What's all this Multiple Bandscope Stuff, Anyhow?

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PackRats/NEWS VHF Conference

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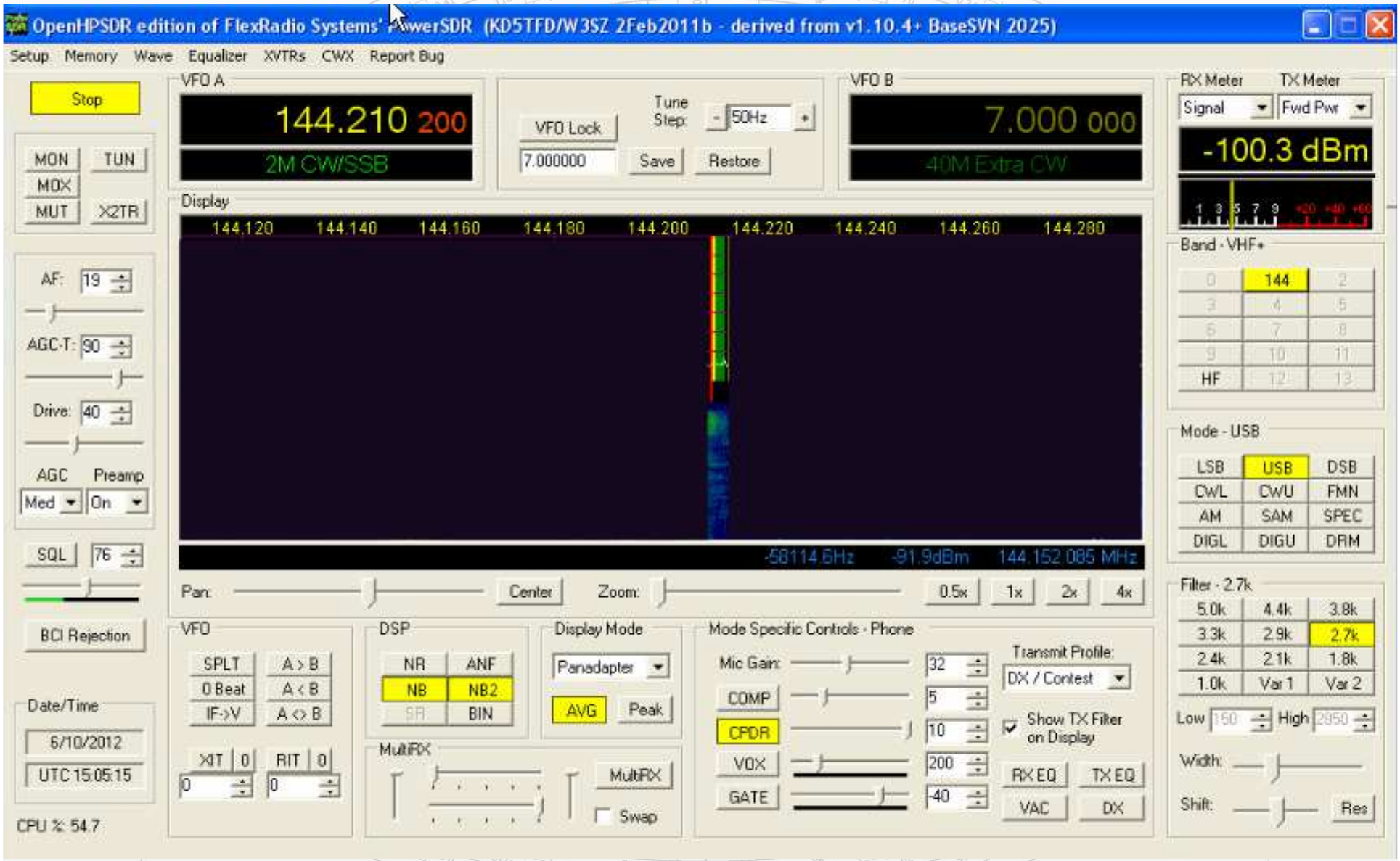
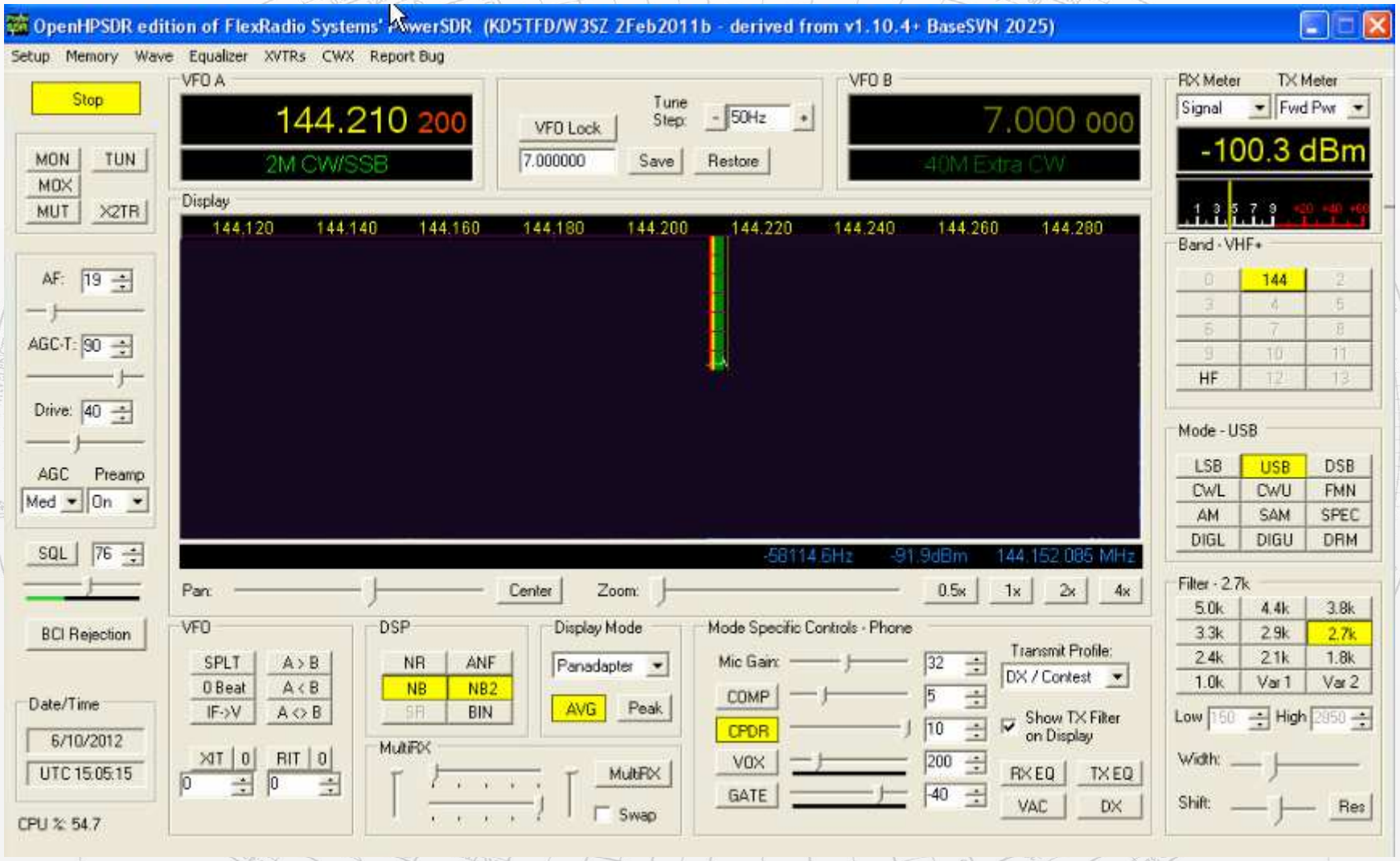
What is a Bandscope?

- A bandscope is a graphical representation of the signals received over a range of frequencies that is significantly larger than the received audio bandwidth.
- Minimal useful display bandwidth: 48kHz
- My preference: 192 kHz (gives 180 kHz)
  - Necessary to have the ability to zoom in
- Both Spectrum and Waterfall necessary


ELECRAFT K3 TRANSCEIVER
14.195.000
14200.00
BAND
MENU
DISP
VOX
QSK
GROUP
METER
MODE
XMIT
ATU TUNE
ALT
±/TEST
TUNE
ATU
POWER
RX ANT
ANT
TX
Δf
RF
SQL
PHONES
MIC
AF
SUB
SHIFT
LO
CUT
HI
WIDTH
NORM
I/II
SPEED
IN
MIC CMP
OUT
PWR
DELAY
MON
FREQ ENT
SCAN
FINE
RSE
SUB
A/B
REV
A►B
V►M
M►V
B SET
VFO
SPLIT
AF REC
AF PLAY
PRE
AGC
XFIL
M1
M2
REC
M3
M4
ATT
OFF
DISP BW
NB
NR
NTCH
LEVEL
ADJ
MAN
MESSAGE
SPOT
CWT
AFX
RIT
XIT
PF1
PF2
PF3
RATE
DISP OFS
CLR


OpenHPSDR edition of FlexRadio Systems' PowerSDR (KD5TFD/W3SZ 2Feb2011b - derived from v1.10.4+ BaseSVN 2025)
Setup Memory Wave Equalizer XVTRs CWX Report Bug
Stop
MON TUN MOX MUT X2TR
AF: 19
AGC-T: 90
Drive: 40
AGC Preamp
Med On
SQL 76
BCI Rejection
Date/Time
6/10/2012
UTC 15:05:15
CPU %: 54.7
VFO A
144.210 200
2M CW/SSB
VFO Lock
Tune Step: 50Hz
7.000000
Save Restore
VFO B
7.000 000
40M Extra CW
RX Meter Signal
TX Meter Fwd Pwr
-100.3 dBm
Display
144.120 144.140 144.160 144.180 144.200 144.220 144.240 144.260 144.280
-58114 6Hz -91.9dBm 144.152 085 MHz
Pan: Center Zoom: 0.5x 1x 2x 4x
Band - VHF+
0 144 2
3 4 5
6 7 8
9 10 11
HF 12 13
Mode - USB
LSB USB DSB
CWL CWU FMN
AM SAM SPEC
DIGL DIGU DRM
Filter - 2.7k
5.0k 4.4k 3.8k
3.3k 2.9k 2.7k
2.4k 2.1k 1.8k
1.0k Var 1 Var 2
Low 150 High 2850
Width:
Shift: Res
VFO
SPLT A > B
0 Beat A < B
IF->V A <> B
XIT 0 RIT 0
0 0
DSP
NR ANF
NB NB2
SR BIN
Display Mode
Panadapter
AVG Peak
MultiRX
MultiRX
Swap
Mode Specific Controls - Phone
Mic Gain: 32
COMP 5
CPDR 10
VOX 200
GATE -40
Transmit Profile:
DX / Contest
Show TX Filter on Display
RX EQ TX EQ
VAC DX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-58114.6Hz -91.9dBm 144.152.085 MHz
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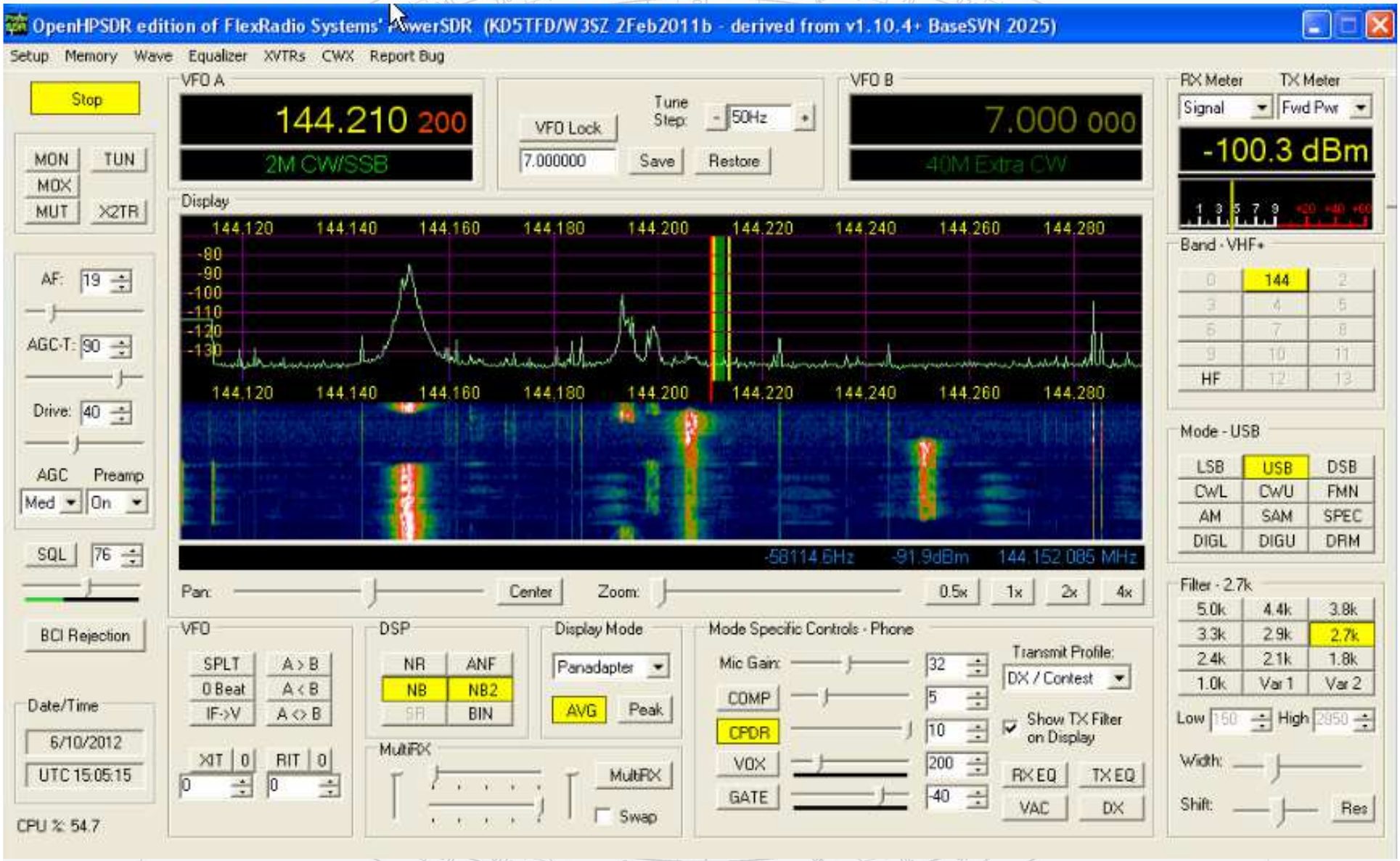
1.0k Var 1 Var 2
Low 150 High 2850
Width:
Shift: Res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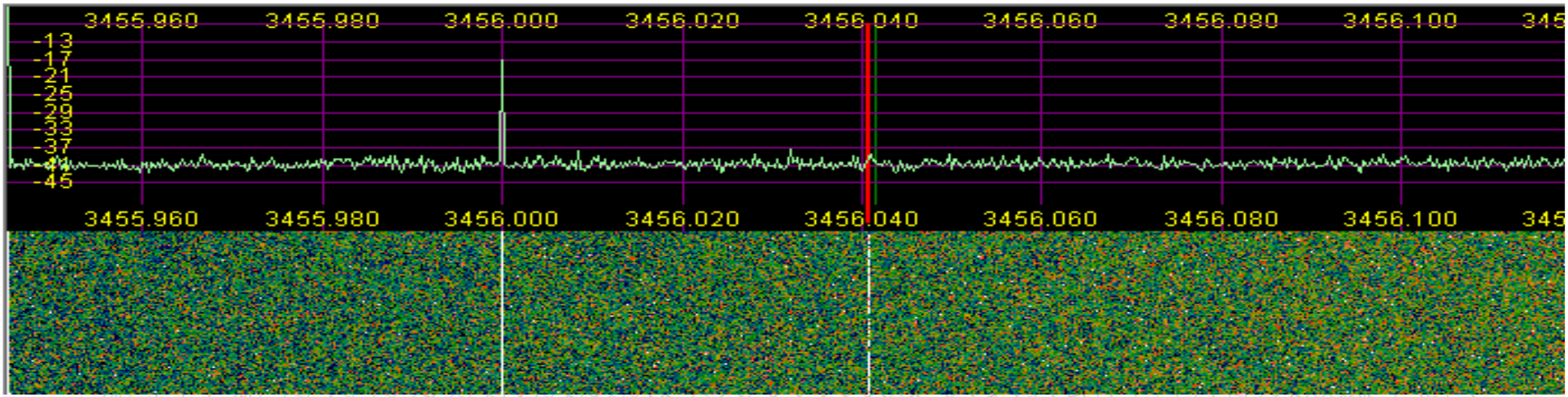
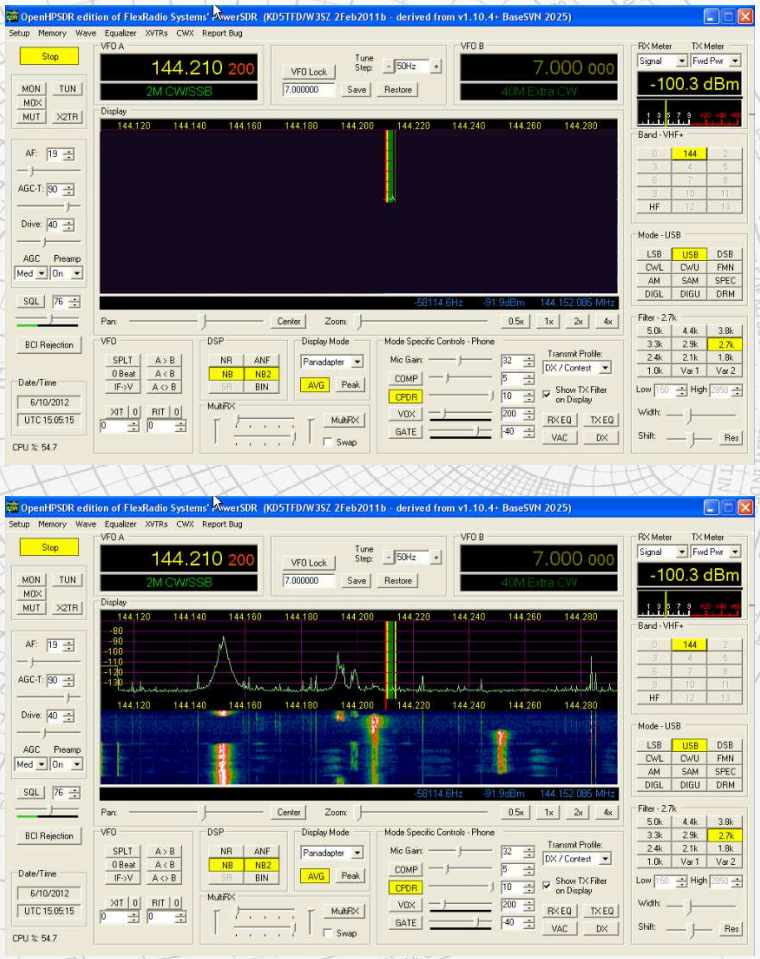


- Having a waterfall is like being able to hear entire 180 kHz bandwidth, using 262,144 receivers, each with bandwidth of 0.73 Hz
- No ringing
- No interference from all the frequencies containing only noise
- Very weak signals literally jump out of the noise on the waterfall
- If your waterfall is set up properly, you can see signals that are much weaker than you can hear
  - So if you can't see it, you will never hear it

Important information

- Is someone on the frequency you are currently listening to?
- Was someone on that frequency at any instant during the past 20 minutes?
- Are any other frequencies within a 192 kHz span currently occupied?
- Were any other frequencies within a 192 kHz span occupied at any instant during the past 20 minutes?

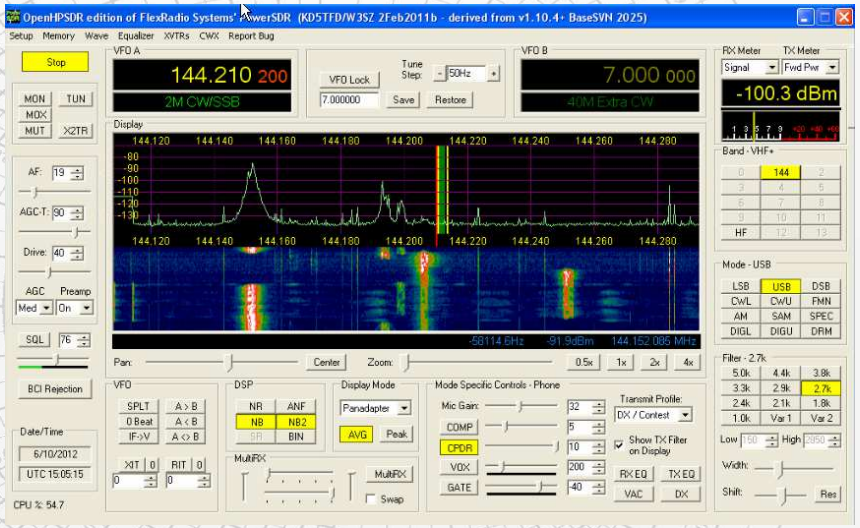


What this “extra” information tells you

- What is the overall level of activity on the band?
  - If more than usual: is the band open to unusual forms of propagation?
  - If less than usual: is something going on elsewhere that has pulled people away?
- Have new stations popped up on the waterfall? If so, you need to work them!

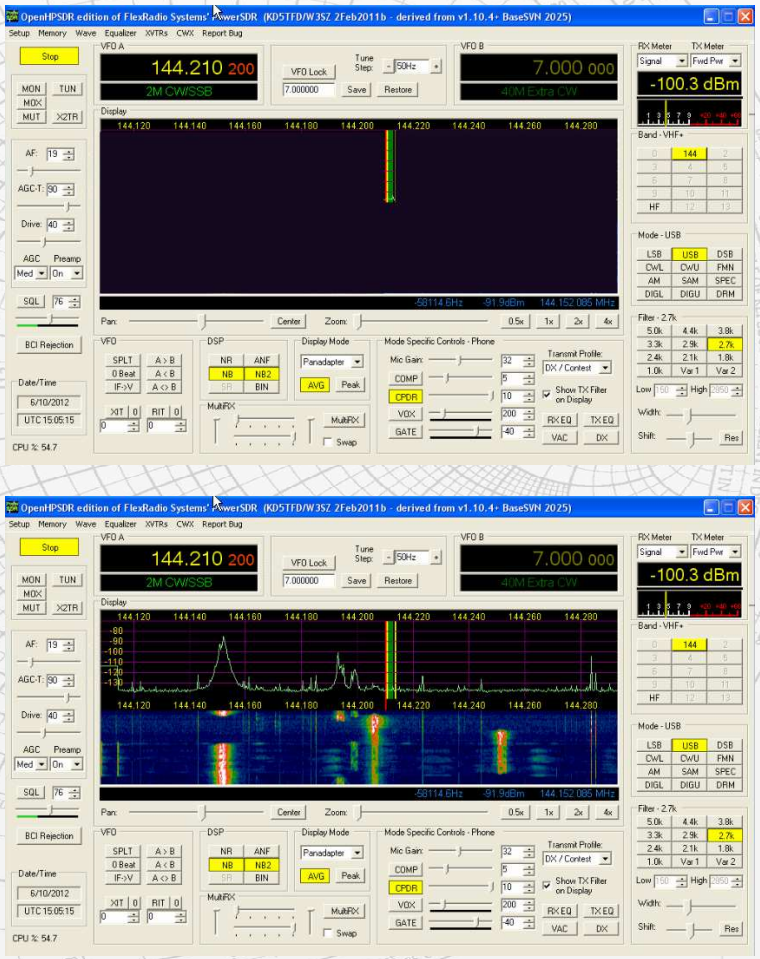
What else the bandscope lets you do

- While you are calling CQ [or searching and pouncing] you can also simultaneously be watching 144.250 so that you know when NN3Q Rover arrives at his new grid
- You can search and pounce while running a frequency [calling CQ] on the same band
- If you want to start calling CQ on a new frequency, the waterfall will show you a clear spot to do so



More benefits from the bandscope

- If you are running the bands and your partner arrives on the new band “off frequency”, you will see him on the bandscope and can immediately go to his frequency. No lost time, no lost contact.

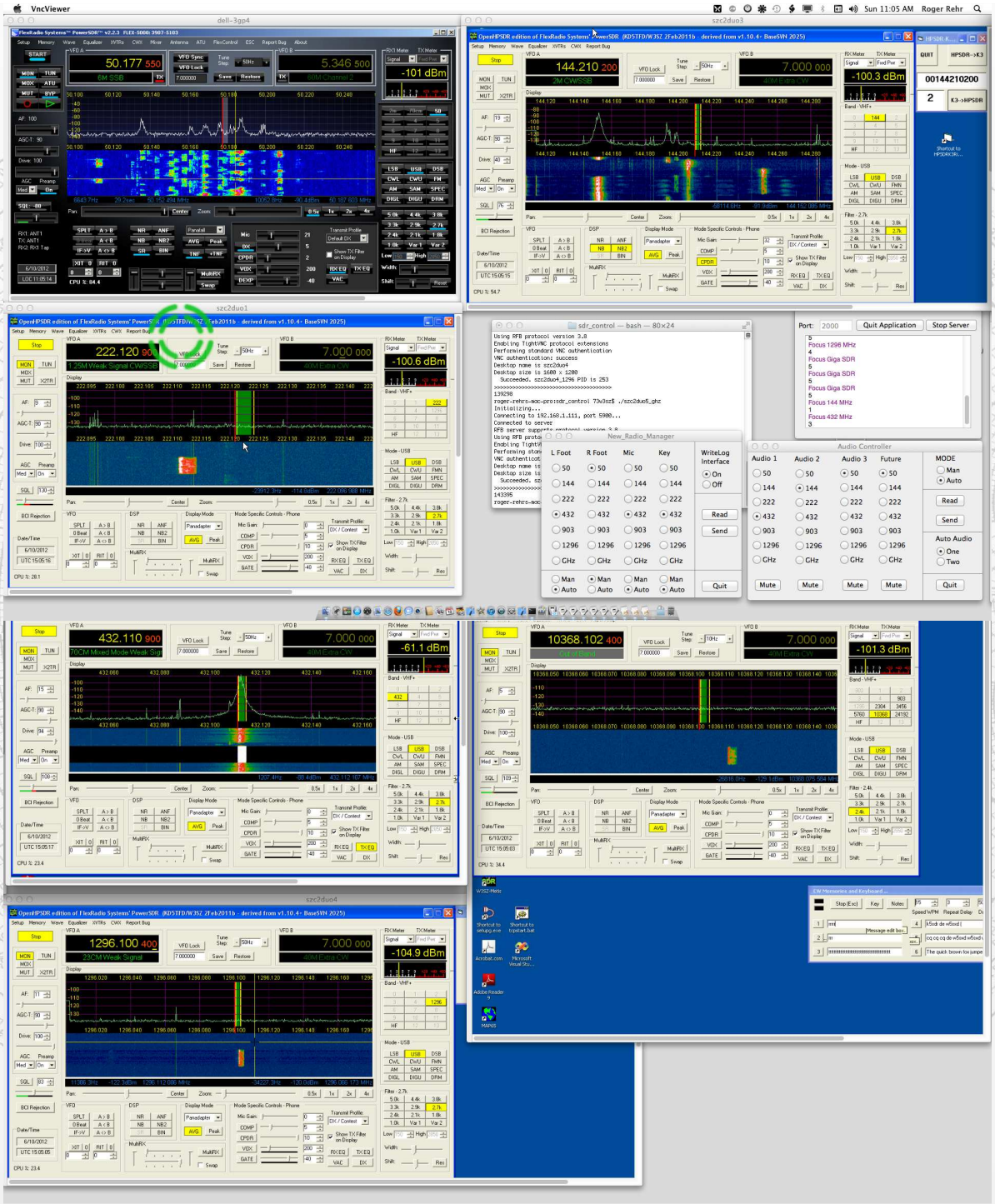


But Wait There's More!

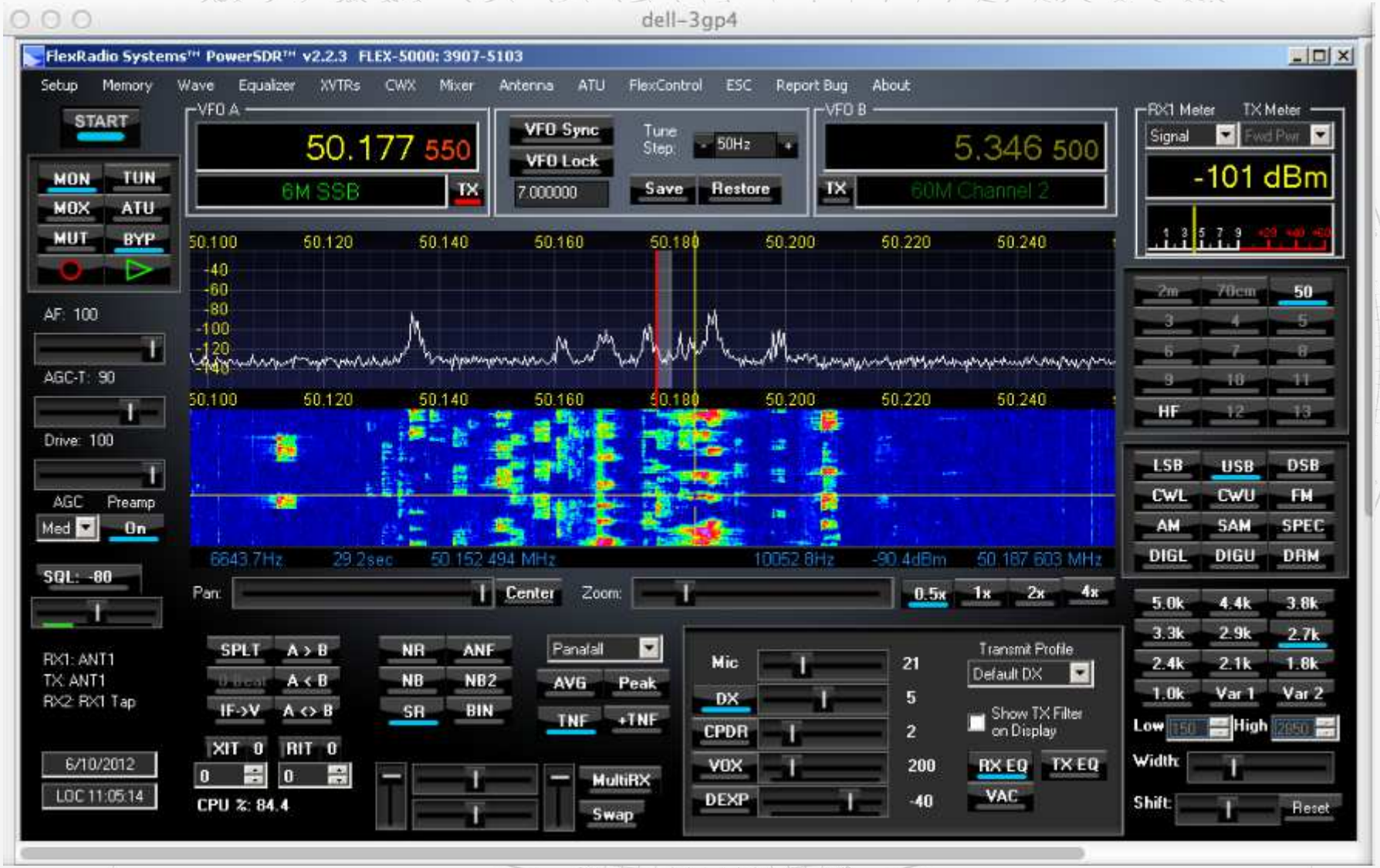
- What could be better than having a bandscope to see everything there is to see on a single band?

Multiple Bandscopes

- Fulltime individual bandscopes on 50,144, 222, 432, 1296 MHz and a shared always-on bandscope for 903 MHz and 2.3 GHz and above


VncViewer
Sun 11:05 AM Roger Rehr
dell-3gp4
szc2duo3
szc2duo1
szc2duo4
sdr_control — bash — 80×24
New_Radio_Manager
Audio Controller
Quit Application
Stop Server
Focus 1296 MHz
Focus Giga SDR
Focus 144 MHz
Focus 432 MHz
50.177 550
5.346 500
144.210 200
7.000 000
222.120 900
432.110 900
10368.102 400
1296.100 400
-101 dBm
-100.3 dBm
-100.6 dBm
-61.1 dBm
-101.3 dBm
-104.9 dBm

Multiple Bandscopes



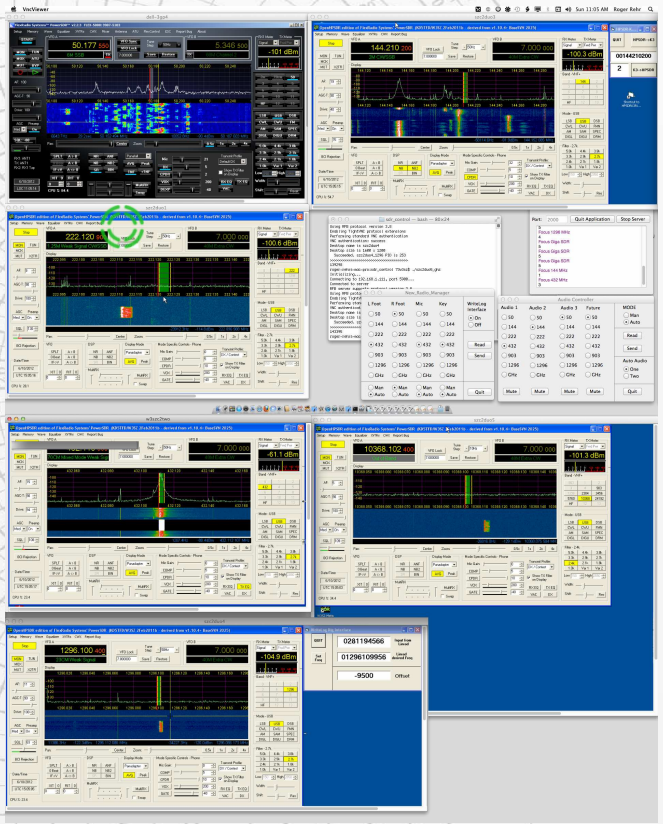
Multiple Bandscopes

- Fulltime individual bandscopes on 50,144, 222, 432, 1296 MHz and a shared always-on bandscope for 903 MHz and 2.3 GHz and above

  Without Fulltime individual bandscopes on multiple bands you will never know what you are missing!

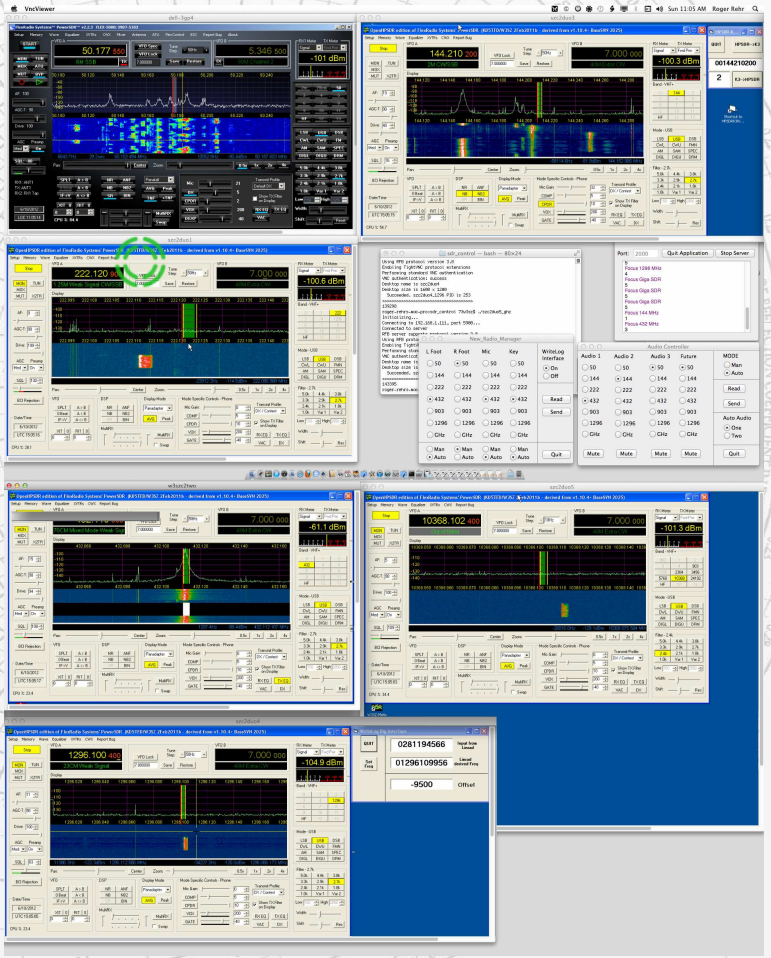
Multiple Bandscopes

- Before jumping to a new band you can see which frequencies are open and avoid landing on someone, whether you are planning to call CQ or running the bands with another station



Multiple Bandscopes

- You can see all possible liaison and fallback frequencies at all times
- If you are running the bands and lose the other station, you will immediately see if he pops up on **any** of the other bands, by watching the bandscopes, and you will not lose him and miss running the remaining bands



Multiple Bandscopes

- Allow you to reduce the number of unknown variables when looking for a station on the microwaves: Three variables (frequency, time, and beam heading) are reduced to just one (beam heading)
- You can find a weak, “invisible” station by rocking the beam heading and watching the bandscope, and use the bandscope to peak and then complete a contact with a signal that you never would have known existed without the bandscope

Multiple Bandscopes

- Because the bandscope lets you find signals so quickly when running the bands, efficiency increases dramatically
  - You can run all bands from 50 MHz through 10 GHz in 5 minutes
- If something “breaks” on a band you may see a drop in the noise floor on the “broken” band while operating on another band, and thus avoid a broken run of the bands, by knowing about this malfunction in advance and acting accordingly

Bandscope Philosophy

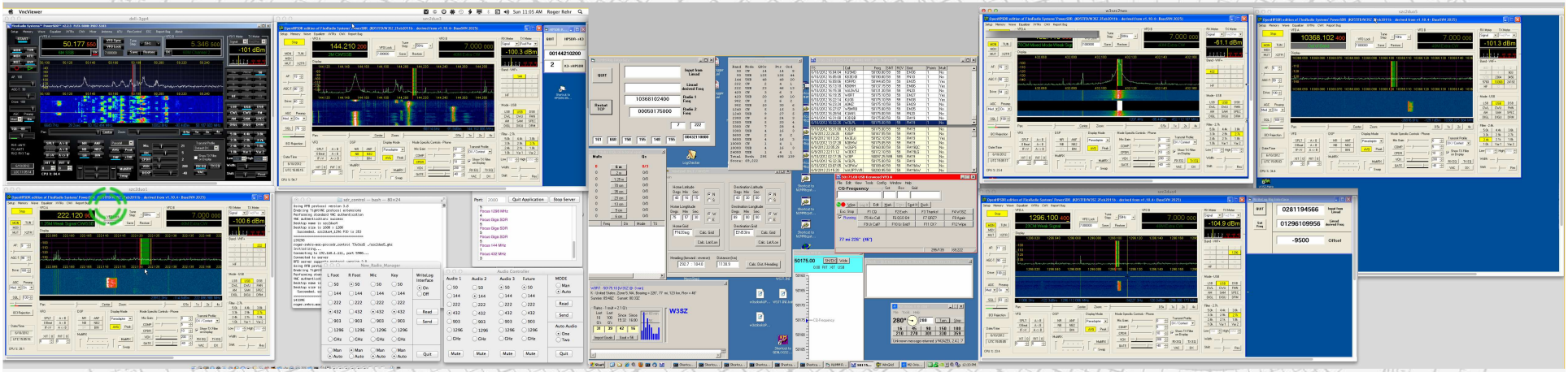
- One Bandscope is good
- Multiple Bandscopes are great
- For best results, the Radio must be the Bandscope and all switching must be automated
  - Otherwise too much time is spent bandswitching and fiddling to get the correct radio, correct Mic, correct footswitch, correct CW key, and receive audio for the appropriate radio/band

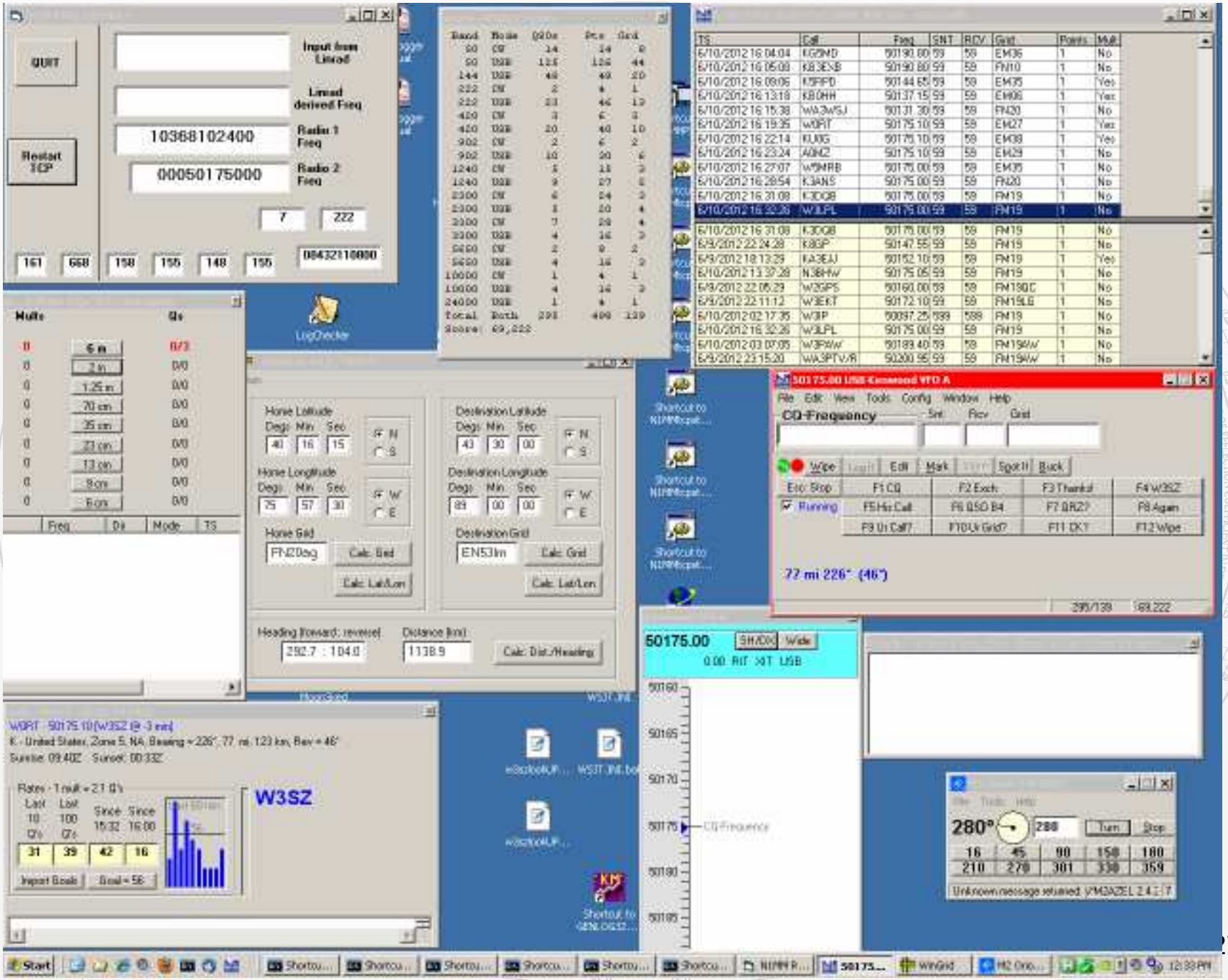
Requisite Station Parameters

- Constant bandscope monitoring of each of the bands 50, 144, 222, 432, and 1296 MHz, and a shared fulltime bandscope for 903 MHz and 2.3 GHz and up
- Band selection by clicking on the appropriate band/radio GUI or typing the desired frequency into N1MM
- Automatic logging of frequency / band
- Automatic switching of Mic, voice keyer, footswitch, key/keyer, and receive audio to the appropriate radio
- All radios to be seen by the logging program (N1MM) as one 11 band radio

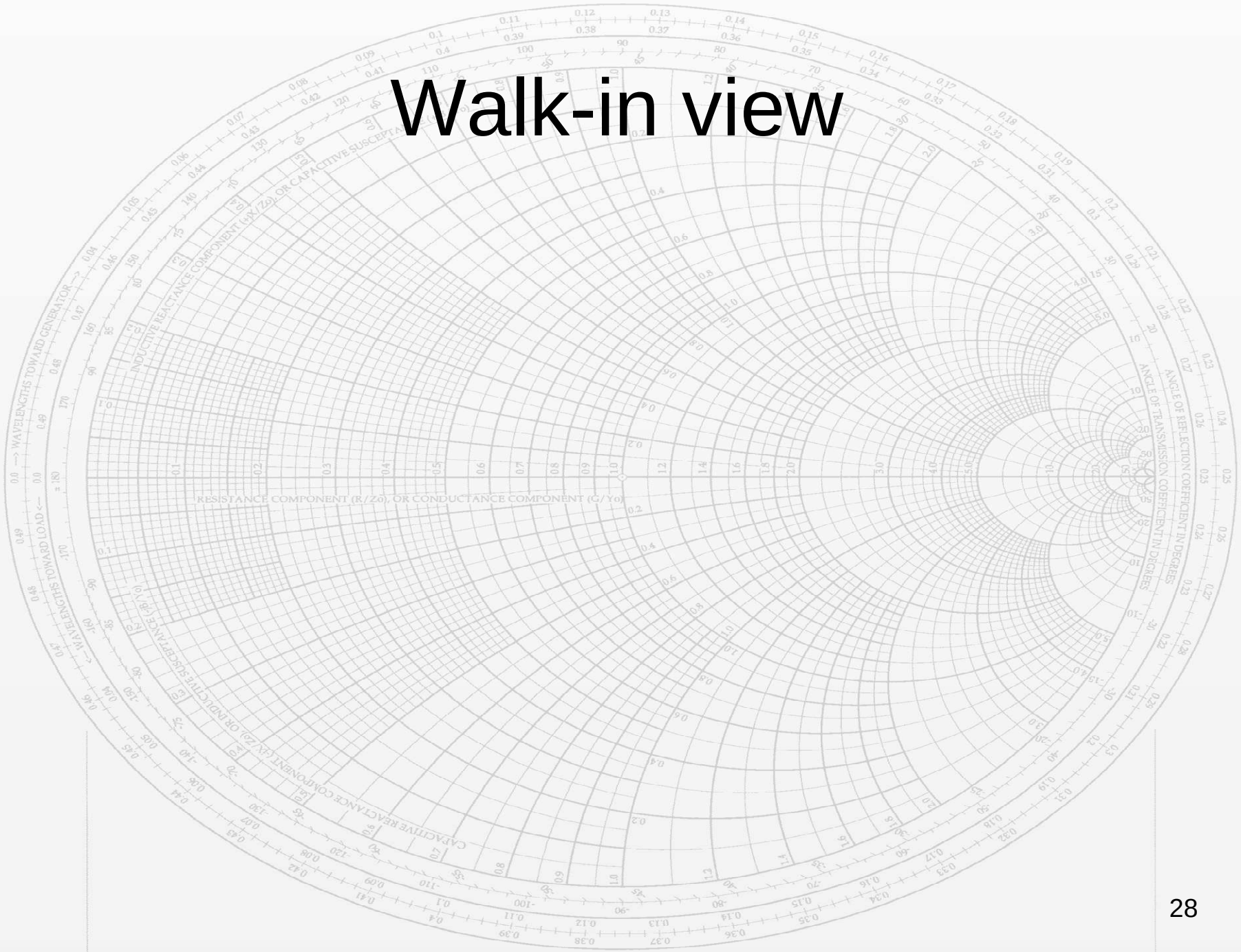
More Station Parameters

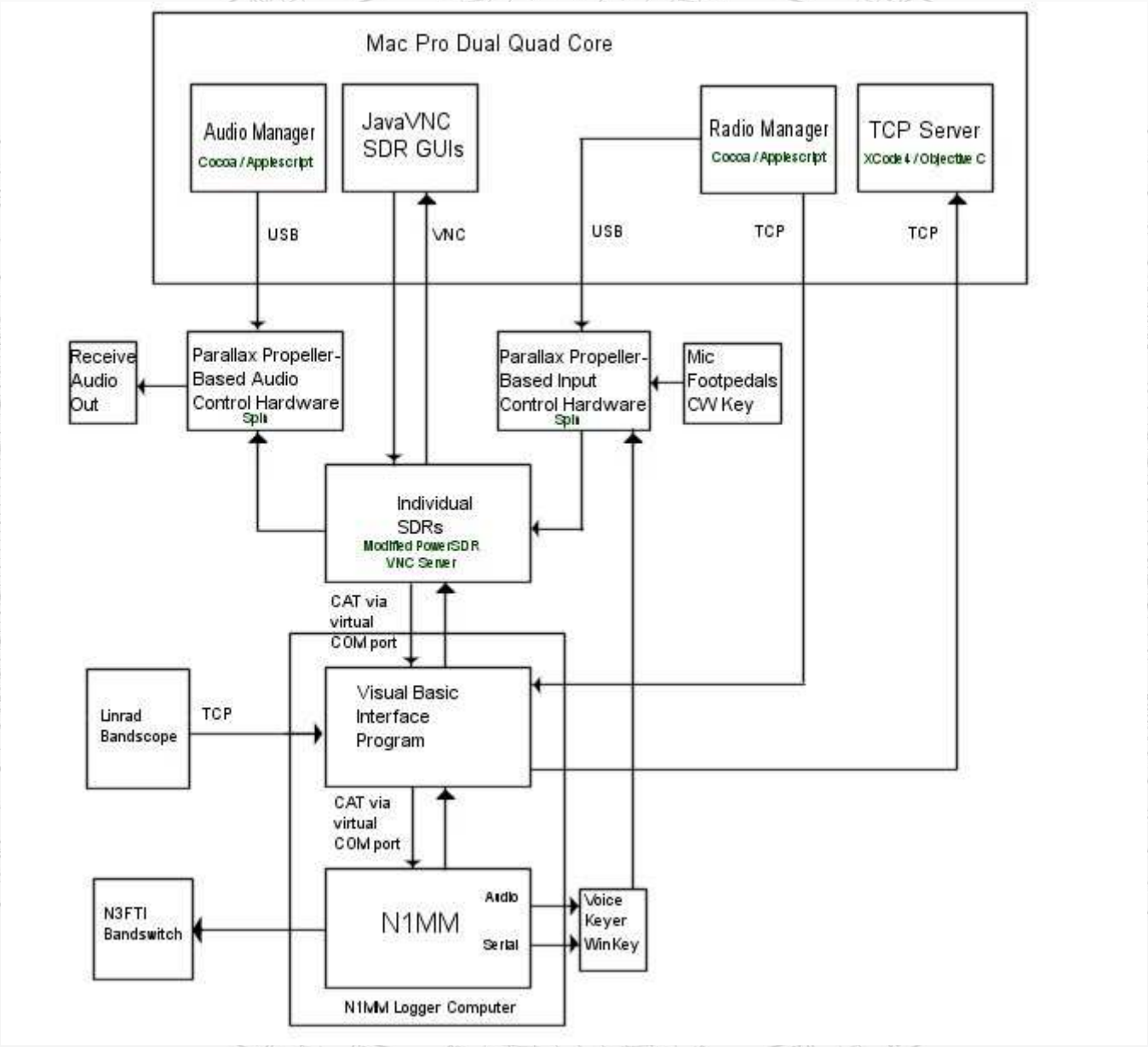
- Full integration of N1MM and the radios
  - When band is selected using N1MM, the appropriate radio is selected and all switching is performed automatically
  - When band is selected by clicking on appropriate radio's GUI, N1MM is set to the radio's frequency and all switching is performed automatically
  - Voice keying and CW keying from N1MM are automatically connected to the appropriate radio
  - Frequency can be changed by [1] clicking on the bandscope, [2] typing the frequency into N1MM, [3] dialing the ShuttlePro2 knob, [4] using the Up/Down arrows on the computer, [5] typing the frequency into the PowerSDR VFO window




QUIT
Restart ICP
Input from Linrad
Linrad derived Freq
10368102400
Radio 1 Freq
000501750000
Radio 2 Freq
Mults
Qs
Home Latitude
Destination Latitude
Home Longitude
Destination Longitude
Home Grid
Destination Grid
Heading (forward: reverse)
Distance (km)
CQ-Frequency
72 mi 226° (46°)
50175.00
W3SZ
280°

Walk-in view


RESISTANCE COMPONENT (R/Z0), OR CONDUCTANCE COMPONENT (G/Y0)
INDUCTIVE REACTANCE COMPONENT (+jX/Z0), OR CAPACITIVE SUSCEPTANCE
CAPACITIVE REACTANCE COMPONENT (-jX/Z0), OR INDUCTIVE SUSCEPTANCE
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD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Audio Manager
Cocoa / Applescript
JavaVNC
SDR GUIs
Radio Manager
Cocoa / Applescript
TCP Server
XCode 4 / Objective C
USB
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Linrad
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Interface
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CAT via
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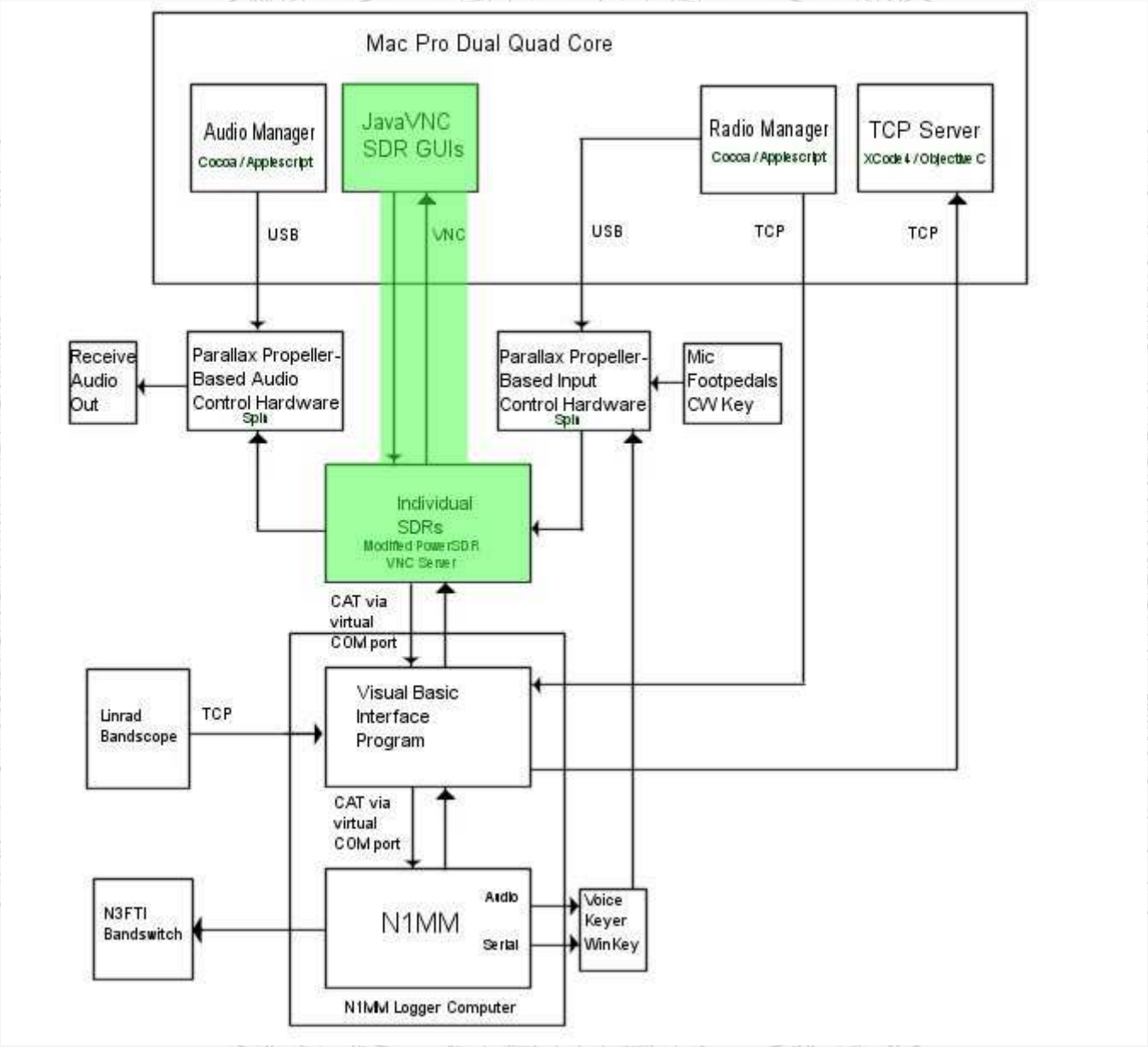
N3FTI
Bandswitch
N1MM
Audio
Serial
Voice
Keyer
WinKey
N1MM Logger Computer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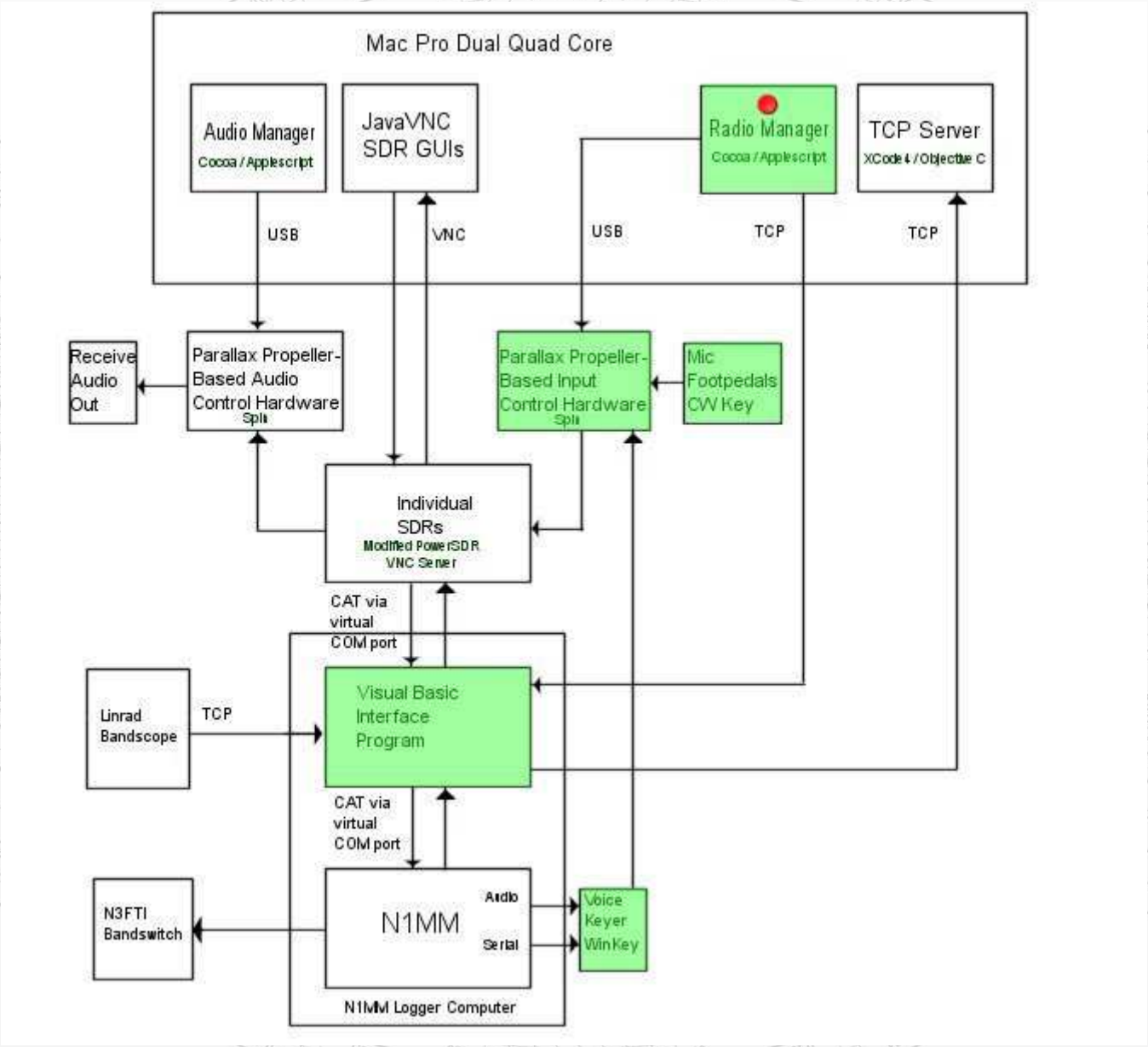
VNC (Virtual Network Computing)

- Transmits keyboard and mouse events (including ShuttlePRO commands) from client (MacPro) to servers (individual SDR computers)
- Transmits graphical screen updates from servers to client
- TightVNC Servers on SDR computers
- TightVNC Java Viewers used on MacPro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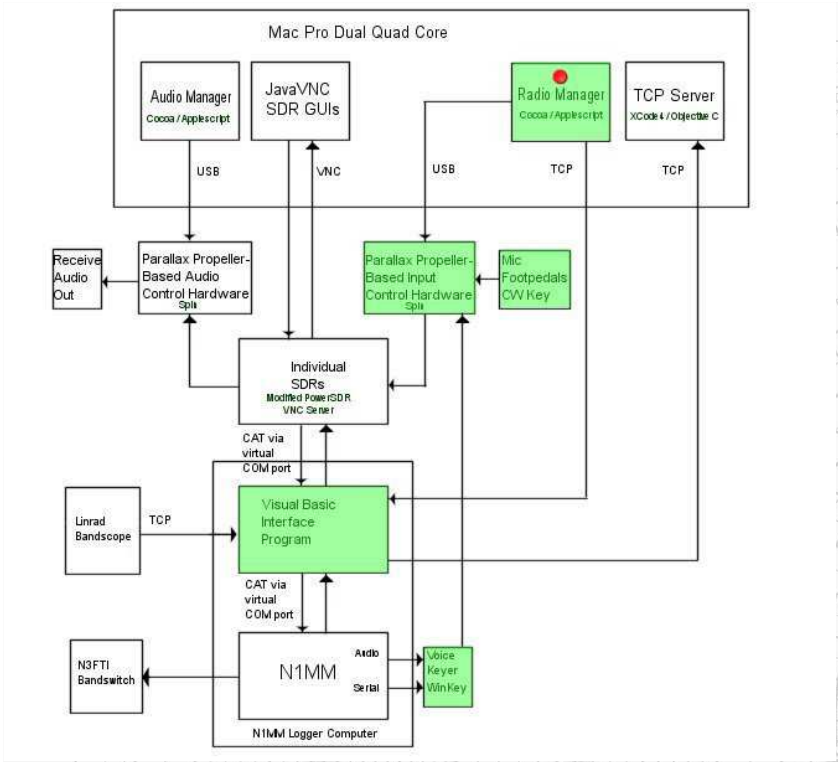
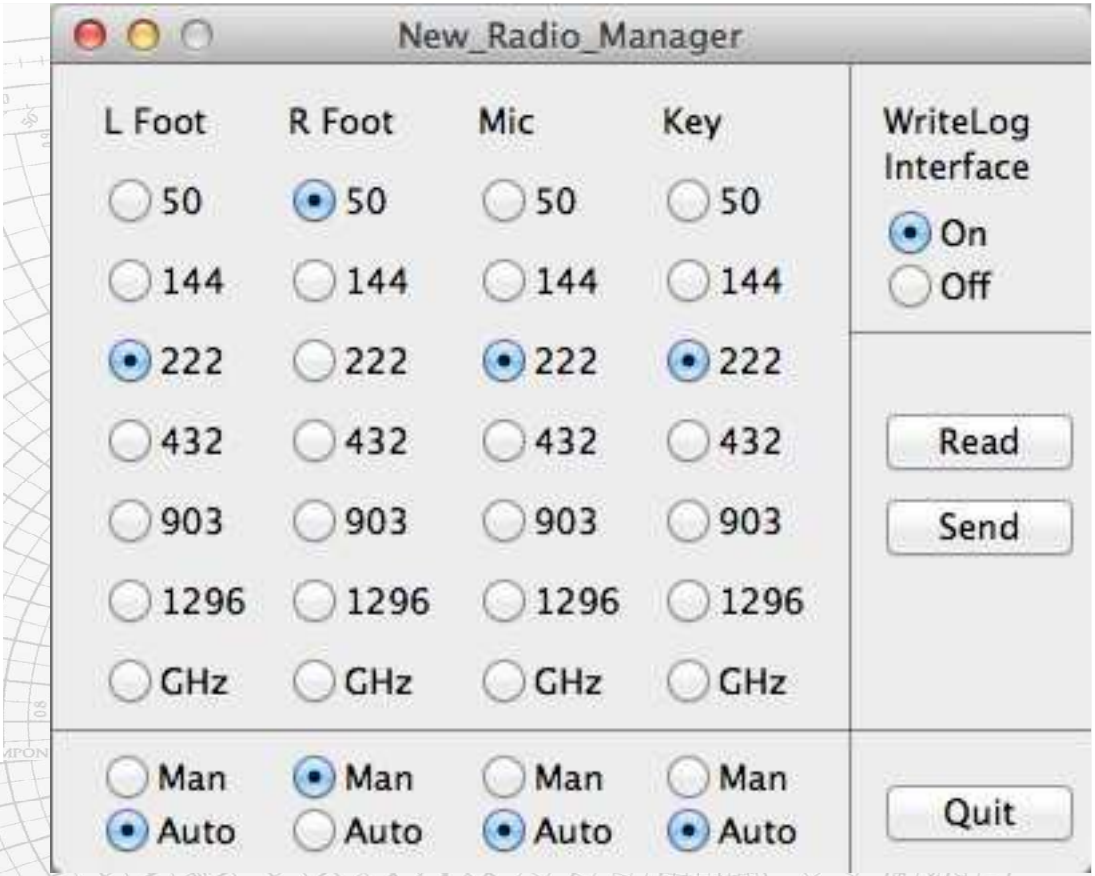




RadioManager (Applescript)

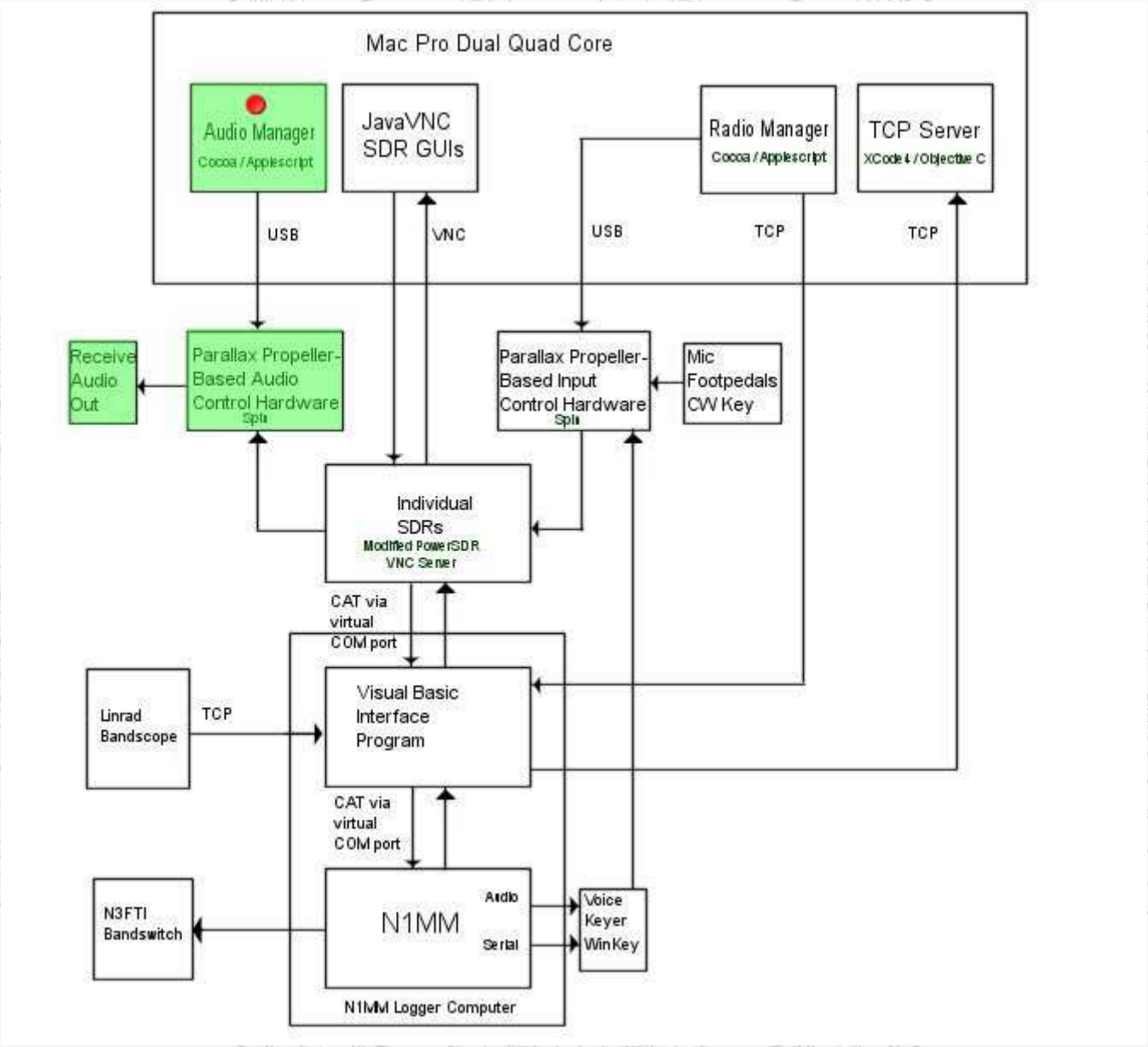
Allows manual or automatic switching of Mic, right and left footswitches, CW key to desired radio

Tells Logging Computer which Band/Radio has GUI Focus:

sets band in N1MM for logging

Done via shell script "/TCPStuff/EchoServer/tcpclient 1296000"

Verbalizes band [say "12 96“]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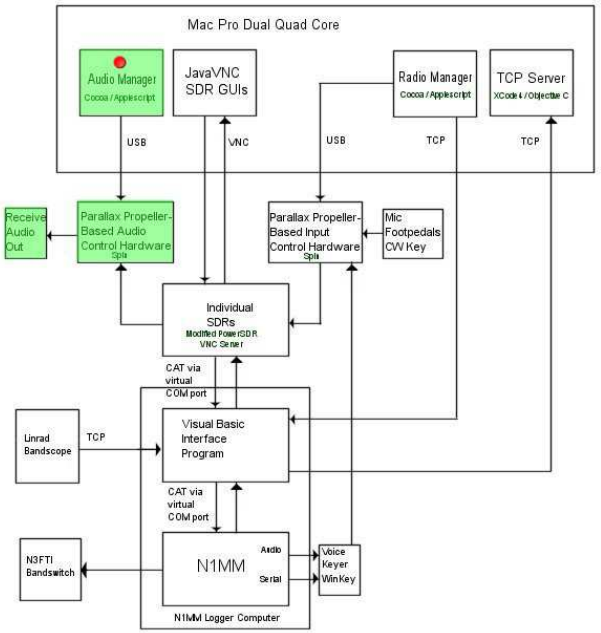
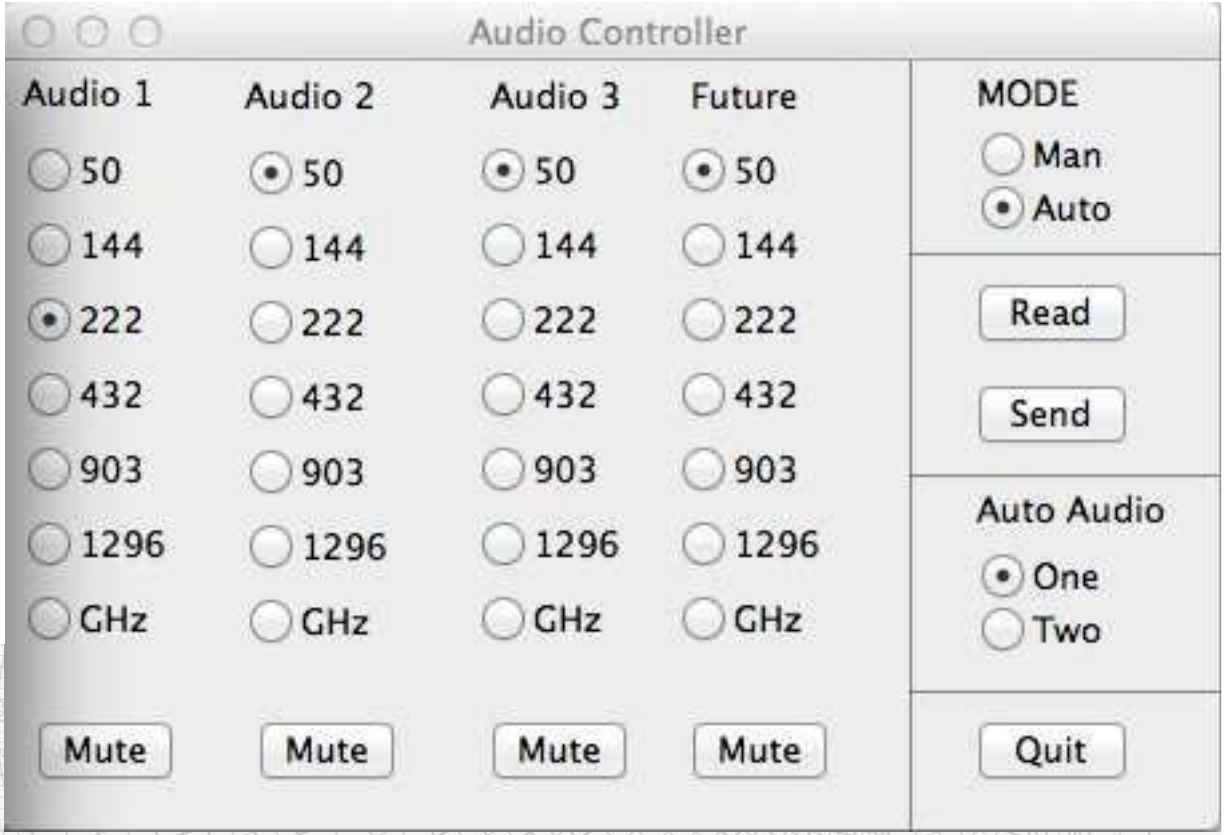
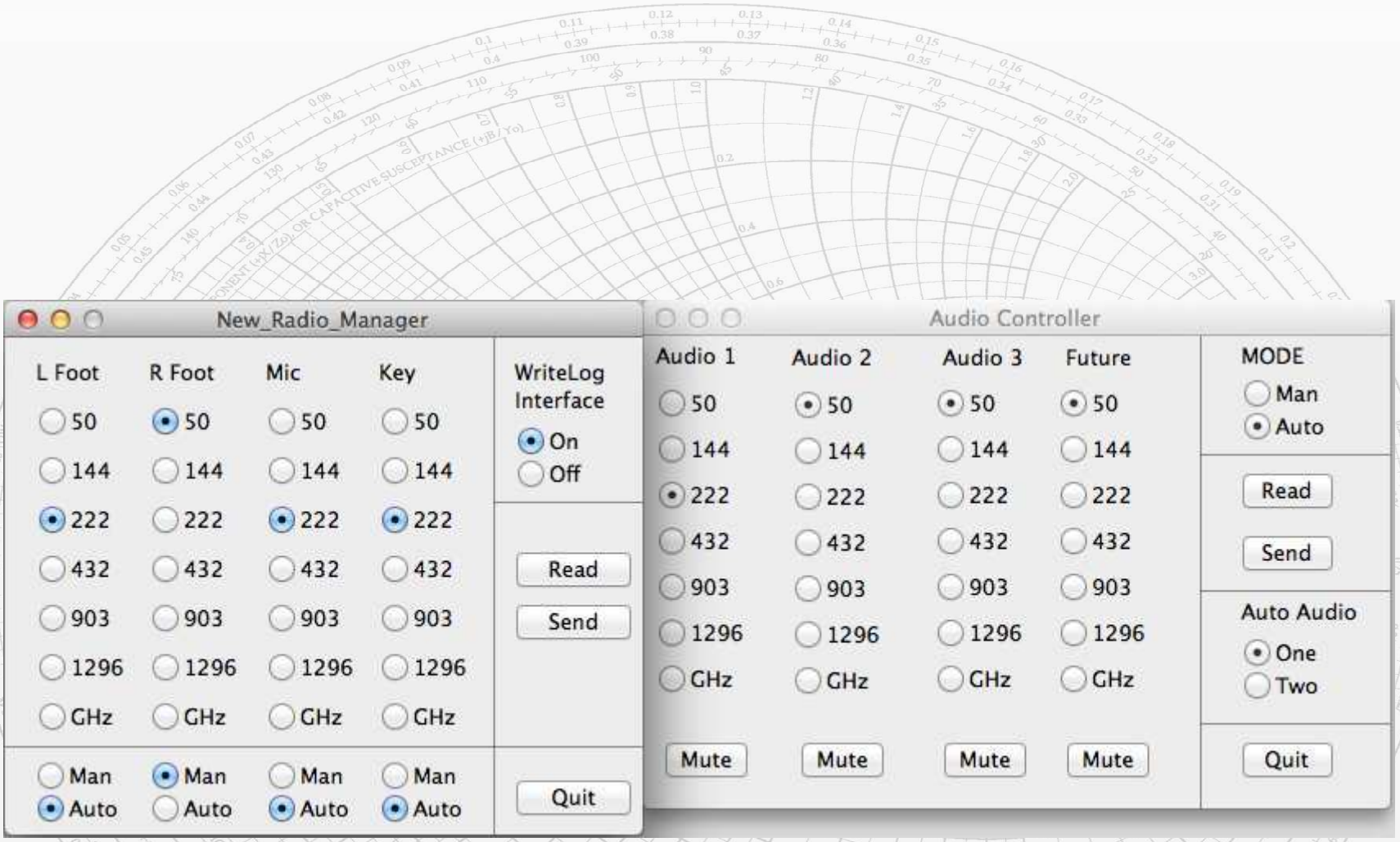


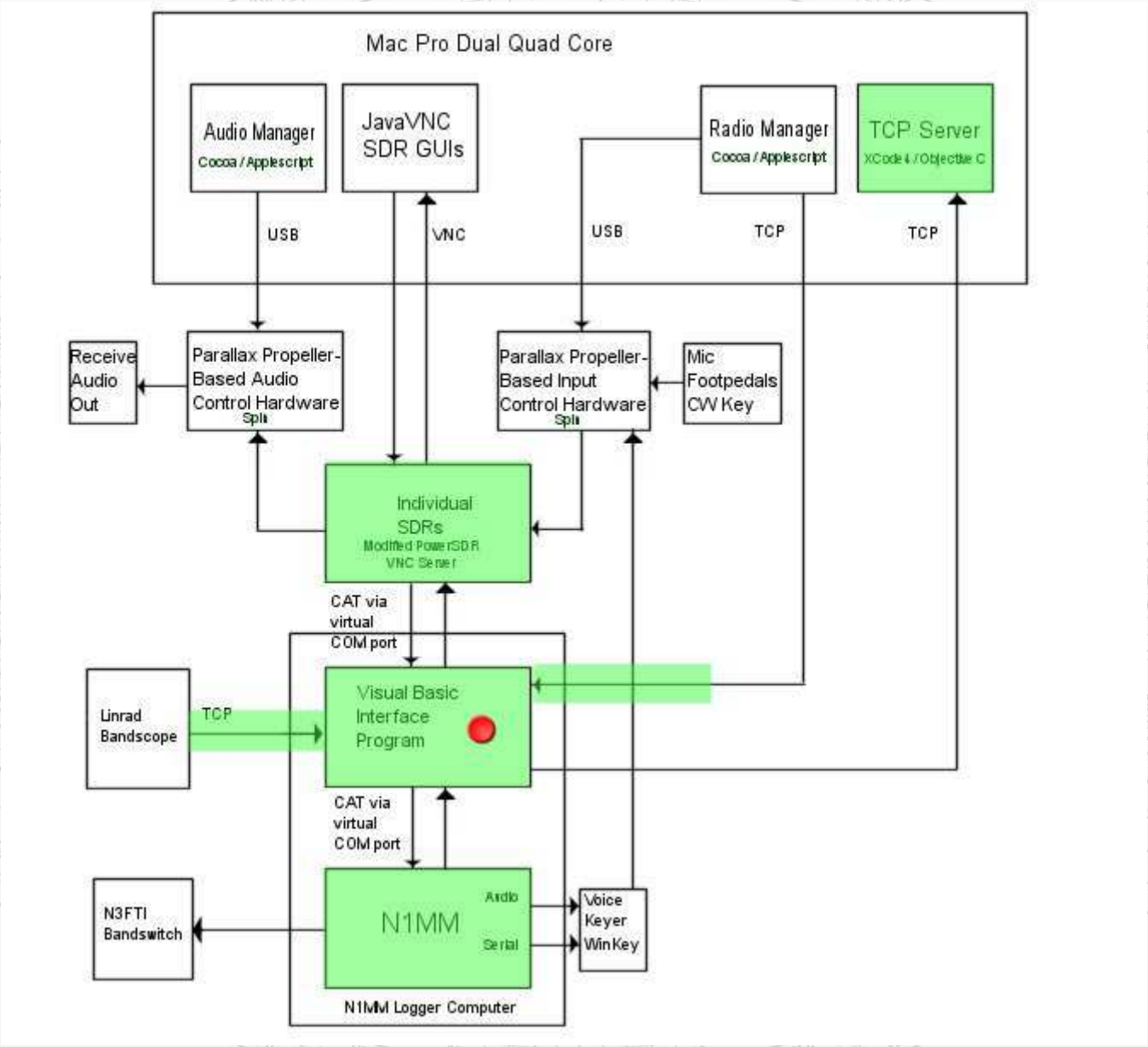


Audio Controller (Applescript)

Directs receive audio from appropriate radios to speakers, headphones, or to computer for digital modes

Allows manual or automatic switching


New_Radio_Manager
L Foot
R Foot
Mic
Key
50
144
222
432
903
1296
GHz
Man
Auto
WriteLog Interface
On
Off
Read
Send
Quit
Audio Controller
Audio 1
Audio 2
Audio 3
Future
Mute
MODE
Man
Auto
Auto Audio
One
Two


Mac Pro Dual Quad Core
Audio Manager
Cocoa / Applescript
JavaVNC
SDR GUIs
Radio Manager
Cocoa / Applescript
TCP Server
XCode 4 / Objective C
USB
VNC
USB
TCP
TCP
Receive
Audio
Out
Parallax Propeller-
Based Audio
Control Hardware
Spli
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Footpedals
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Individual
SDRs
Modified PowerSDR
VNC Server
CAT via
virtual
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Linrad
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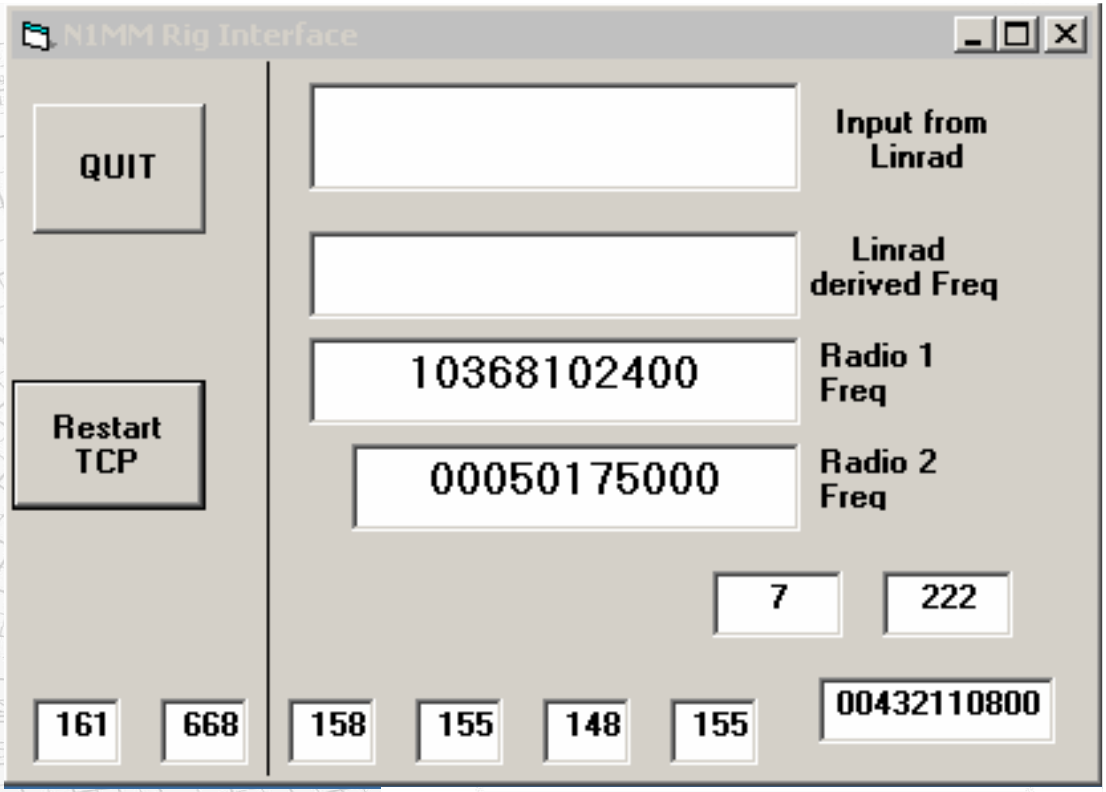
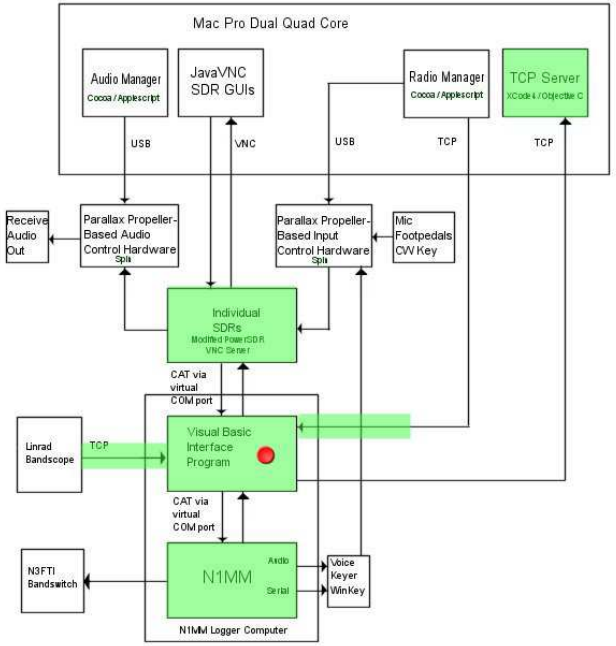
TCP
Visual Basic
Interface
Program
CAT via
virtual
COM port
N3FTI
Bandswitch
N1MM
Audio
Serial
Voice
Keyer
WinKey
N1MM Logger Computer

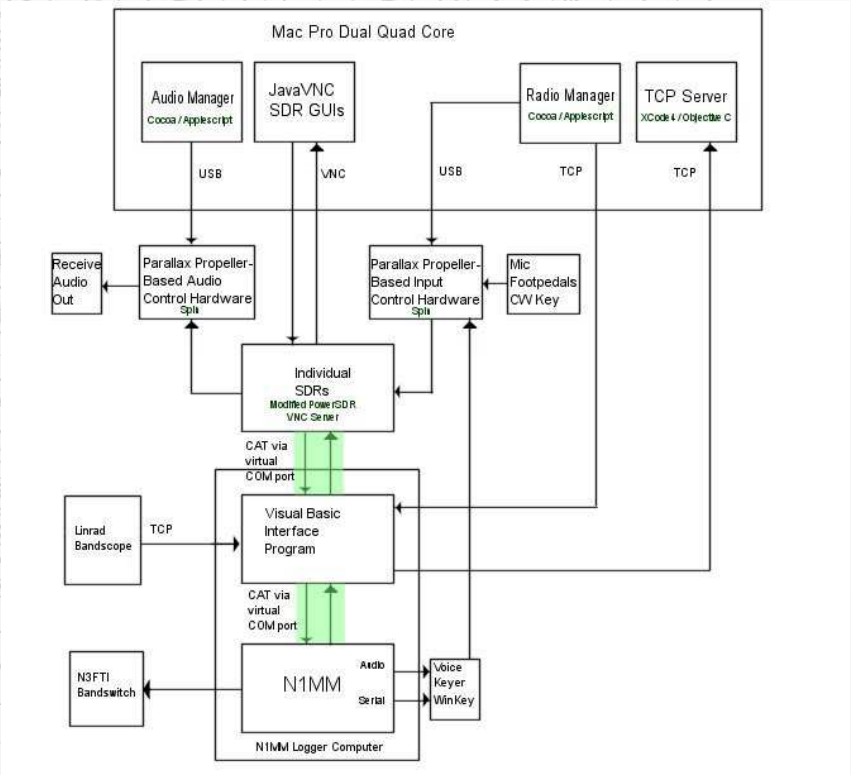
- Visual Basic Interface Program on N1MM computer
  - Receives band information from MacPro, sends it to N1MM
  - Receives CAT information from appropriate radio and sends it to N1MM
  - Sends CAT information from N1MM to appropriate radio
  - Sends band information from N1MM to Mac Pro
  - Receives frequency information from Linrad and sends to appropriate radio

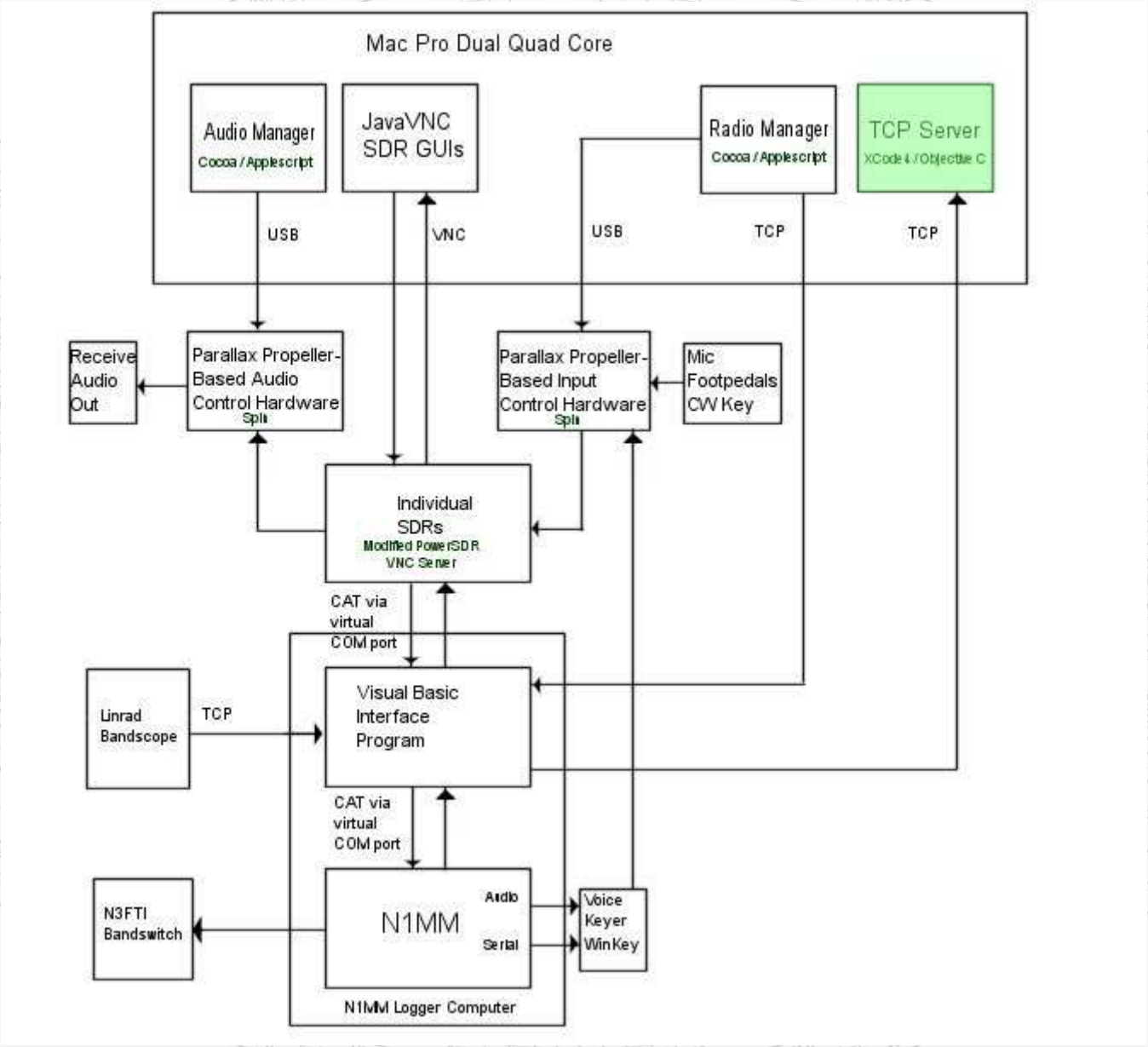




Virtual / TCP Com ports

- Com0com
  - open source kernel-mode virtual serial port driver for Windows
  - unlimited number of virtual COM port pairs
- Hub4com
  - Allows multiple connections to one virtual COM port
- Both run in the background; invisible once started

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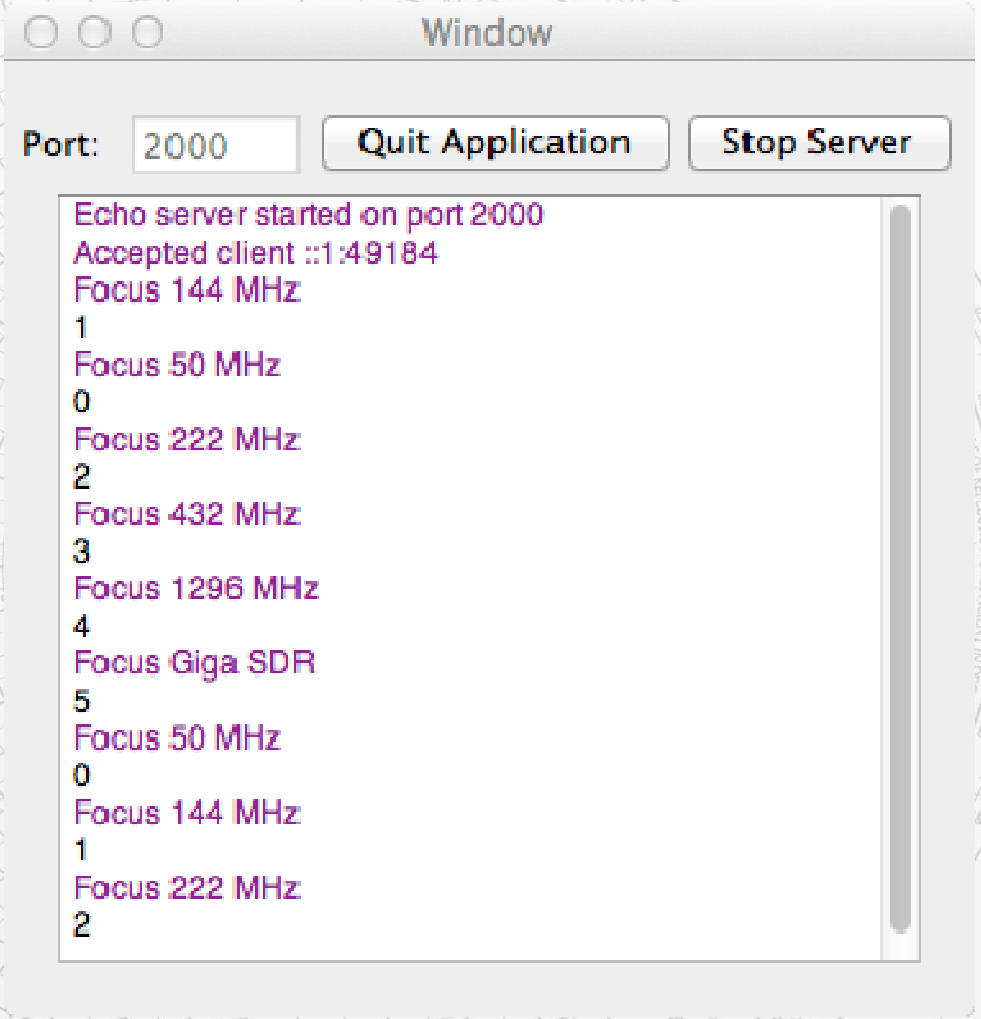
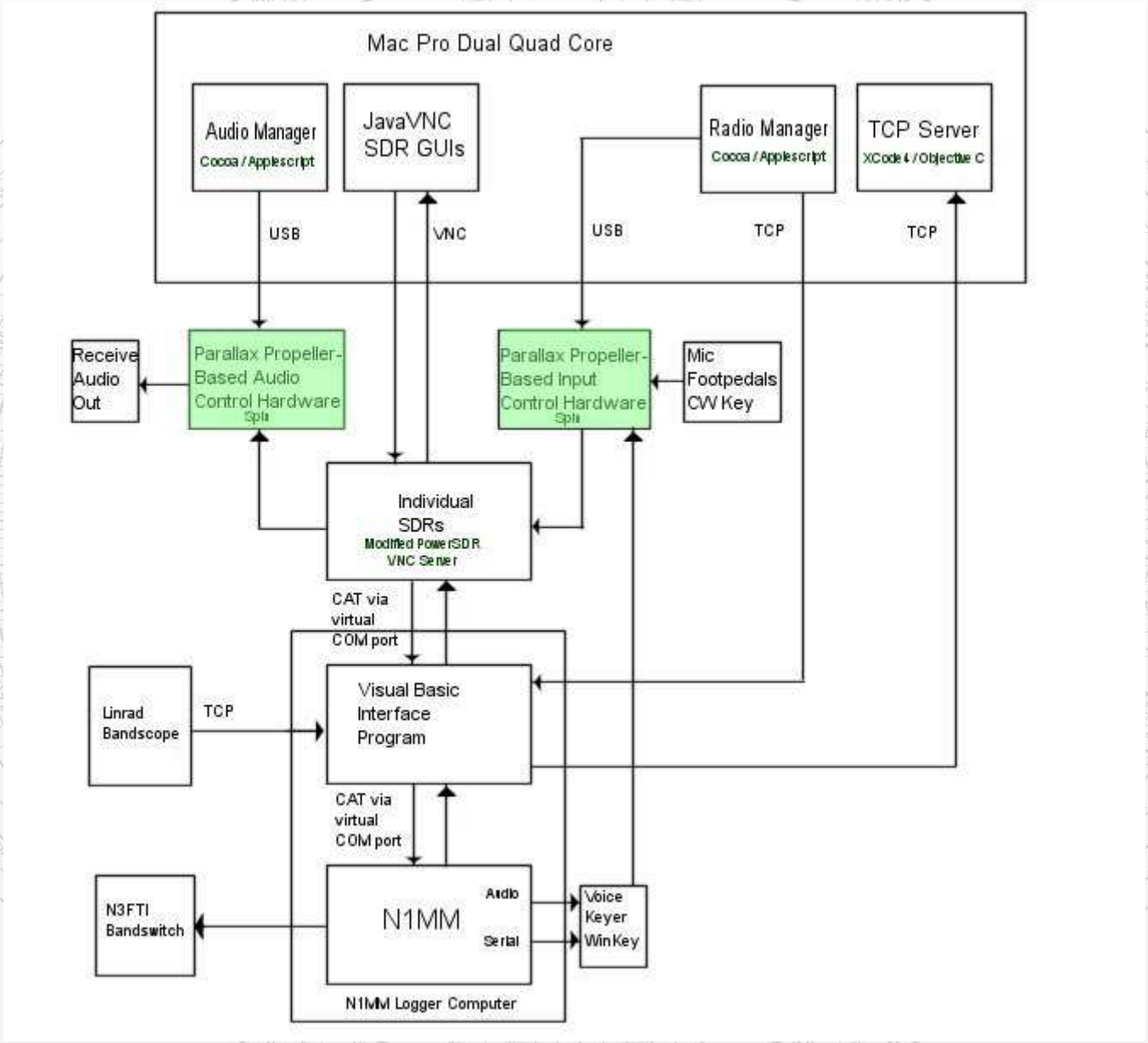
TCP Server (Objective C:)

Receives band information from N1MM logging program via Visual Basic Program on N1MM Computer, gives Focus to the appropriate GUI / band / radio on MacPro

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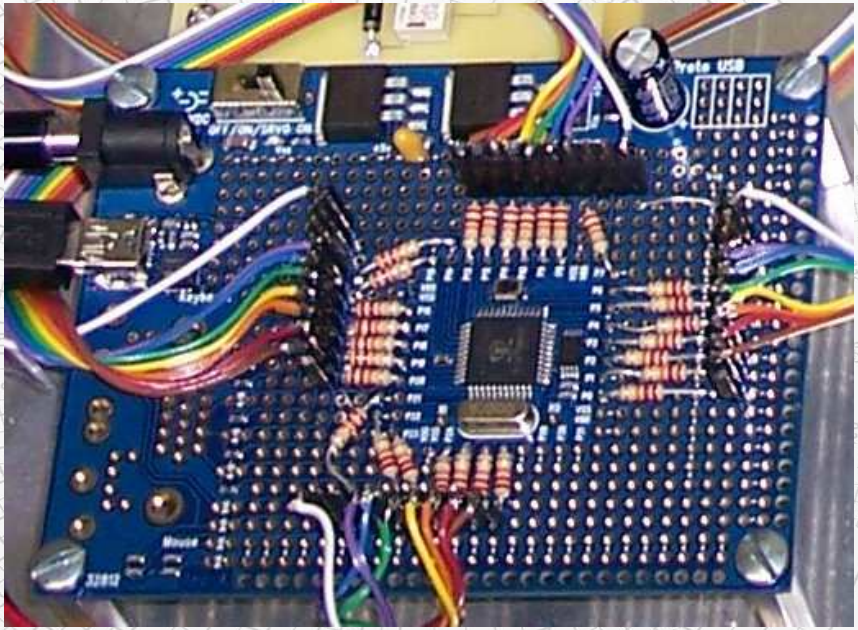
N1MM Logger Computer

Parallax Propeller USB SDR Controller Software

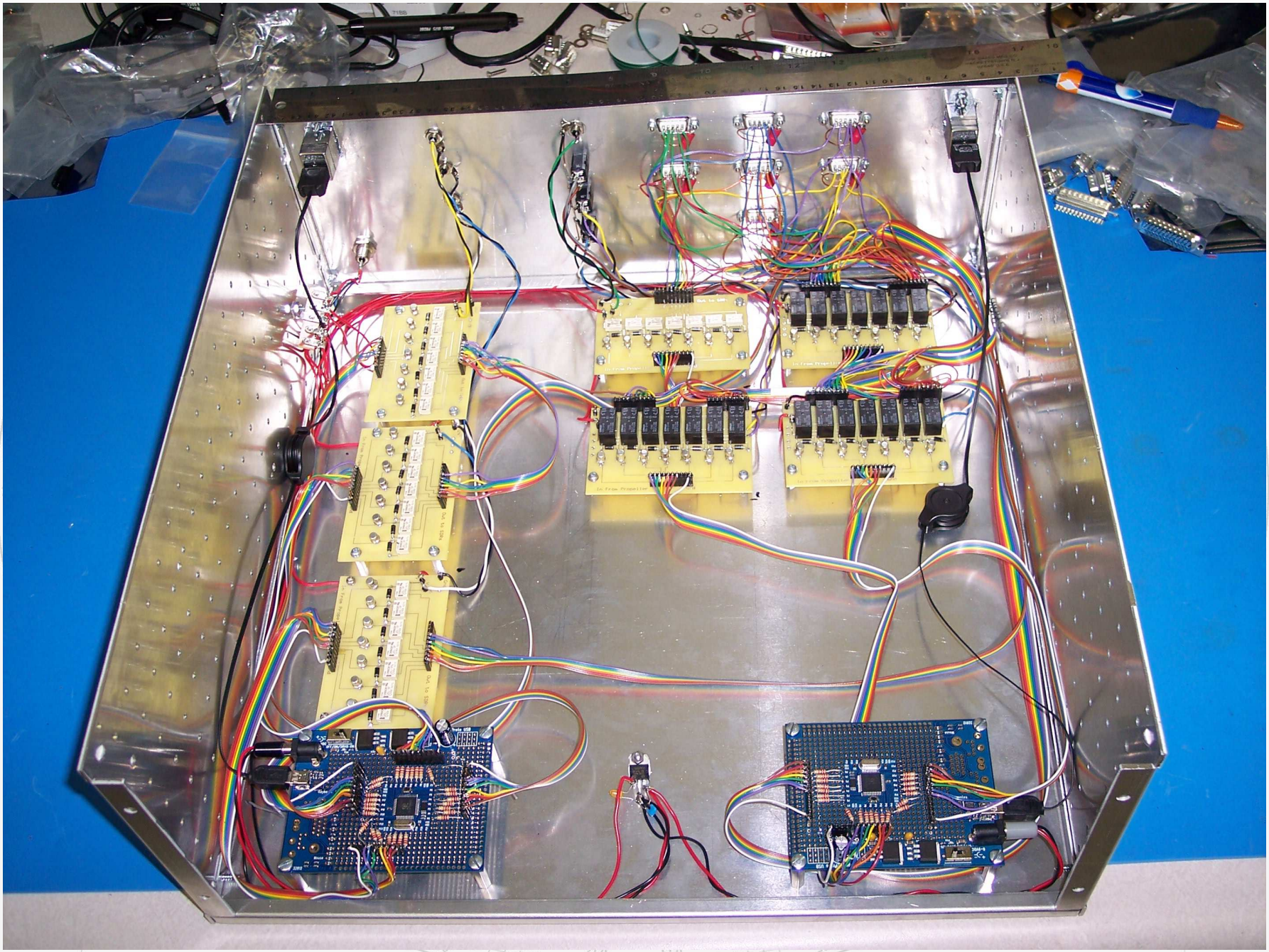
Propeller has 8 32 bit processors [Cogs]
20 MIPS each
Can program in SPIN or in Assembly language

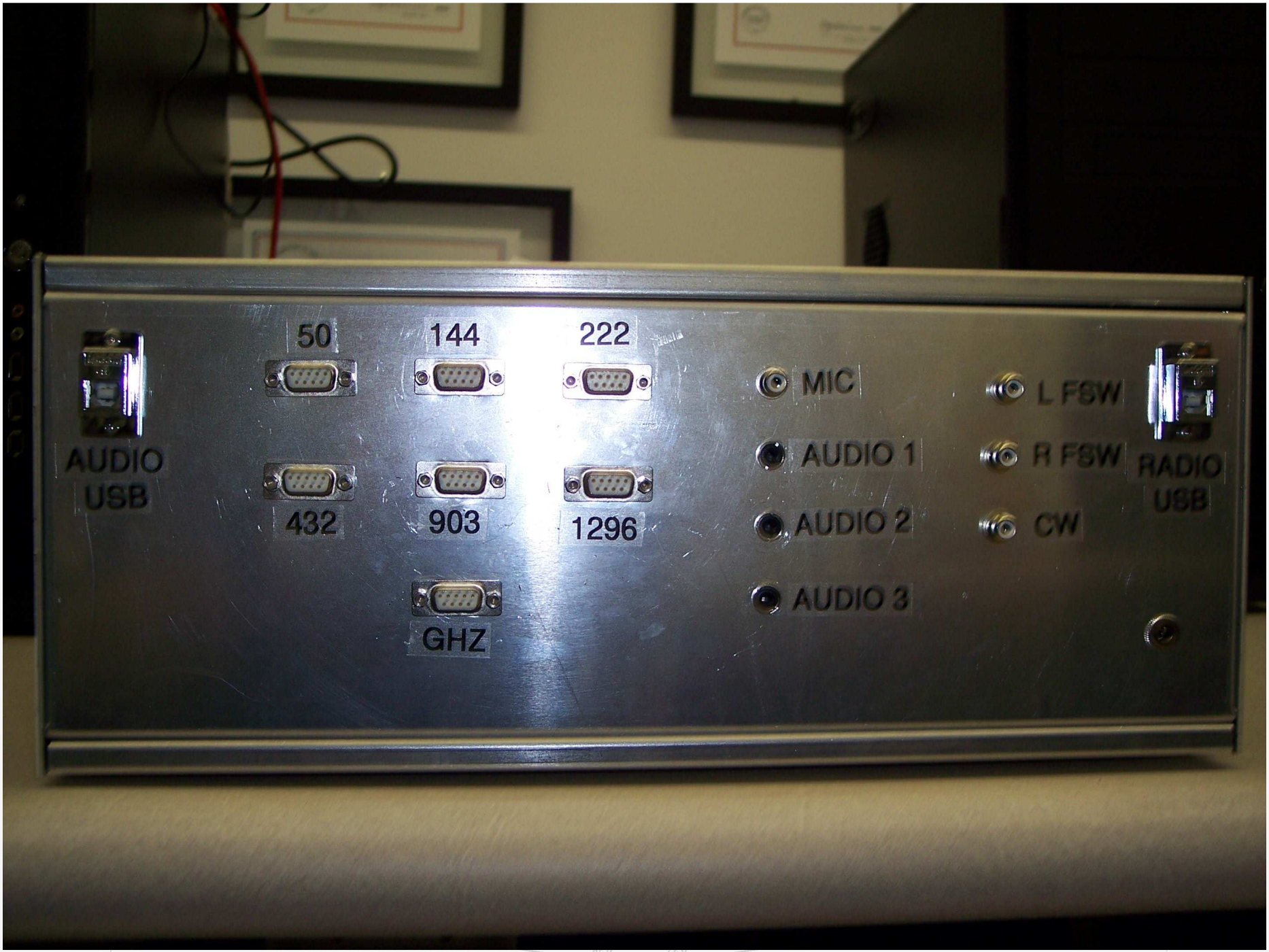


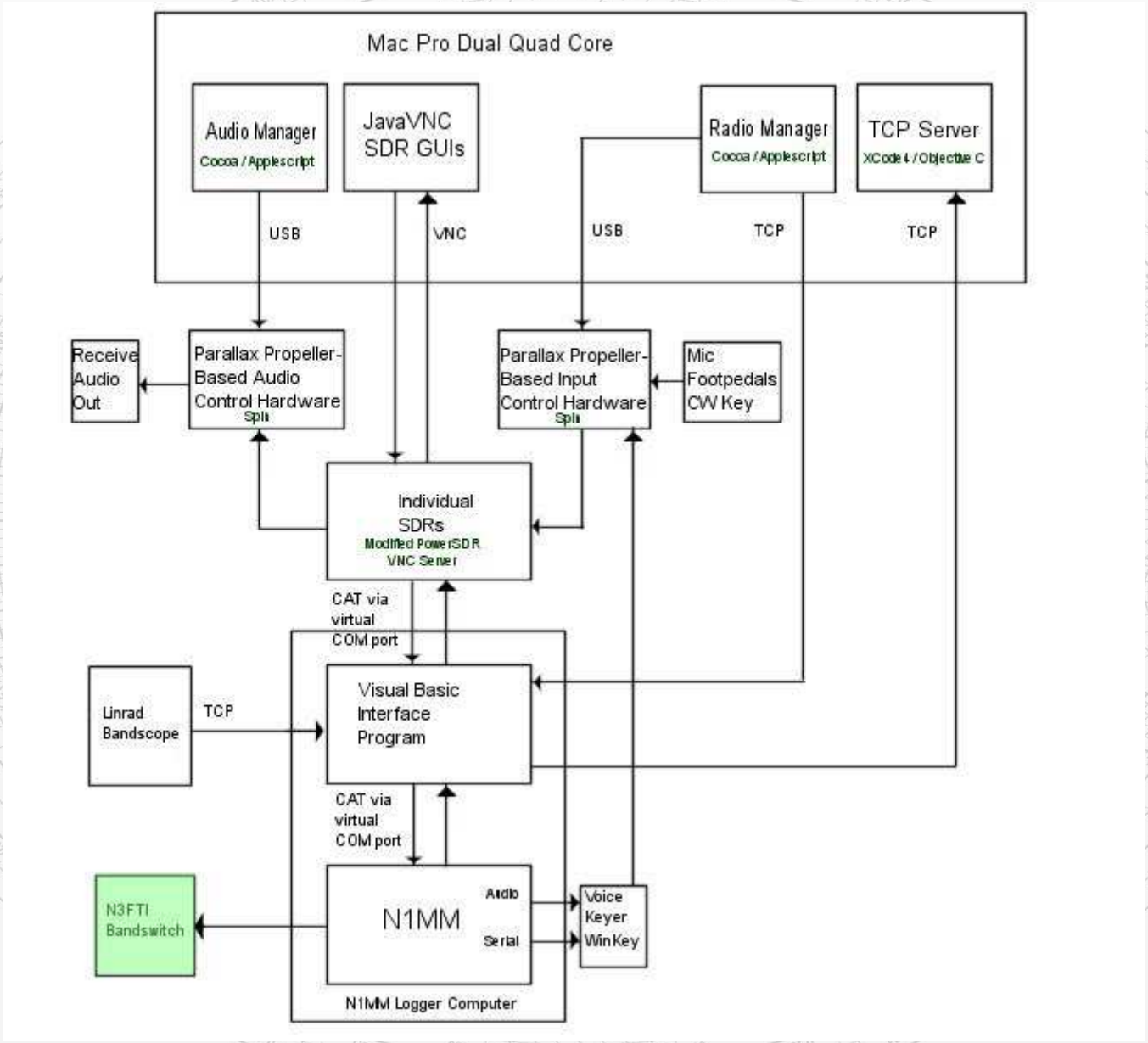
```
Spin:
        DIRA[00..29]~~
        OUTA[00..29] := 0
        Debu.start(31, 30, 0, 19200)
        waitcnt(clkfreq*2 + cnt)
        Debu.rxflush
repeat
        Debu.rxflush
        Debu.str(string("Start Data Acquisition",10,13))
                repeat until STRT == 49
                                Debu.str(string("Enter
        STRT",10,13))
                                STRT := Debu.rx '
                                OUTA[23] := 1
                                Debu.tx(STRT)
                                Debu.str(string(" equals
        STRT",10,13,10,13))
                                if STRT == 49 '
                                                OUTA[23] := 1
                                else

                        Debu.str(string("Wrong initialization
        constant",10,13,10,13))
```


W3SZ MULTI SDR CONTROLLER




AUDIO
USB
50
144
222
MIC
L FSW
RADIO
USB
AUDIO 1
R FSW
432
903
1296
AUDIO 2
CW
AUDIO 3
GHZ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N1MM Logger Computer


EME V/H
50
144
222
432
903
1296
2304
3456
5760
10G
24G
TX
Computer
Man
8
4
2
1
ON/OFF
Wattmeter
432
903
1296
50
222
222
144
50
Rig 1
Rig 2
Tower box Vin
27.9
13.11
Tower 12 V
uwave Tx Indicator
0.10

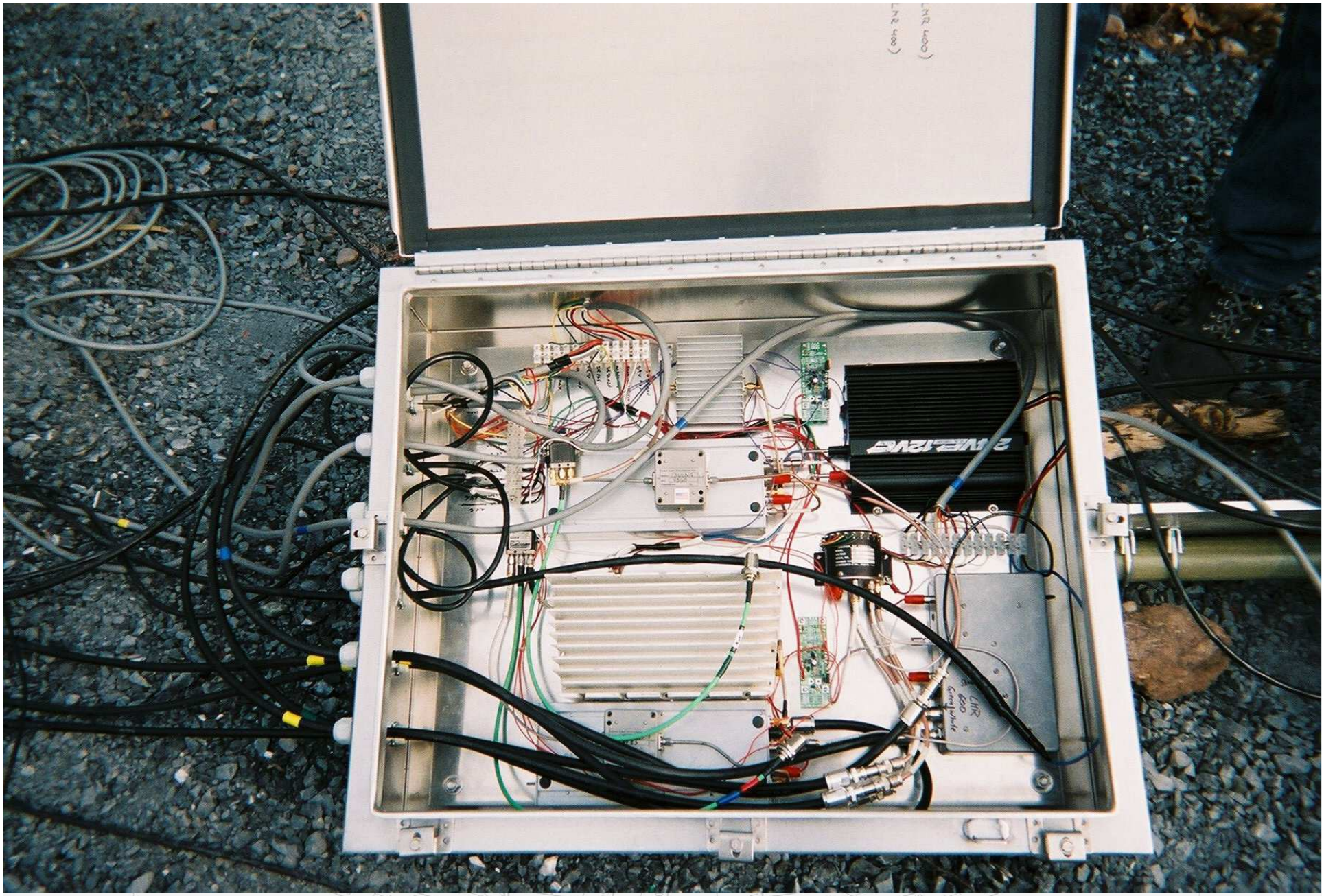
Computers

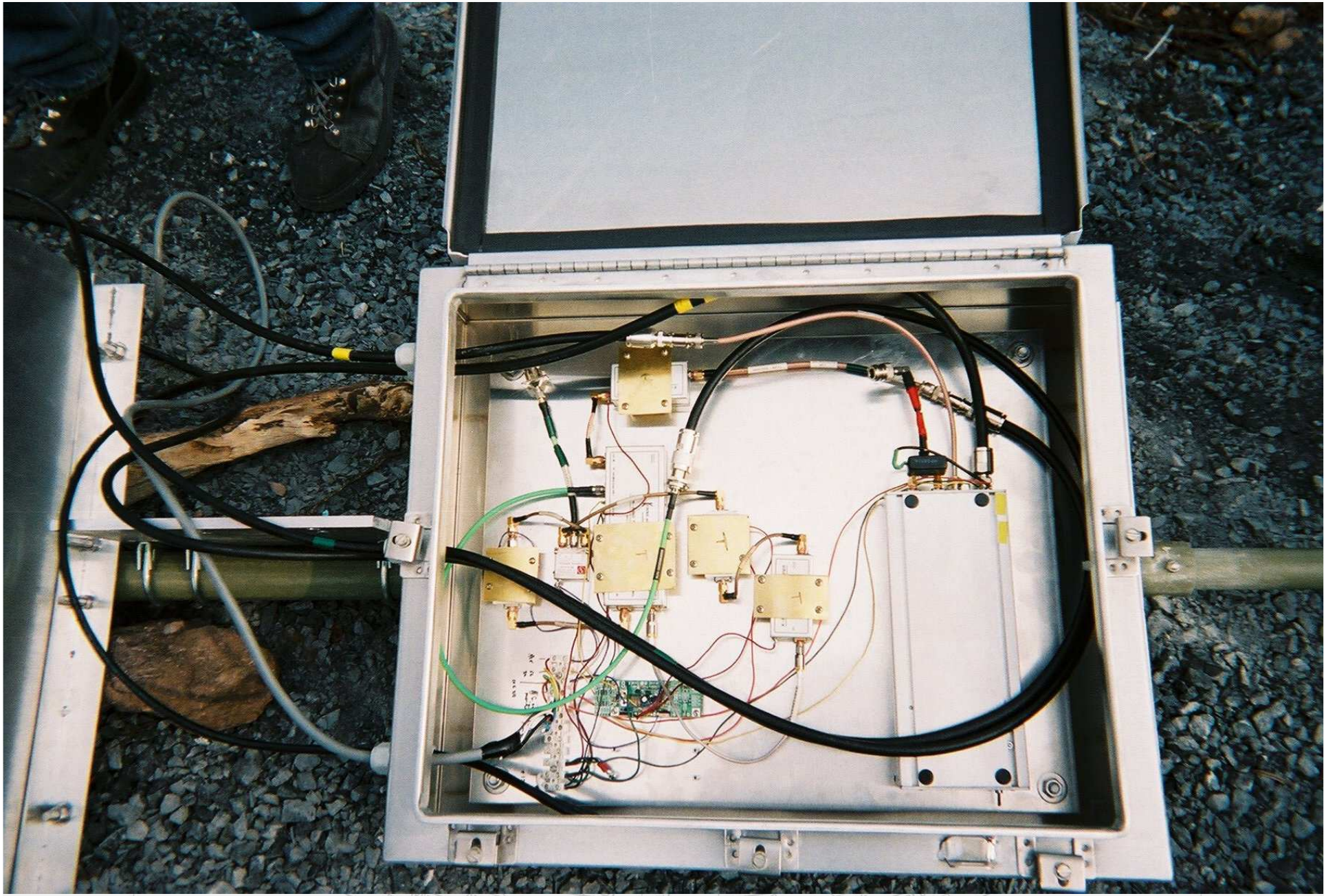
- Radio User Interface: Mac Pro Dual Quad Core running OS X 10.7 (Lion)
- 50 MHz SDR: 3.2 GHz Pentium 4
- HPSDR: (5) 3.1 GHz Core 2 Duo
- Logging Computer: Pentium 4 (? 2.8 GHz)
- Linrad Computer: 3.1 GHz Core 2 Duo

- Except for the Mac Pro, all homebrew or repurposed

Radio Hardware

- IF radios
  - 50 MHz Flex 5000
  - 144 MHz K3 with HPSDR Bandscope
  - 222, 432, 1296 MHz individual HPSDR
  - 903 MHz and 2.3 GHz thru 24 GHz shared HPSDR
- Transverters
  - Mix of DEMI (7), SSB (1), Kuhne (2), and Elecraft (1)

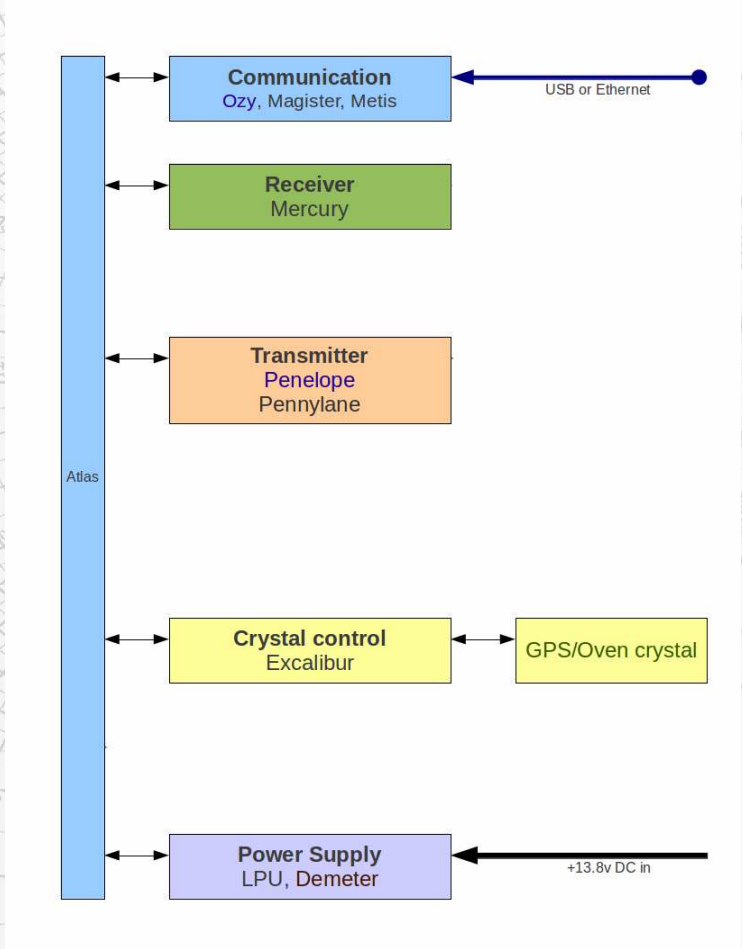




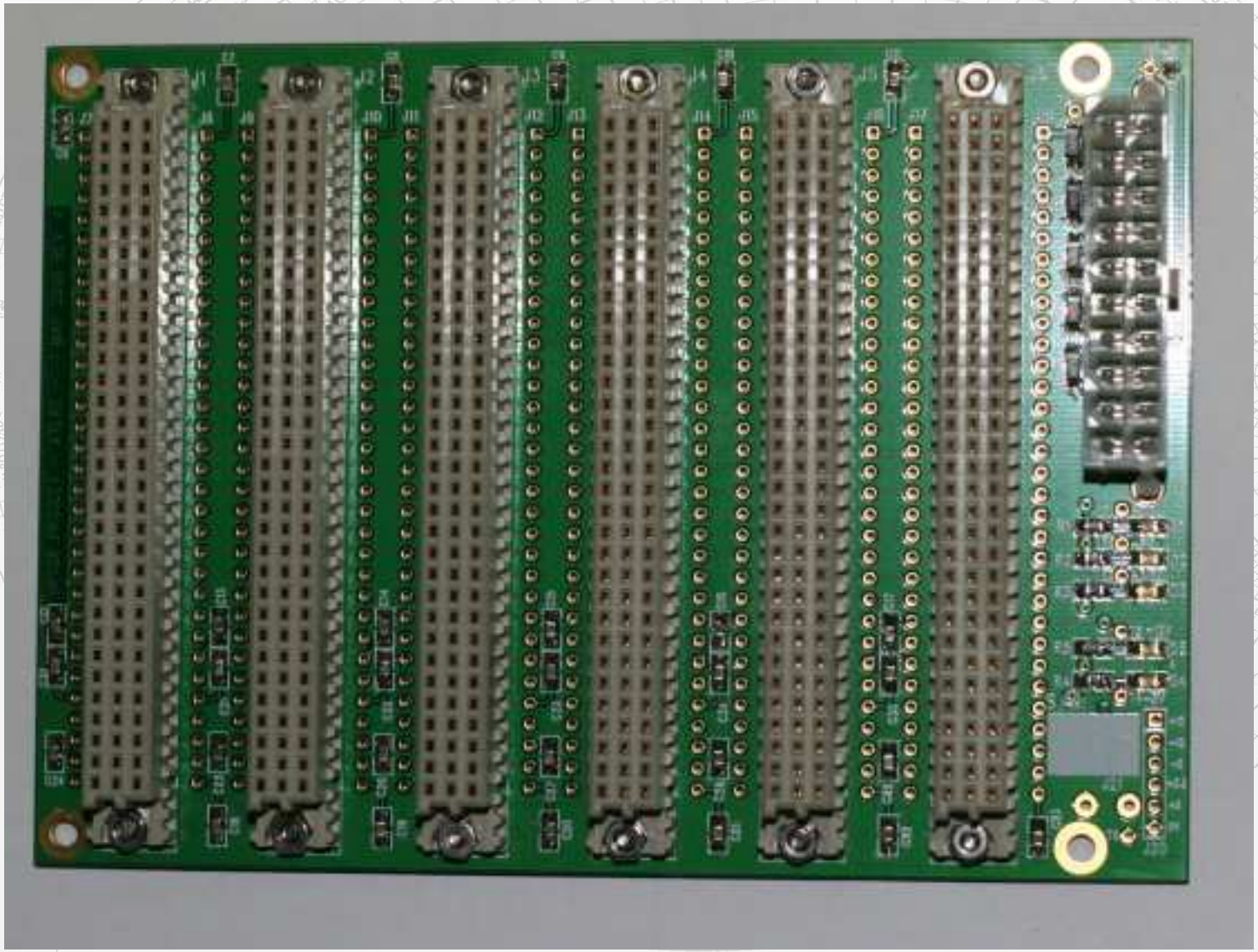
HPSDR

High Performance Software Defined Radio

- Modular experimental SDR
  - Mercury: direct sampling 0-65 MHz receiver
  - Penelope: direct upconversion transmitter
  - Metis: Ethernet interface
  - Ozy: USB interface
  - Excalibur: GPS-disciplined clock
  - Atlas: backplane
- Used for 28 MHz IF

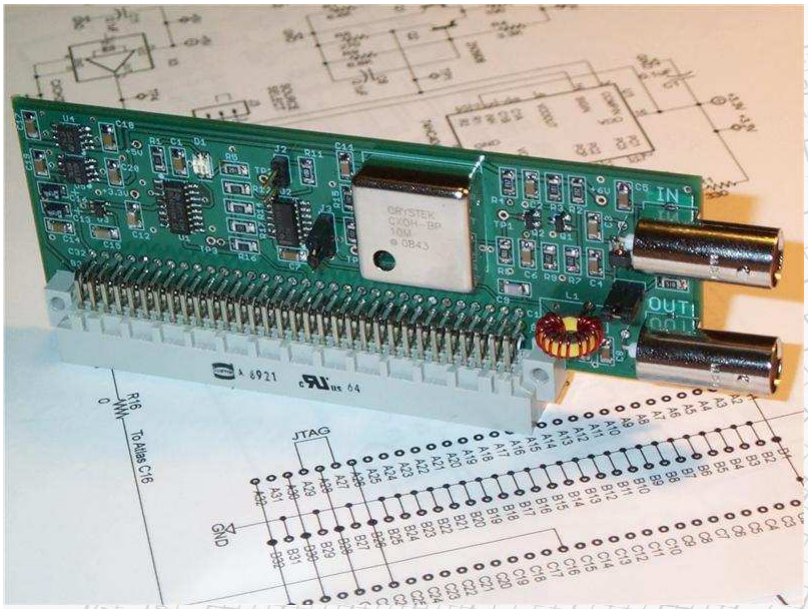


Atlas



- Metis [Ethernet]
- Ozymandias [USB]
- Magister [USB]

Excalibur



- Mercury (Receiver)

Pennylane

Penelope

HPSDR Software: MODIFIED PowerSDR

- Stock FFT size in PowerSDR is 4096
- If bandscope width is 192 KHz, then bin size is 192000/4096 = 47 Hz
  - For weak CW signals, this large bin size results in markedly reduced bandscope sensitivity
- I modified PowerSDR software to allow FFT sizes from 4096 thru 262144
  - At largest FFT size this gives bin size of 0.73 Hz, markedly improving bandscope sensitivity

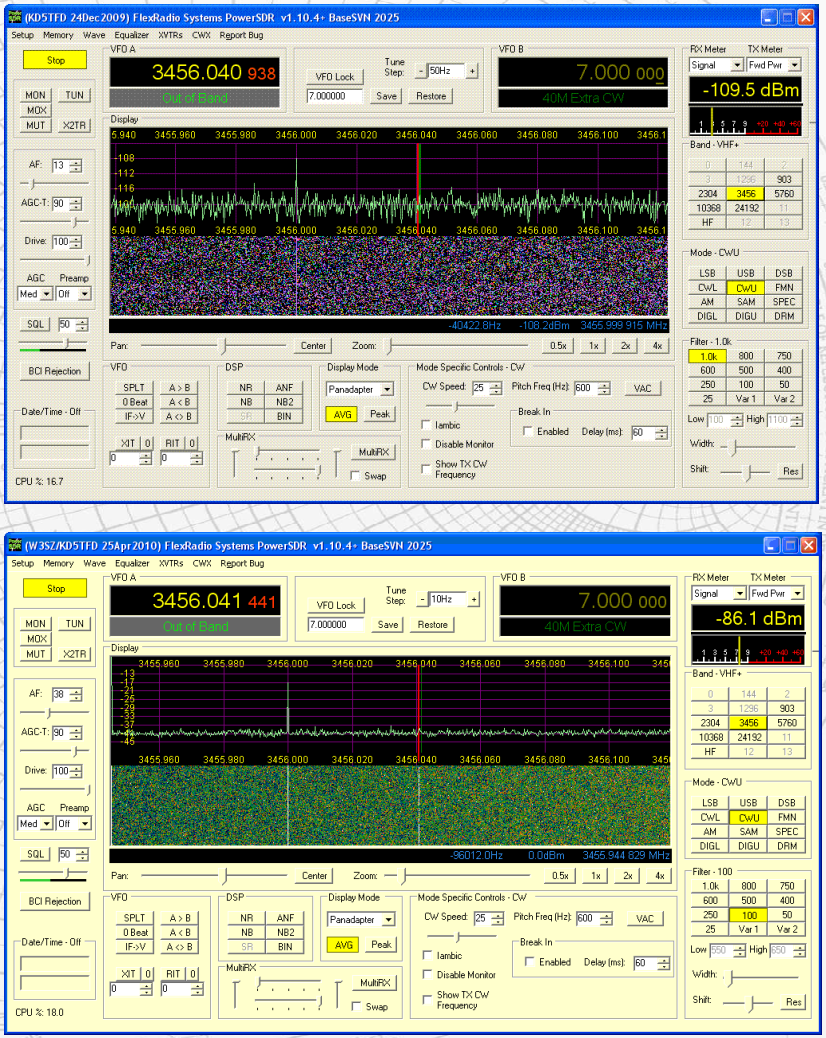
HPSDR Software: MODIFIED PowerSDR

- The loss of sensitivity with the standard FFT size is a REAL problem
  - First time I used stock PowerSDR (September ARRL VHF Contest 2009) there were many signals I could not see, but which were easily visible on simultaneously running Linrad bandscope with large FFT size
  - The modified PowerSDR with large FFT size sees the weak signals missed by the standard version of PowerSDR

Standard vs Modifed PowerSDR

- Effect exists on both zoomed and unzoomed bandscopes [because they have the same FFT size]
- STD wide at right on top
- MOD wide at right on bottom

[On both, ignore birdie at 3456.000]



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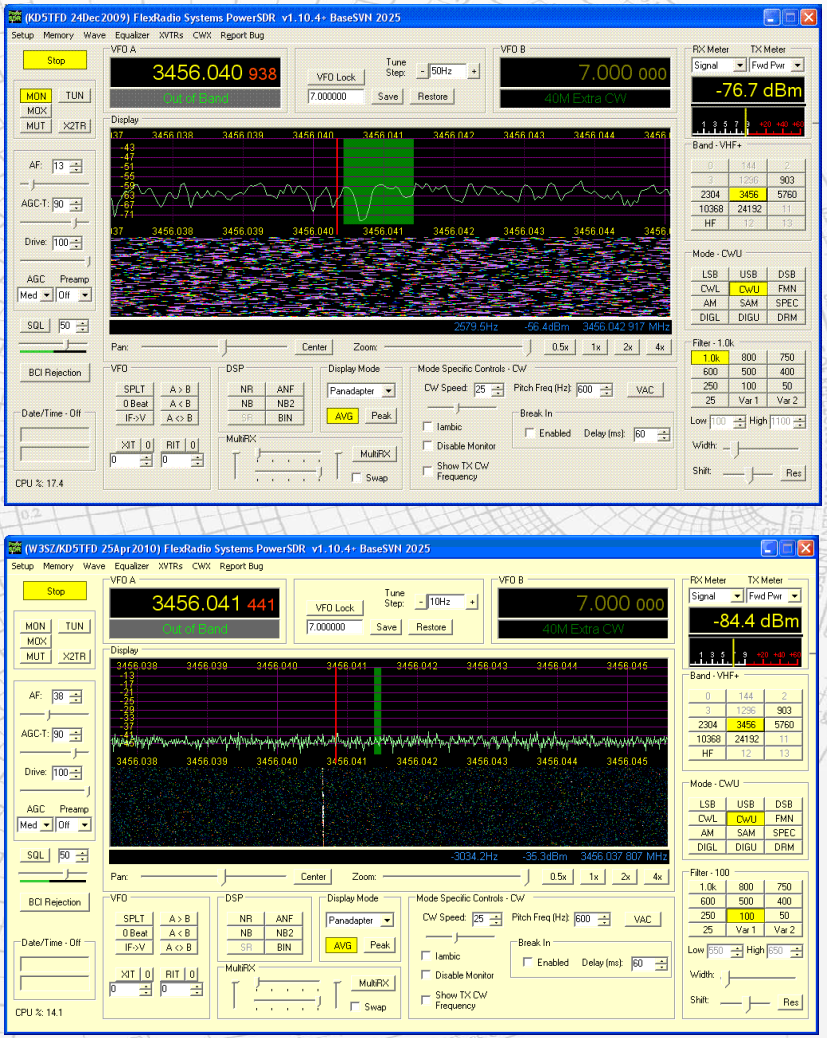
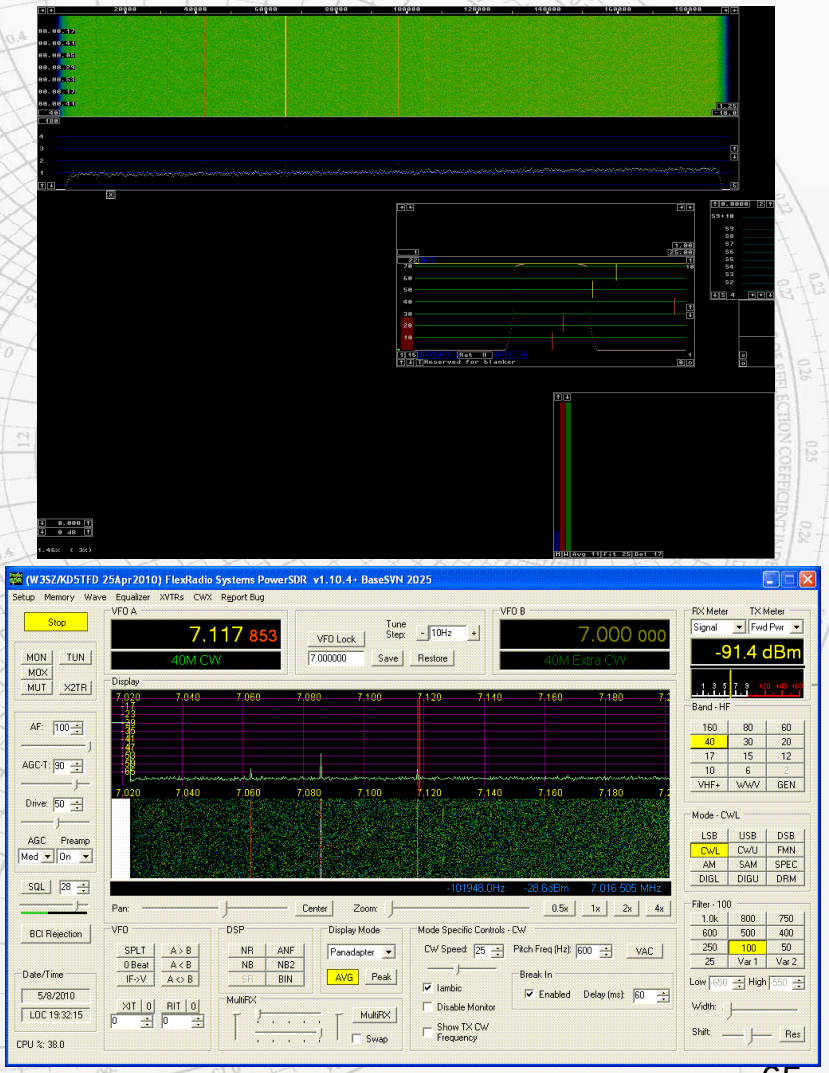


Standard vs Modifed PowerSDR

- With the large FFT size, the modified PowerSDR is not <u>significantly</u> inferior to Linrad bandscope for microwave work
  - 3456 MHz recording



Multiple Bandscopes Summary

- One bandscope is good
- Multiple Bandscopes are better
- Best is when “The Radio is the Bandscope”
- Automatic bandswitching and switching of Mic, CW key, footswitches, and receive audio is essential
- Full integration of radios and logging software is required
- Need large FFT to maintain bandscope sensitivity
- For more information, read the article in the Conference Proceedings and visit my website www.nitehawk.com/w3sz