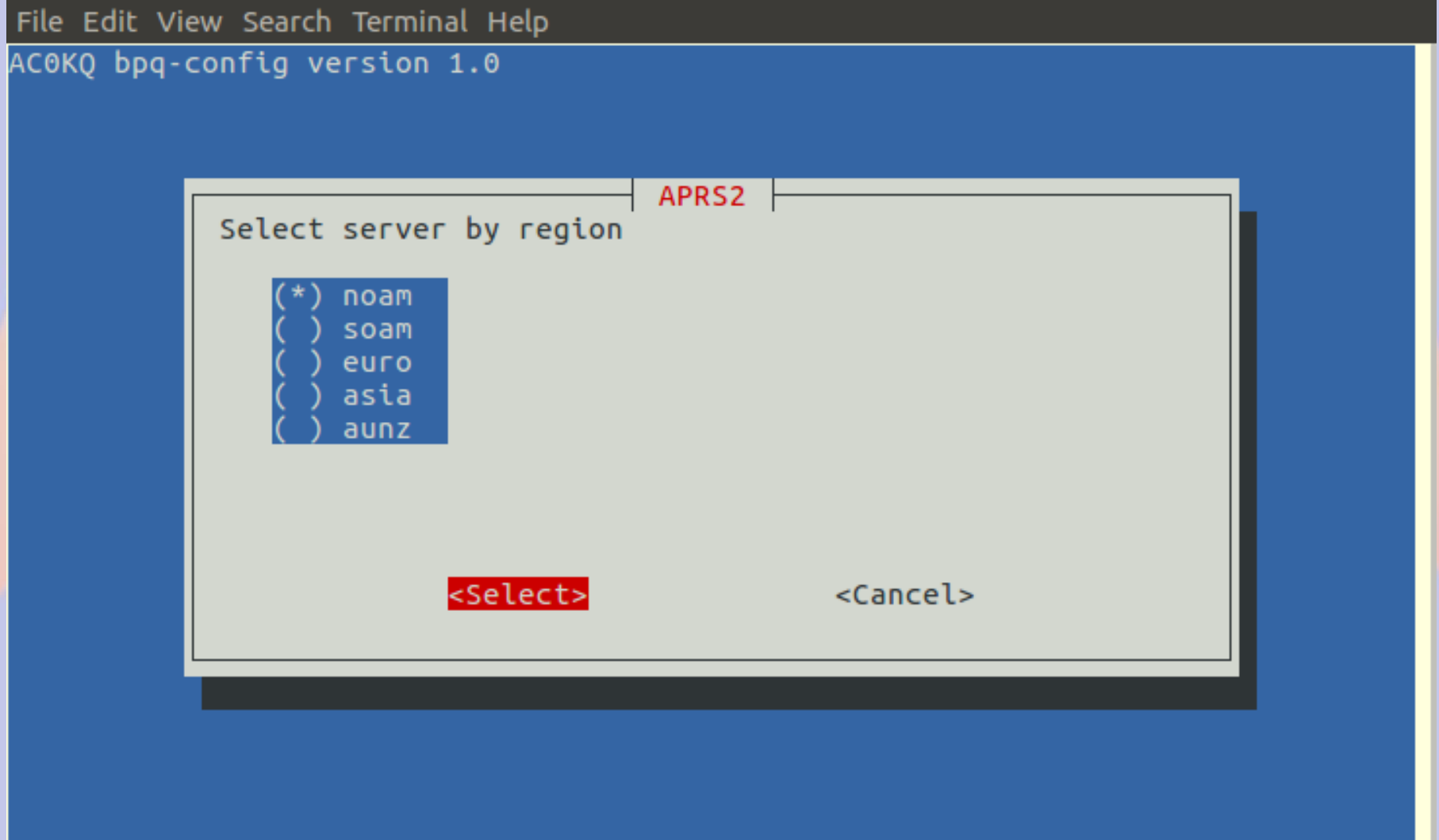
Set Parameter

WinLink RMS	No
Chat Server	No
APRS iGate	Yes
APRS SSID	14
APRS Symset	B
APRS Symbol	a
Status Message	RMHAM iGate Conifer
Latitude	3931.04N
Longitude	10521.00W
<b>APRS2</b>	

<Set> <Finish>

# Select APRS2 Gateway

(bpq-config generates password automatically)





# iGate Add Port Configuration

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Set Parameter		Configure port
		Type
		Device Type
		Device Number
		Frequency
		Digipeat            Yes
		Power
		Height
		Gain
<Set>		<Finish>

# Set Port Type to APRS

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

	Type
of port	
<input type="checkbox"/> Packet	
<input checked="" type="checkbox"/> APRS	
<input type="checkbox"/> APRS rx only	
<input type="button" value="Select"/>	<input type="button" value="Cancel"/>

# Set Serial Port

(Note that this is a Beaglebone so 4 ports)

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Device Type

Serial ports are numbered 1, 2, 4 or 5

Serial  
 I2C

<Select>

<Cancel>

# Select Serial Port Number

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Configure port	
Set Parameter	
Type	APRS
Device Type	Serial
<b>Device Number</b>	
Frequency	
Digipeat	Yes
Power	
Height	
Gain	
<Set>	<Finish>

# Select Serial Port Number

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Device Number

Enter Device Number

Serial ports are numbered 1, 2, 4 or 5

1

<Ok>

<Cancel>

# APRS Frequency 1

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Configure port	
Set Parameter	
Type	APRS
Device Type	Serial
Device Number	1
Frequency	
Digipeat	Yes
Power	
Height	
Gain	
<Set>	<Finish>

# APRS Frequency 2

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Frequency
Enter Frequency kHz e.g. 145050
<input type="text" value="144390"/>
<input type="button" value="&lt;Ok&gt;"/> <input type="button" value="&lt;Cancel&gt;"/>

# Node Page Update

N0SZ's BPQ32 Web Server - Chromium

N0SZ's BPQ32 Web S x

192.168.11.114:8080/Node/CFGSave?N0000BF0D8620

## BPQ32 Node N0SZ

[Routes](#) [Nodes](#) [Ports](#) [Links](#) [Users](#) [Stats](#) [Terminal](#) [Driver Windows](#) [Stream Status](#) [APRS Pages](#) [Mail Server Pages](#) [SYSOP Signin](#) [Edit Config](#)



# APRS Main Page

**N0SZ-14's BPQ32 APRS Web Server**

## All Stations

(This page will automatically refresh every five minutes)

The following is a list of all the stations heard in the past 120 minutes, both on RF and on the internet.

There are 21 callsigns in the list, click a callsign to get an information page for that station.

<a href="#">AC0VP-10</a>	<a href="#">BVILLE</a>	<a href="#">KB0USE</a>	<a href="#">KC0D</a>	<a href="#">KC0D-6</a>	<a href="#">KC0WUV</a>	<a href="#">KD0SQA-4</a>	<a href="#">N0EB</a>
<a href="#">N0LNE</a>	<a href="#">N0SZ-14</a>	<a href="#">N0SZ-2</a>	<a href="#">N0WGM-3</a>	<a href="#">N1GEP-1</a>	<a href="#">N7GN-5</a>	<a href="#">W0JAW</a>	<a href="#">W0JRL-15</a>
<a href="#">WA0GEH</a>	<a href="#">WB5PJB-B</a>	<a href="#">WD4IXD</a>	<a href="#">WD4IXD-10</a>	<a href="#">WQ8M-9</a>			

# APRS RF Stations

N0SZ-14's BPQ32 Web Server - Chromium

N0SZ-14's BPQ32 W x

192.168.11.114:8080/aprs/allrf.html

[Home](#)  
[All Stations](#)  
[RF Stations](#)  
[All WX Stations](#)  
[RF WX Stations](#)  
[All Mobile Stations](#)  
[RF Mobile Stations](#)  
[All Objects](#)  
[RF Objects](#)  
[Information](#)  
[Node Pages](#)

## N0SZ-14's BPQ32 APRS Web Server

### RF Stations

(This page will automatically refresh every five minutes)

The following is a list of all the stations heard on RF in the past 120 minutes.

'\*' after a callsign means that it was heard via a digi

The list only includes callsigns heard on RF, direct or via digipeaters. It does not include callsigns heard on the internet, or heard as third-party RF traffic via IGATEs.

There are 8 callsigns in the list, click a callsign to get an information page for that station.

Callsign	Symbol	Location	Miles	Bearing	Last heard
<a href="#">KC0D</a>	No. Digi	39°22.20'N 104°40.76'W	37.2	106	02:17:57
<a href="#">KC0D-6*</a>	WX Station	39°18.13'N 104°41.32'W	38.3	113	02:20:18
<a href="#">KD0SQA-4*</a>	Digi	39°40.14'N 104°55.46'W	25.0	65	02:16:58
<a href="#">N0EB</a>	XAPRS	39°53.56'N 104°58.15'W	32.9	38	02:21:22
<a href="#">N0SZ-2*</a>	Car	40°07.90'N 104°55.73'W	47.9	28	02:19:20
<a href="#">N0WGM-3*</a>	WX Station	40°48.92'N 104°47.64'W	94.3	18	02:20:59
<a href="#">N1GEP-1*</a>	Rover	39°40.36'N 104°45.90'W	32.9	71	02:18:02
<a href="#">N7GN-5*</a>	WX Station	40°32.73'N 105°05.53'W	72.3	11	02:19:50

# APRS Station Map

N0SZ-14's BPQ32 Web Server - Chromium

N0SZ-14's BPQ32 Web Server

192.168.11.114:8080/aprs/find.cgi?call=N0SZ-2

<a href="#">Home</a>
<a href="#">All Stations</a>
<a href="#">RF Stations</a>
<a href="#">All WX Stations</a>
<a href="#">RF WX Stations</a>
<a href="#">All Mobile Stations</a>
<a href="#">RF Mobile Stations</a>
<a href="#">All Objects</a>
<a href="#">RF Objects</a>
<a href="#">Information</a>
<a href="#">Node Pages</a>

## N0SZ-14's BPQ32 APRS Web Server


(This page will automatically refresh every five minutes)

### Information about [N0SZ-2](#)

Click the callsign to look it up on qrz.com  
Location: 40°07.90'N 104°55.73'W  
The bearing from N0SZ-14 to N0SZ-2 is 028 degrees, the distance is 47.9 Miles

Last posit: TPPWYP,W0UPS-5,WIDE1,KC0D,WIDE2\*

Status:  
Last heard 00:05:11 ago



The map displays a region in Colorado, centered around Longmont. A red car icon representing station N0SZ-2 is located east of Longmont, near the intersection of I-25 and I-76. Major roads shown include I-25, I-76, I-70, I-78, I-85, I-87, I-90, I-94, I-170, I-176, I-225, I-270, I-275, I-276, I-277, I-278, I-279, I-280, I-281, I-282, I-283, I-284, I-285, I-286, I-287, I-288, I-289, I-290, I-291, I-292, I-293, I-294, I-295, I-296, I-297, I-298, I-299, I-300, I-301, I-302, I-303, I-304, I-305, I-306, I-307, I-308, I-309, I-310, I-311, I-312, I-313, I-314, I-315, I-316, I-317, I-318, I-319, I-320, I-321, I-322, I-323, I-324, I-325, I-326, I-327, I-328, I-329, I-330, I-331, I-332, I-333, I-334, I-335, I-336, I-337, I-338, I-339, I-340, I-341, I-342, I-343, I-344, I-345, I-346, I-347, I-348, I-349, I-350, I-351, I-352, I-353, I-354, I-355, I-356, I-357, I-358, I-359, I-360, I-361, I-362, I-363, I-364, I-365, I-366, I-367, I-368, I-369, I-370, I-371, I-372, I-373, I-374, I-375, I-376, I-377, I-378, I-379, I-380, I-381, I-382, I-383, I-384, I-385, I-386, I-387, I-388, I-389, I-390, I-391, I-392, I-393, I-394, I-395, I-396, I-397, I-398, I-399, I-400, I-401, I-402, 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I-975, I-976, I-977, I-978, I-979, I-980, I-981, I-982, I-983, I-984, I-985, I-986, I-987, I-988, I-989, I-990, I-991, I-992, I-993, I-994, I-995, I-996, I-997, I-998, I-999, I-1000.

# Report on aprs.fi

The screenshot shows the aprs.fi website interface in a Chromium browser. The main map displays a location in Ontario, Canada, with a popup for call sign **NOSZ-14**. The popup contains the following information:

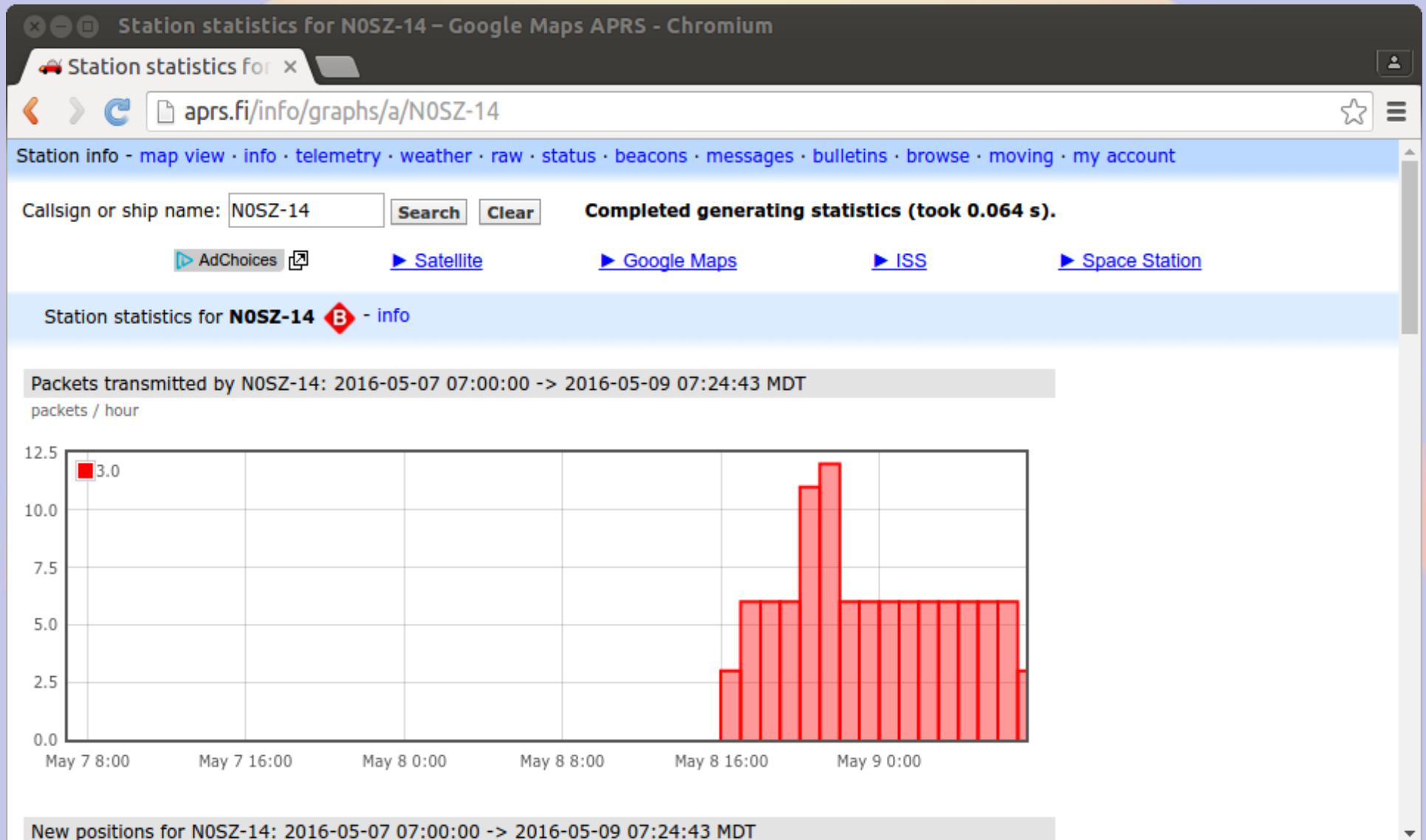
- NOSZ-14** · center · zoom · info
- 2015-09-26 16:16:56 - 2016-05-09 06:53:22
- BPQ32 Igate V 6.0.12.35*
- RMHAM iGate*
- [APBPQ1 via TCPIP\*,qAC,T2ONTARIO]
- being tracked · stop tracking · track in Street View

The right sidebar contains the following elements:

- aprs.fi · Login**
- Free Travel Maps** (Get Maps, Directions & Traffic Conditions With OnlineMapFinder!)
- Track callsign: Clear (with a search input field)
- Address, city or Locator: Clear (with a search input field)
- Show last: 1 hour (with a dropdown menu and Show all button)
- Track tail length: 1 hour (with a dropdown menu)
- NOSZ-14** (with a red diamond icon and a menu icon)
- Updated: 2016-05-09 06:53:22 (29m)
- Position: 39°31.04' N 105°21.00' W
- Year selection: 2014, 2015, 2016 (with a calendar icon and navigation arrows)
- Other SSIDs:** NOSZ (with a red diamond icon), NOSZ-10 (with a red diamond icon), NOSZ-12 (with a green diamond icon), NOSZ-15 (with a red diamond icon), NOSZ-2 (with a red diamond icon and a car icon), NOSZ-3 (with a car icon), NOSZ-4 (with a red diamond icon and a car icon), NOSZ-7 (with a red diamond icon and a car icon), BBS (with a red diamond icon)
- Wx: 43°F 84% 1003 mbar 0.2 MPH N

The bottom of the page shows the Google logo, map data copyright (©2016 Google), a 2 km scale bar, and links for Terms of Use and Report a map error.

# Data graph on aprs.fi



# BPQ Port 1

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

**Port Configuration**  
Select port to

- 1 Add port
- 2 Delete port
- 3 Port 1**
- 4 Port 2

<Select>    <Finish>

# Port 1 is for BBS/RMS

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Configure port

Set Parameter

Type	Packet
Device Type	Serial
Device Number	1
Frequency	145050
Digipeat	Yes
Power	40
Height	50
Gain	6

<Set>                      <Finish>

# BPQ Port 2

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

**Port Configuration**  
Select port to

- 1 Add port
- 2 Delete port
- 3 Port 1
- 4 Port 2**

<Select>    <Finish>



# Port 2 is for APRS

File Edit View Search Terminal Help

AC0KQ bpq-config version 1.0

Configure port

Set Parameter

Type	APRS
Device Type	Serial
Device Number	2
Frequency	144390
Digipeat	Yes
Power	50
Height	50
Gain	6

<Set>                      <Finish>

# BPQ Ports Page

N0SZ-7's BPQ32 We x

192.168.11.88:8008/Node/Ports.html

## BPQ32 Node N0SZ-7

[Routes](#) [Nodes](#) [Ports](#) [Links](#) [Users](#) [Stats](#) [Terminal](#) [Driver Windows](#) [Stream Status](#) [APRS Pages](#) [Mail Server Pages](#) [SYSOP Signin](#) [Edit Config](#)

### Ports

Port	Driver	ID	Beacons
1	<a href="#">ASYNC</a>	145.050 MHz 1200 bps	<a href="#">Beacons</a>
2	<a href="#">ASYNC</a>	144.390 MHz 1200 bps	<a href="#">Beacons</a>
3	TELNET	Telnet Server	
4	<a href="#">BPQAXIP</a>	AX/IP/UDP	<a href="#">Beacons</a>

# About bpq-config

- ***bpq-config*** is designed to get you started
  - It covers most installations, but not all
- It keeps its on configuration file **`.bpqconfig`**
  - Easier to parse
  - Hand edits are lost when using bpq-config
  - Version 1.1 *may* parse `bpq32.cfg` instead
- This is new software
  - Bug reports and improvements are welcome
  - Patches are even more welcome



# **Part 3**

# **AllStarLink Repeater**

# What is AllStarLink?

- Asterisk VOIP software for radio
- Interfaces with radio via URlx
  - CM119 USB audio chip
  - DB25 connector
- Can roll your own with equivalent fob

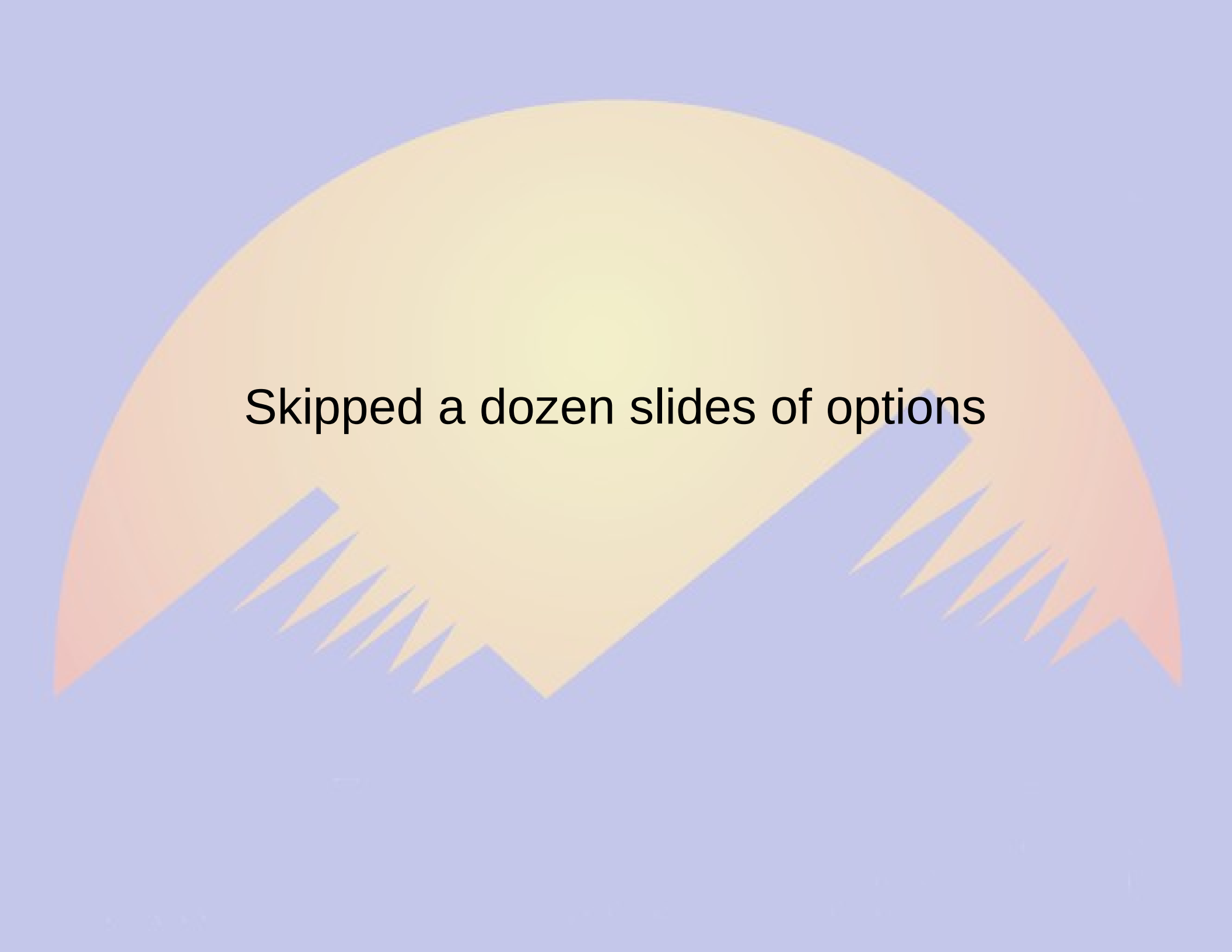


# Installing AllStarLink

- **Download from [www.hamviop.com](http://www.hamviop.com)**
  - Burn image to SD card
- **Program your radio/repeater**
  - Set radio to encode/decode CTCSS
  - On Motorola set accessories to output COS & PL on pin 8
- **Tune a receiver to to the radio frequency**
- **Power up rPi**
  - Allison will announce the IP address

# Initial Login (password is root)

```
willem@bashful: ~  
File Edit View Search Terminal Help  
willem@bashful:~$ ssh -p 222 root@192.168.100.237  
root@192.168.100.237's password:  
RPi2-3 Version 1.02beta Allstar - March 26, 2016 - WA3DSP, KB4FXC, W0AMN  
  
It appears that this is the first time this system  
has been booted. It would be prudent to change a few  
key settings now for the sake of security and convenience.  
Once this information is entered, the system will reboot  
and the next time the system boots, this message will not  
re-appear.  
  
Would you like to run first setup now ([y],n) ?   
*****  
Initial setup information  
  
Enter new UNIX password:   
Retype new UNIX password:   
passwd: password updated successfully  
Enter Node Number: 40552
```



Skipped a dozen slides of options



# Done

```
root@pi40552:~  
File Edit View Search Terminal Help  
-----  
(final info)  
  
After any simpleusb.conf changes you should do an Asterisk restart. This  
will restart and reload the Asterisk modules. These simpleusb changes will  
not take effect until Asterisk is restarted.  
  
If needed, please run "simpleusb-tune-menu" program at the Linux prompt to set  
your sound levels.  
-----  
Do you want to restart Asterisk to enable selections: ([y],n): ?  
Restarting Asterisk..  
Restarting Asterisk...  
[root@pi40552 ~]#
```

# Set Levels

```
root@pi40552:/etc/asterisk
File Edit View Search Terminal Help
[root@pi40552 asterisk]# simpleusb-tune-menu

active (command) USB Radio device is [usb]
1) Select USB device
2) Set Rx Voice Level (using display)
3) Set Transmit A Level
4) Set Transmit B Level
E) Toggle Echo Mode (currently Disabled)
F) Flash (Toggle PTT and Tone output several times)
P) Print Current Parameter Values
S) Swap Current USB device with another USB device
T) Toggle Transmit Test Tone/Keying (currently Disabled)
W) Write (Save) Current Parameter Values
0) Exit Menu

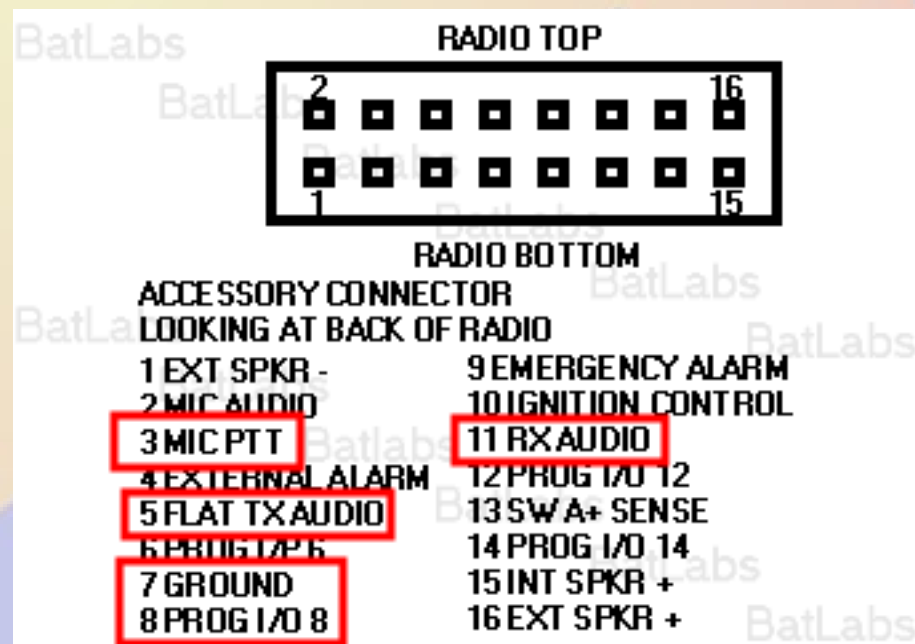
Please enter your selection now: 
```



# /etc/asterisk/simpleusb.conf

- Configuration for Motorola SM50

```
[usb]
eeprom=0
hdwtype=0
rxboost=1
carrierfrom=usb
ctcssfrom=usb
txmixa=voice
txmixb=no
invertptt=0
duplex=0
plfilter=yes
deemphasis=no
preemphasis=yes
rxaudiodelay=0
```



# Isnode

Allstar Connected Nodes and Status - Chromium

Allstar Connected N x

pi40552/cgi-bin/lnodes\_web?node=40552

## Status for AC0KQ - Node 40552

Last update - 05/11/2016 20:04:14 My IP - 66.109.219.132

[View this Node Graphically](#) [Search/Command another Node](#)

Selected system state	0
Signal on Input	NO
System	ENABLED
Parrot Mode	DISABLED
Scheduler	ENABLED
Tail Time	STANDARD
Time out timer	ENABLED
Incoming connections	ENABLED
Time out timer state	RESET
Time outs since system Initialization	0
Identifier state	CLEAN
Kerchunks today	7
Kerchunks since system Initialization	7
Keyups today	12
Keyups since system Initialization	12
DTMF commands today	1
DTMF commands since system Initialization	1
Last DTMF command executed	81
TX time today	00:00:44211
TX time since system Initialization	00:00:44211
Uptime	01:25:06
Nodes currently connected to us	
Autopatch	ENABLED
Autopatch state	DOWN
Autopatch called number	N/A
Reverse patch/IAXRPT connected	DOWN
User linking commands	ENABLED
User functions	ENABLED

Node	Call	Description	Location
40552	AC0KQ	446.200	portable

Node	Peer	Reconnects	Direction	Connect Time	Connect State
Host			Node	State	
67.215.233.178:4569			40552	Registered	

# Incoming Audio


PI40552 | Allmon | 40552 - Chromium

PI40552 | Allmon | 4 x

pi40552/allmon2/link.php?nodes=40552

## Allstar Monitor II

Monitoring the World One Node at a Time



About 40552 Logout

29571  Permanent


Connect Disconnect Monitor Local Monitor Control Panel

**Node 40552 - AC0KQ 446.200 portable** [Bubble Chart](#)

Node	Node Information	Received	Link	Direction	Connected	Mode
29571	AC0KQ 447.850- Evergreen, CO	000:00:15	ESTABLISHED	OUT	00:02:02	Transceive

\*

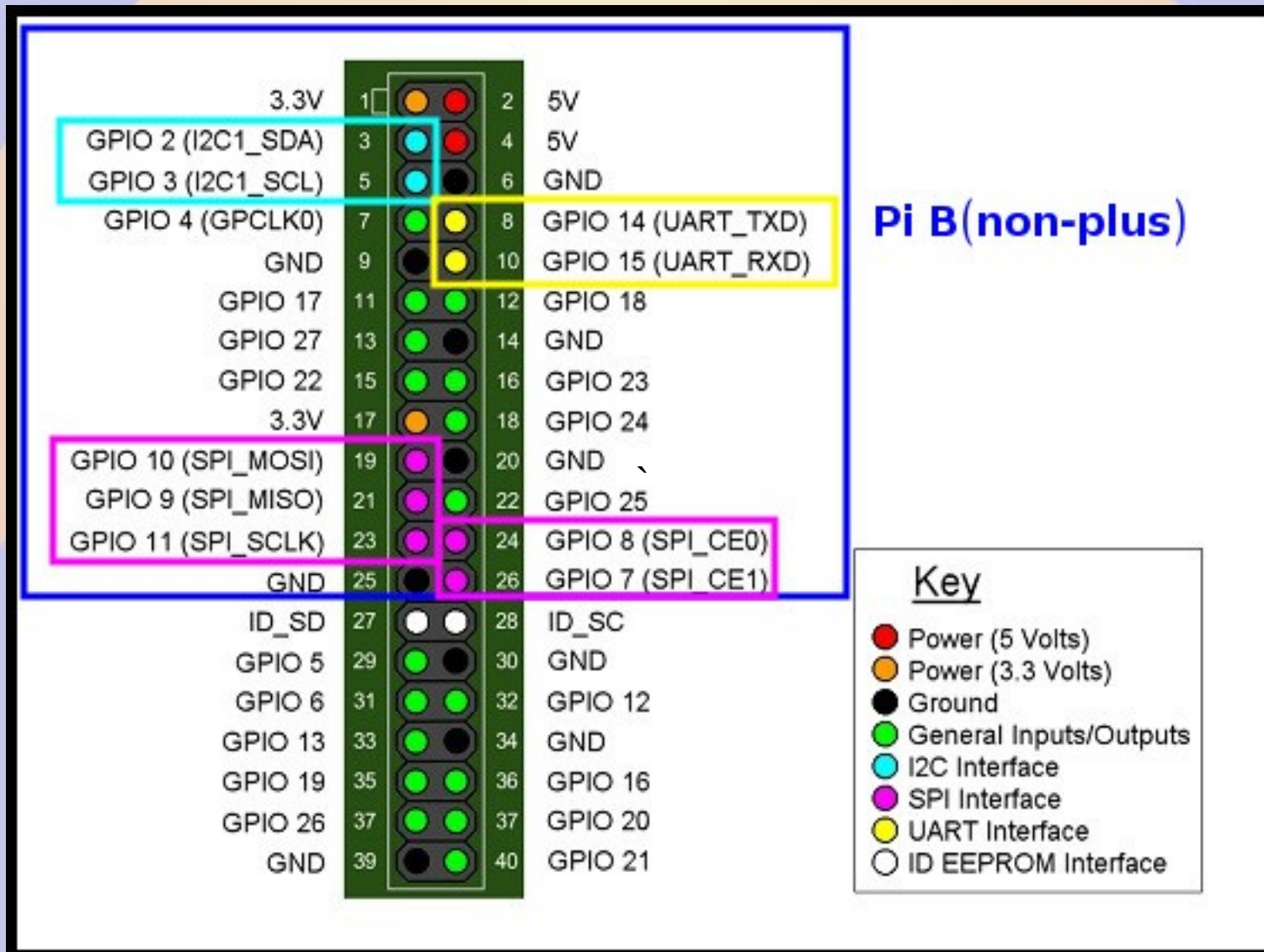
Site by WD6AWP. [There are some who call me... Tim?](#)

A stylized illustration of a sun rising over a range of mountains. The sun is a large, semi-circular shape with a gradient from yellow to orange, positioned in the upper half of the frame. Below it, a range of blue mountains is visible, with the sun's rays appearing to illuminate the peaks. The background is a solid light blue color.

# **Part 4**

# **Control and Monitoring**

# Raspberry Pi Header





# Pins are multiplexed

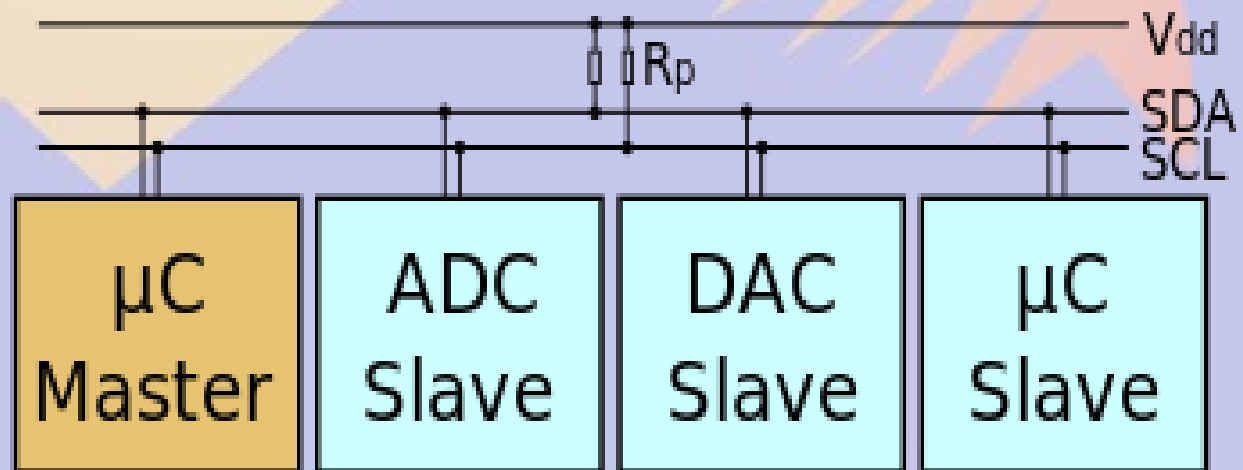
- Pins configured for different uses
- GPIO 14&15  $\Leftrightarrow$  UART TxD/RxD
- GPIO 2&3  $\Leftrightarrow$  I<sup>2</sup>C SDA&SCL
- GPIO 7&8&9&10&11  $\Leftrightarrow$   
SPI MOSI&MISO&SCL&CE0&CE1
- GPIO 18&19  $\Leftrightarrow$  PWM 0&1
- 16-26 GPIO pins

# Raspberry Pi Serial

- **Single serial port**
  - `/dev/ttyAMA0`
- **Speeds up to 115200 bps**
- **TTL level signals**
- **By default connected to getty**

# Raspberry Pi I<sup>2</sup>C

- **Inter-Integrated Circuit**
  - Serial bus (a.k.a SMBus)
- **Default speed 400,000 bps**
- **rPi has single external I<sup>2</sup>C bus**
  - 127 devices
- **Control lines**
  - SDA (data)
  - SCL (clock)



# Enable I<sup>2</sup>C with raspi-config 1

```
pi@raspberrypi: ~  
File Edit View Search Terminal Help  
  
Raspberry Pi Software Configuration Tool (raspi-config)  
  
1 Expand Filesystem          Ensures that all of the SD card s  
2 Change User Password      Change password for the default u  
3 Boot Options              Choose whether to boot into a des  
4 Wait for Network at Boot  Choose whether to wait for networ  
5 Internationalisation Options Set up language and regional sett  
6 Enable Camera             Enable this Pi to work with the R  
7 Add to Rastrack           Add this Pi to the online Raspber  
8 Overclock                 Configure overclocking for your P  
9 Advanced Options          Configure advanced settings  
0 About raspi-config        Information about this configurat  
  
                <Select>                <Finish>
```

# Enable I<sup>2</sup>C with raspi-config 2

```
willem@aid2: ~
File Edit View Search Terminal Help

Raspberry Pi Software Configuration Tool (raspi-config)

A1 Overscan          You may need to configure oversca
A2 Hostname          Set the visible name for this Pi
A3 Memory Split      Change the amount of memory made
A4 SSH                Enable/Disable remote command lin
A5 Device Tree        Enable/Disable the use of Device
A6 SPI                Enable/Disable automatic loading
A7 I2C                Enable/Disable automatic loading
A8 Serial             Enable/Disable shell and kernel m
A9 Audio              Force audio out through HDMI or 3
AA GL Driver          Enable/Disable experimental desk

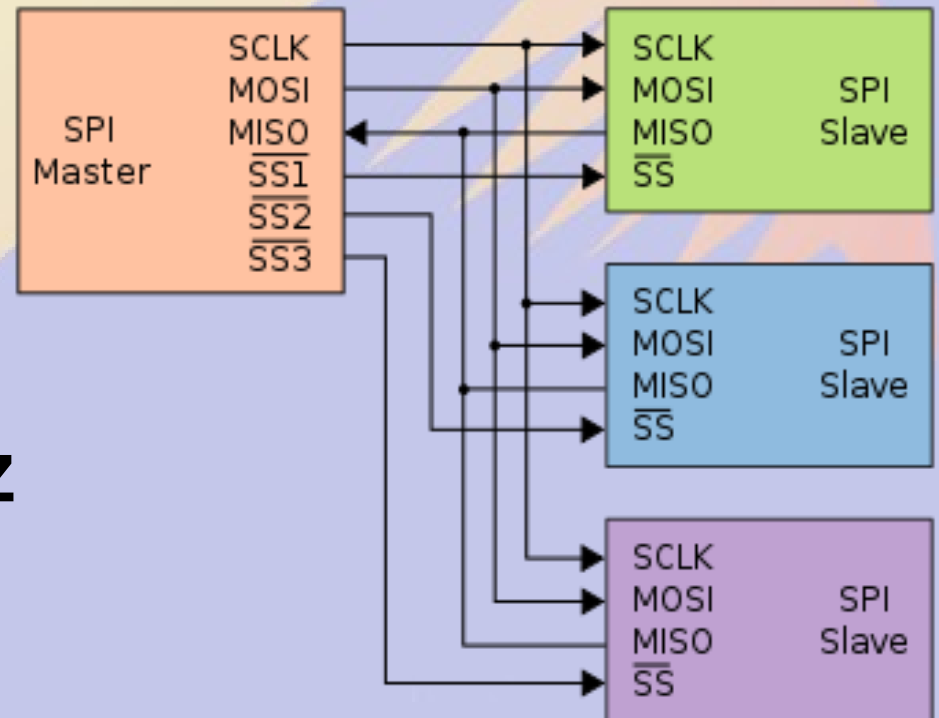
<Select>                <Back>
```

# I<sup>2</sup>C devices

- **TNC-Pi**
- **INA219 current sensor**
- **Temperature/pressure/RH sensors**
- **LCD displays**
- **Accelerometers**
- **Digital I/O pins**
- **Analog<>Digital I/P pins**

# SPI bus

- **Serial Peripheral Interface**
- **Signals (supports 2 slaves)**
  - MasterOutSlaveIn
  - MasterInSlaveOut
  - **Clock**
  - **CE0 (SS1)**
  - **CE1 (SS2)**
- **Speeds up to 250 MHz**



# raspi-config enable SPI

```
willem@aid2: /sys/bus/i2c/drivers/stmpe-i2c
File Edit View Search Terminal Help

Raspberry Pi Software Configuration Tool (raspi-config)

A1 Overscan          You may need to configure oversca
A2 Hostname          Set the visible name for this Pi
A3 Memory Split      Change the amount of memory made
A4 SSH               Enable/Disable remote command lin
A5 Device Tree       Enable/Disable the use of Device
A6 SPI               Enable/Disable automatic loading
A7 I2C               Enable/Disable automatic loading
A8 Serial            Enable/Disable shell and kernel m
A9 Audio             Force audio out through HDMI or 3
AA GL Driver         Enable/Disable experimental desk

<Select>           <Back>
```



# SPI Devices

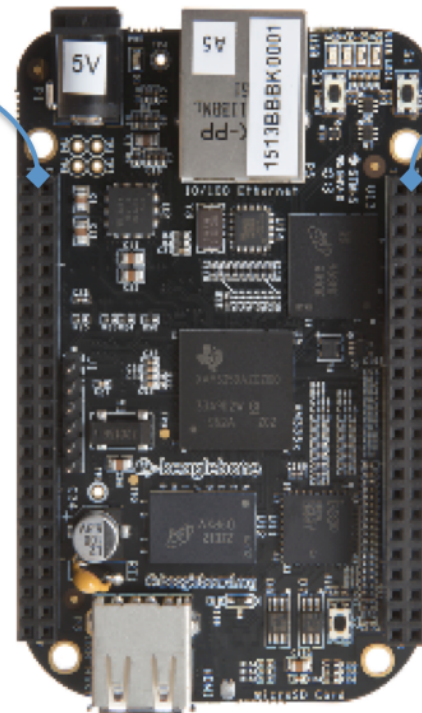
- **Faster than I<sup>2</sup>C, but uses more pins**
- **Same devices as I<sup>2</sup>C, but adds**
  - **GPS**
  - **Ethernet/WiFi/Bluetooth/RFID**
  - **Memory**
- **Full duplex**

# Beagle Bone Black

## Cape Expansion Headers

P9

DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BTN	9	10	SYS_RESETN
UART4_RXD	11	12	GPIO_60
UART4_TXD	13	14	EHRPWM1A
GPIO_48	15	16	EHRPWM1B
SPIO_CS0	17	18	SPIO_D1
I2C2_SCL	19	20	I2C2_SDA
SPIO_DO	21	22	SPIO_SCLK
GPIO_49	23	24	UART1_TXD
GPIO_117	25	26	UART1_RXD
GPIO_115	27	28	SPI1_CS0
SPI1_DO	29	30	GPIO_112
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	ECAPPWMO
DGND	43	44	DGND
DGND	45	46	DGND



P8

DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
GPIO_66	7	8	GPIO_67
GPIO_69	9	10	GPIO_68
GPIO_45	11	12	GPIO_44
EHRPWM2B	13	14	GPIO_26
GPIO_47	15	16	GPIO_46
GPIO_27	17	18	GPIO_65
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DAT0	25	26	GPIO_61
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_AC_BIAS
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

### LEGEND

POWER/GROUND/RESET

AVAILABLE DIGITAL

AVAILABLE PWM

SHARED I2C BUS

RECONFIGURABLE DIGITAL

ANALOG INPUTS (1.8V)

# Pins are multiplexed

- **Default configuration**
  - **Power&Reset Buttons**
  - **4 serial ports**
  - **8 analog inputs (1.8V max)**
  - **1 external I<sup>2</sup>C bus (127 devices)**
  - **19-128 GPIO pins**
  - **Switched 5V/3.3V DC**

# Limitations

- **Pins connect directly to CPU**
  - Long wires are CPU antennas!
- **rPi & BBB GPIO Pins are 3.3 V**
  - Max current 16 mA in or out
  - Max combined output current 50 mA
- **BB Analog In Pins are 1.8V**

# Device Tree

- **Unix: Everything is a File**
- **/sys maps to hardware**
  - In kernel virtual file system
- **Get status by reading**
- **Set status by writing**

# Reading analog pins on BBB

- **Enable analog pins in device tree**

```
echo cape-bone-iiio>/sys/devices/bone_capemgr.*/slots
```

- **Read value of pin AIN0 in mV**

```
cat /sys/devices/ocp.*/helper.*/AIN0
```

```
580
```

- **Voltage on pin AIN0 is 0.580V**

# Show pin voltages in Python 1

```
#!/usr/bin/python

for i in range(0,8):
    # Snarf file
    fd = open("/sys/devices/ocp.3/helper.16/AIN%d" % i)
    text = fd.read()
    fd.close()
    # Decode voltage
    V = float(text)/1000
    # Print voltage
    print "AIN%d = %5.3fV" % (i,V)
```

# Show pin voltages in Python 2

**./aread**

AIN0 = 1.740V

AIN1 = 1.481V

AIN2 = 1.645V

AIN3 = 0.867V

AIN4 = 0.589V

AIN5 = 0.709V

AIN6 = 0.852V

AIN7 = 1.678V



# Limitations

- **Maximum voltage is 1.8V**
- Use a voltage divider to increase
  - Use 1% or better resistors
  - Max 1 kohm for lower leg
- No analog in on rPi
  - use MCP3008 or similar and SPI

# Assigning pins to GPIO

- **`/sys/class/gpio/export`**
  - Maps pin to GPIO
  - `echo 18 > /sys/class/gpio/export`
- **`/sys/class/gpio/unexport`**
  - Removes pin from GPIO map
  - `echo 18 > /sys/class/gpio/unexport`
- Root access required

# Manipulating GPIO

- **When mapped to GPIO, a new directory is created for that pin**
  - */sys/class/gpio/gpioXX*
- Files in this directory controls pin
  - direction = in or out
  - value = 0 or 1

# Checking pin value

- In or out?
  - **cat /sys/class/gpio/gpio18/direction**
- High or low?
  - **cat /sys/class/gpio/gpio18/value**

# Changing the GPIO direction

- Set pin for input
  - `echo in > /sys/class/gpio/gpio18/direction`
- Set pin for output
  - `echo out > /sys/class/gpio/gpio18/direction`

# Changing the GPIO value

- Set pin voltage high
  - `echo 1 > /sys/class/gpio/gpio18/value`
- Set pin for output
  - `echo 0 > /sys/class/gpio/gpio18/value`

# python access to pins

- **Import the GPIO package**  
`import Rpi.GPIO as GPIO`
- **Name the pins by their GPIO#**  
`GPIO.setmode(GPIO.BCM)`
- **Name pins by their board number**  
`GPIO.setmode(GPIO.BOARD)`

# python set pins for in/out

- **Set pin 18 for output**

**GPIO.setup(18,GPIO.OUT)**

- **Set pins 18,23,24&25 for output**

**GPIO.setup([18,23,24,25],GPIO.OUT)**

- **Set pin 18 for input**

**GPIO.setup(18,GPIO.IN)**



# python set/get pin value

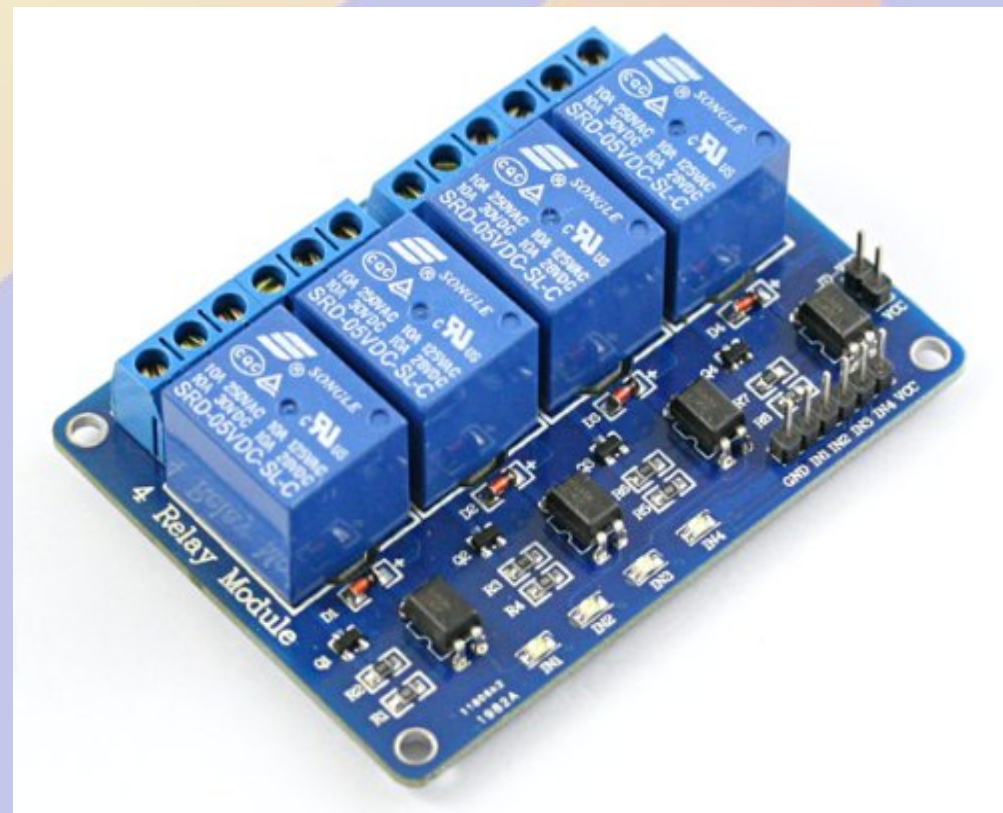
- **Set pin 18 high**  
**GPIO.output(18,1)**
- **Set pin 18 low**  
**GPIO.output(18,0)**
- **Read pin 18 value**  
**p18 = GPIO.input(18)**

# Input pin status

- Set pin 23 to input with pull up
- `GPIO.setup(24,GPIO.IN,pull_up_down=GPIO.PUD_UP)`
  - ground to activate
- Set pin 24 to input with pull down
- `GPIO.setup(24,GPIO.IN,pull_up_down=GPIO.PUD_DOWN)`
  - Pull up to 3.3V
- A 1k series resistor is typically a good idea

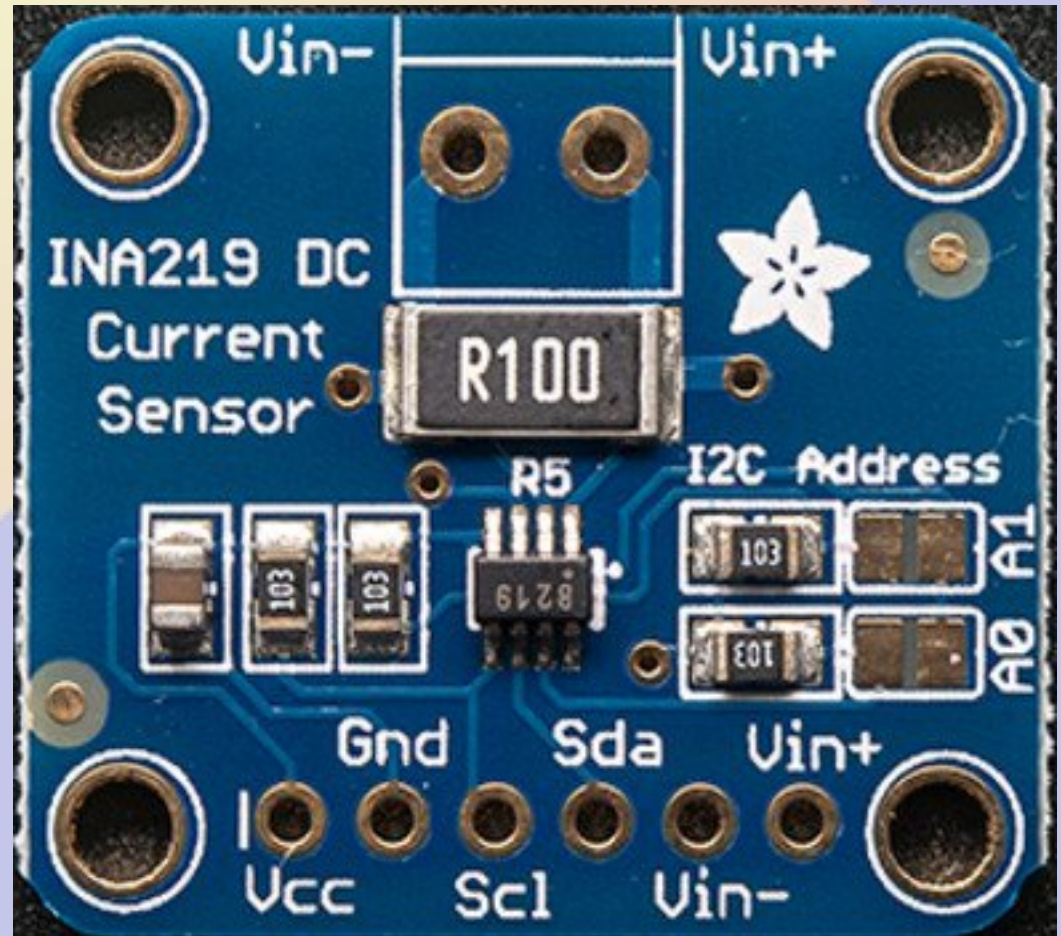
# Important Limitations

- GPIO pins are 3.3 V
- Current limited to 16mA
- Opto-isolate relays



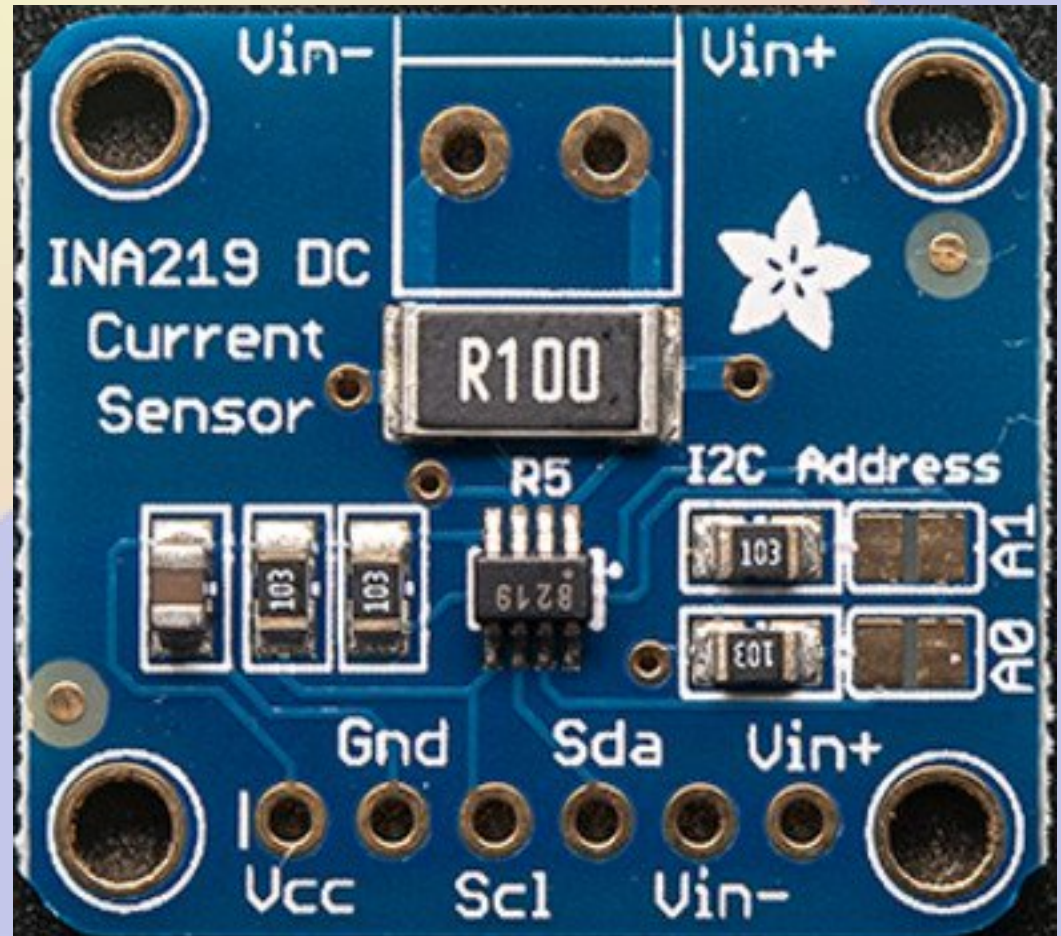
# I<sup>2</sup>C Example: Voltage & Current

- TI INA219 I<sup>2</sup>C high side monitor
- Max 26V
- Current Sense  
40-320mV  
shunt
- Chip \$2.50
- Adafruit \$10



# Adafruit Breakout

- I<sup>2</sup>C address 0x40 0x41 0x42 0x43
  - solder jumpers
- 0.1 ohm shunt reads to 3.2A

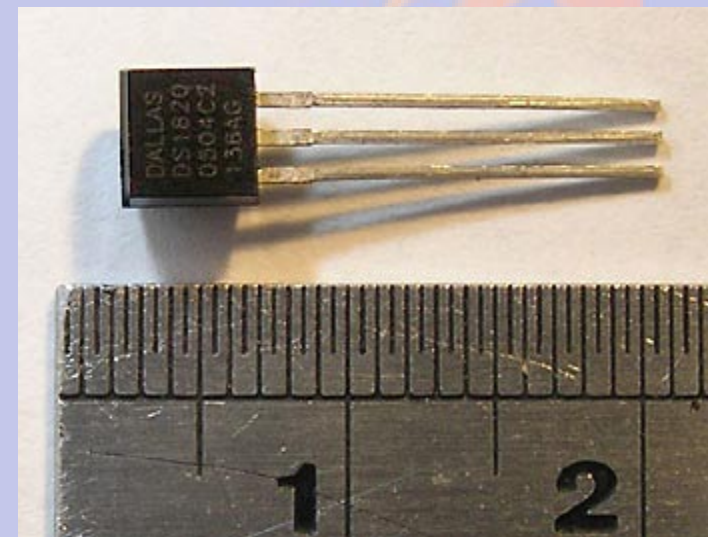


# Python Usage

```
import Subfact_INA219 as INA219  
ina = INA219()  
V = ina.getBusVoltage_V()  
mA = ina.getCurrent_mA()
```

# Reading 1wire Temperatures

- **1wire uses a single data bus**
- **Each device has unique address**
- **DS18S20 is a TO-92 temperature sensor with 0.5C resolution for \$2.50**
- **Can use parasite power (but not on rPi)  
Use 4k7 pullup**



# Getting 1wire output

- **ls /sys/bus/w1/devices**

```
10-000802fba50d
```

```
10-000802fbe2f6
```

```
10-000802fbf0f9
```

```
w1_bus_master1
```

- **10 means it is a DS18S20 temp, the test is a unique serial number**



# Getting the Data

```
cat /sys/bus/w1/devices/w1_bus_master1/w1_master_slaves
```

```
10-000802fbe2f6
```

```
10-000802fbf0f9
```

```
10-000802fba50d
```

```
cat /sys/bus/w1/devices/10-000802fbe2f6/w1_slave
```

```
2c 00 4b 46 ff ff 0e 10 17 : crc=17 YES
```

```
2c 00 4b 46 ff ff 0e 10 17 t=21875
```

Temperature of first sensor is 21.875 °C

# Reading Temps in Python 1

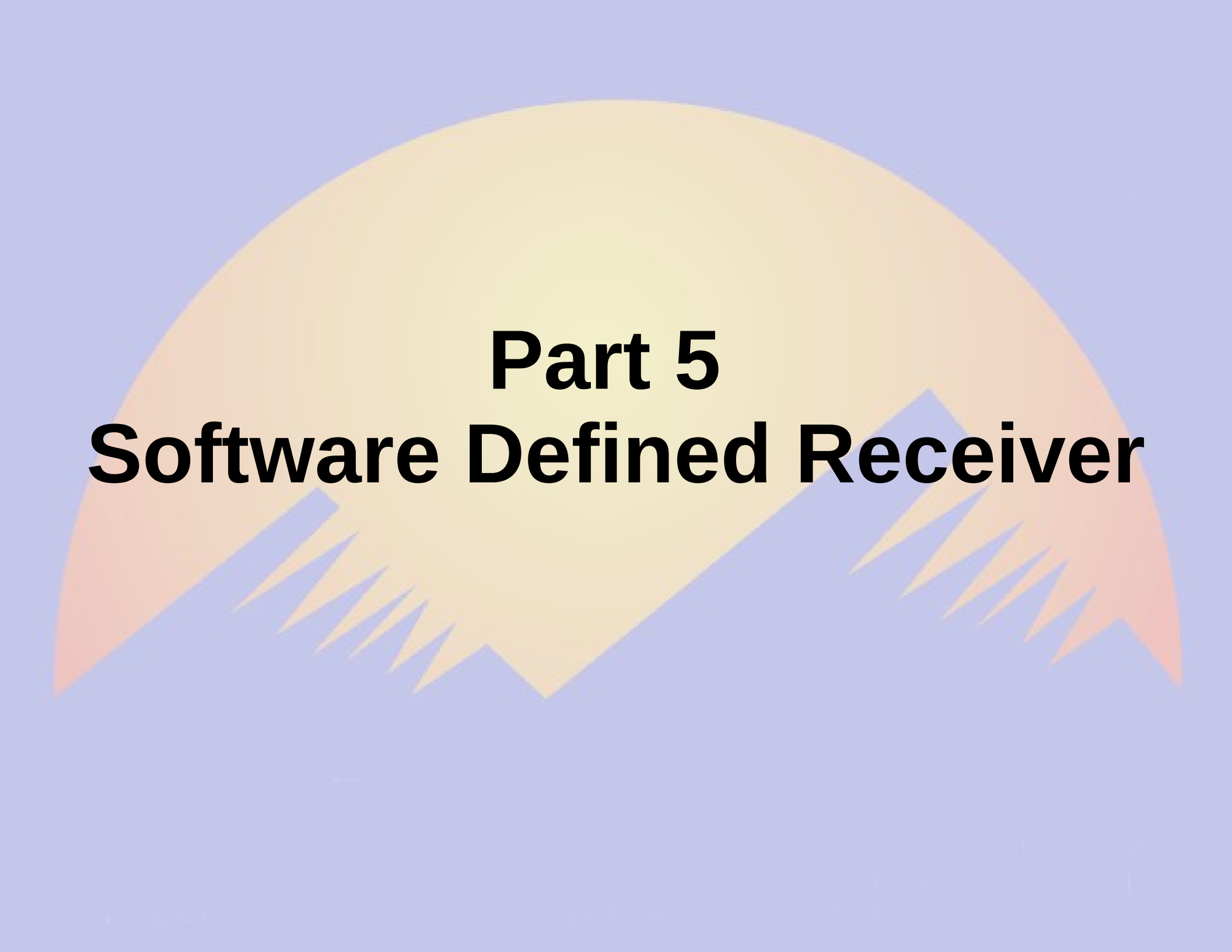
```
# Snarf the slave list file
fd=open("/sys/bus/w1/devices/w1_bus_master1/w1_master_slaves")
text = fd.read()
fd.close()
# Split text on line breaks
slaves = filter(None,text.split("\n"))
# Sort so that order is predictable
slaves.sort()
```

# Reading Temps in Python 2

```
# Blank dictionary
temps = {}
# Loop over devices
for slave in slaves:
    if slave=="": continue
    # Snarf device file
    fd = open("/sys/bus/w1/devices/"+slave+"/w1_slave")
    text = fd.read()
    fd.close()
    # Split lines
    lines = text.split("\n")
    words = lines[1].split(" ")
    # Get temperature
    C = float(words[9][2:])/1000
    F = 9*C/5+32
    # Add result to dictionary
    temps[slave] = "%.1fF" % F
```

# Observations

- **Temperature conversion occurs when you cat the file**
  - About 700mS per device
- **Temperature reads are best done using a separate thread**
- **rPi 1wire support in *raspi-config***

A stylized illustration of a sun rising over a mountain range. The sun is a large, semi-circular shape with a gradient from yellow to orange, positioned in the upper half of the frame. Below it, a range of blue mountains is visible. The background is a solid light blue color.

# **Part 5**

# **Software Defined Receiver**

# ADSB SDR Receiver

- Receiver based on RTL2832 USB
- About \$20 on Amazon
- Also used in many ham related SDR projects



# Software Build

## Build and install rtl-sdr module and software

```
git clone git://git.osmocom.org/rtl-sdr.git
cd rtl-sdr
mkdir build
cd build
cmake ../ -DINSTALL_UDEV_RULES=ON
make
cd ..
```

**/usr/local/bin/rtl\_tcp** is a TCP server for remote monitoring

# dump1090 Build

## Build and install dump1090 and related software

```
git clone git://github.com/MalcolmRobb/dump1090.git  
cd dump1090  
make  
cd ..
```



# Running web interface

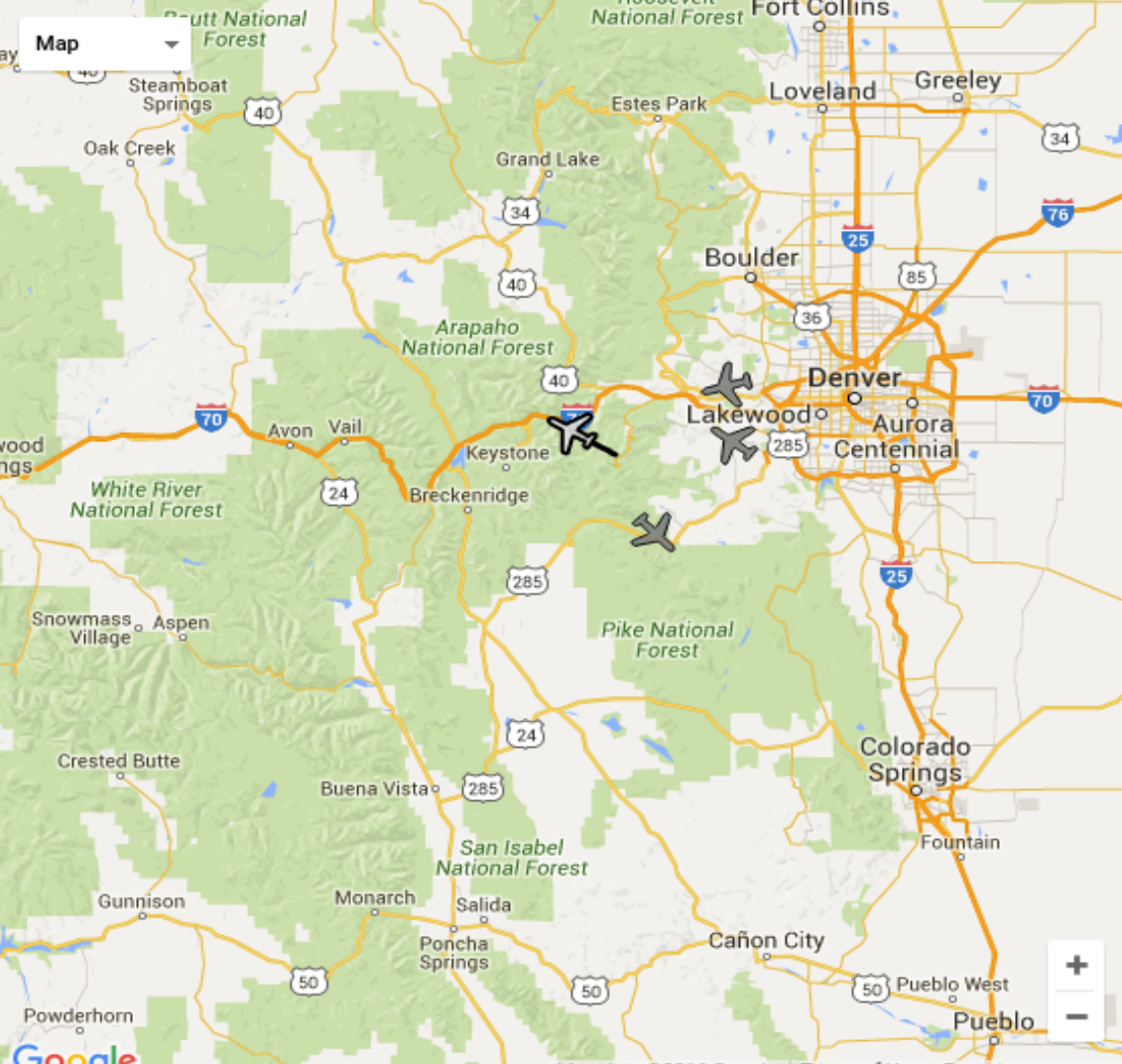
- **`./dump1090 --net --lon -105 --lat 39`**
  - `--net` enables web interface port 8080**
  - `--lon` and `--lat` sets location**
- **Run at boot from rc.local**

# Running



DUMP1090 - Chromium

DUMP1090

adsb:8080



Map

Local Time  UTC Time 

[ Reset Map ] [ Settings ]

**AAL1355** [\[FR24\]](#) [\[FlightStats\]](#) [\[FlightAware\]](#)

Altitude: 36000 ft Squawk: 6251  
Speed: 396 kt ICAO (hex): ab6fdd  
Track: 300° (NW)  
Lat/Long: 39.663391, -105.759828

ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Seen
albabb	CPZ5932	2732	19100	344	255	46	0
ab6fdd	AAL1355	6251	36000	396	300	512	5
a0f828	DAL17	7240	38000	426	306	399	0
a0a092			44975	451	136	121	10

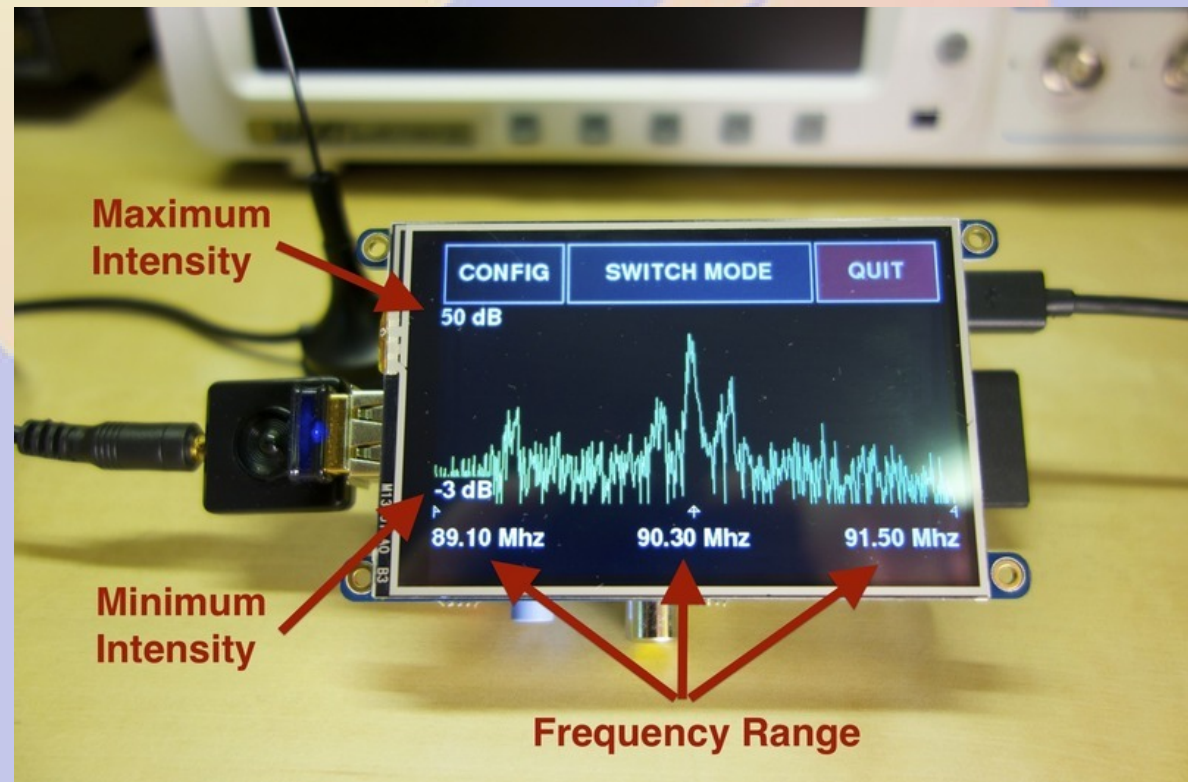
Google

Map data ©2016 Google Terms of Use Report a map error

# Other SDR Projects

- The rPi 3 is a 1.2GHz 64 bit quad core machine with 1GB memory
  - Processing power to do cool stuff
- Adafruit Freq Show
- GNU radio

Eric Schneider  
RMHAM U  
April 15, 2017

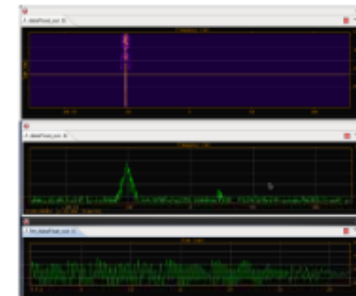


# RasHAWK

Custom User Interface



Spectrum Displays



Command & Control (C2) Laptop



GPS

iPhone Hotspot (tether to Internet)



Location Mapping on Tablet



Control & Streaming Data



WiFi Router  
SSID:  
rashawk\_wlan

Transmitter Node



REDHAWK  
Device Node



RasHawk  
Sensors



REDHAWK  
Device Nodes



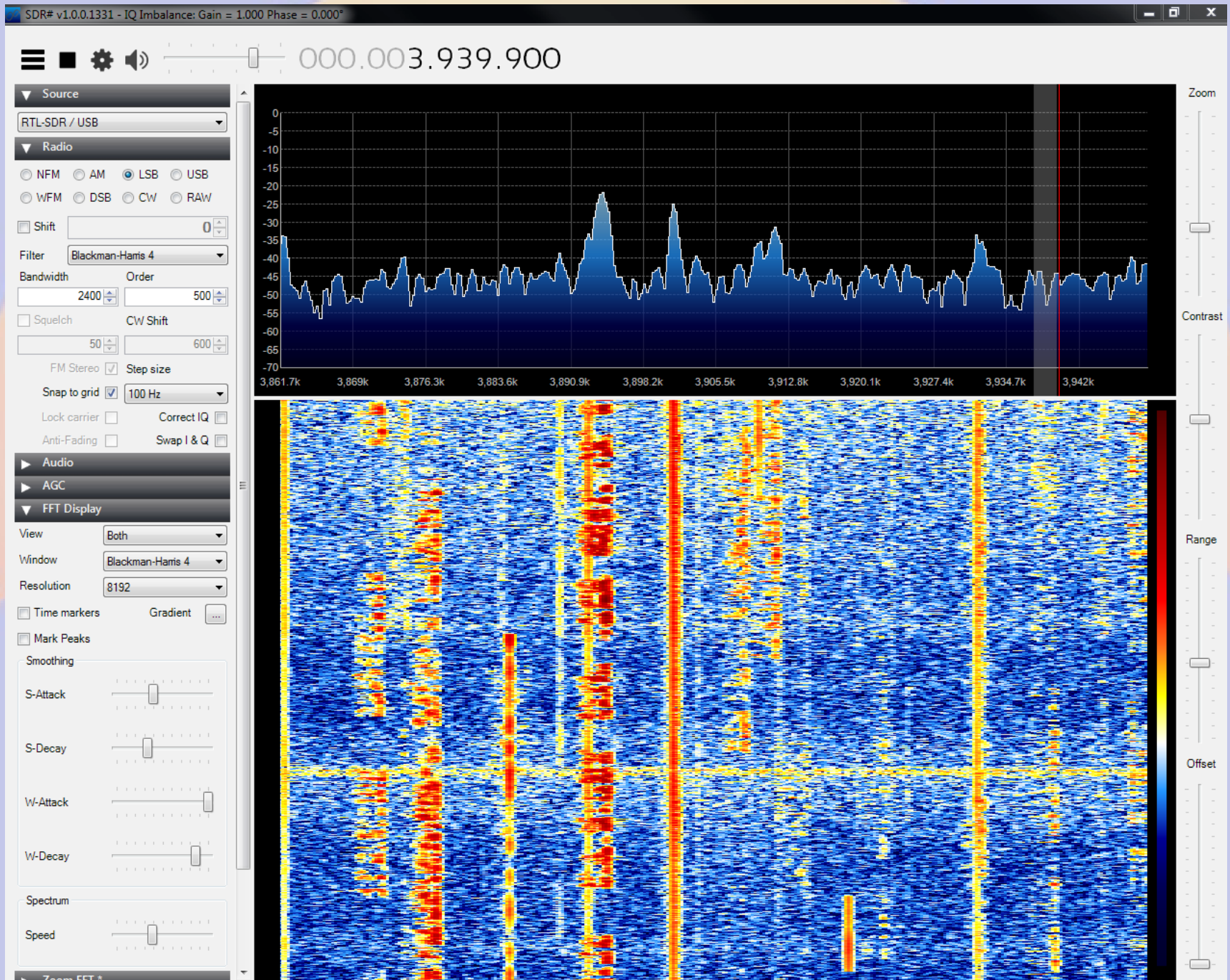
Raspberry Pi  
with Antenna Switch




# SDR TCP server

- Start *rtl\_tcp* as root
  - `rtl_tcp -a <ipaddress>`
  - Default port is 1234 (set with -p)
- Connect to it with an SDR program such as SDR# or GNU Radio on a device with enough power to process the data

# SDR# Screenshot



A stylized sun with a yellow-to-orange gradient, partially obscured by a blue horizon line. The sun's rays are depicted as sharp, triangular shapes pointing upwards. The background is a solid light blue color.

# **Part 6**

## **Other Projects**

# rPi / TNC-Pi / screen / xastir





# SmokePi (SmokePing rPi)

