

Introduction to Cheap SDRs for Radio Monitoring

Ultra cheap software defined radio

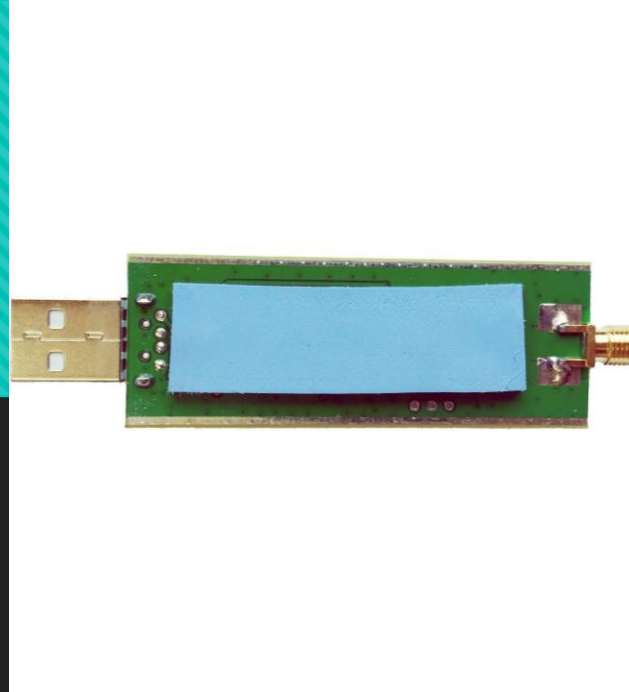
Who Am I?

- Running the RTL-SDR.com blog since 2013
- Collecting stories relating to ultra cheap radio
- Redesigned the RTL-SDR dongle for improved SDR performance
- Started sigidwiki.com, a collection of signal sounds and spectrum analyzer/waterfall images.
- **www.rtl-sdr.com**

What is the RTL-SDR?

- A very cheap RX software defined radio
 - 2.4 MHz bandwidth, tuning range 24 – 1.7 GHz. Some go down to HF.
- Originally (and still is) a DVB-T TV Tuner
 - Highly mass produced in China – very cheap
- Hardware hackers found the SDR feature
 - Originally designed for FM radio reception
- Opened up a whole new world of experimentation.
 - New (and old) blood returning to the radio scene.





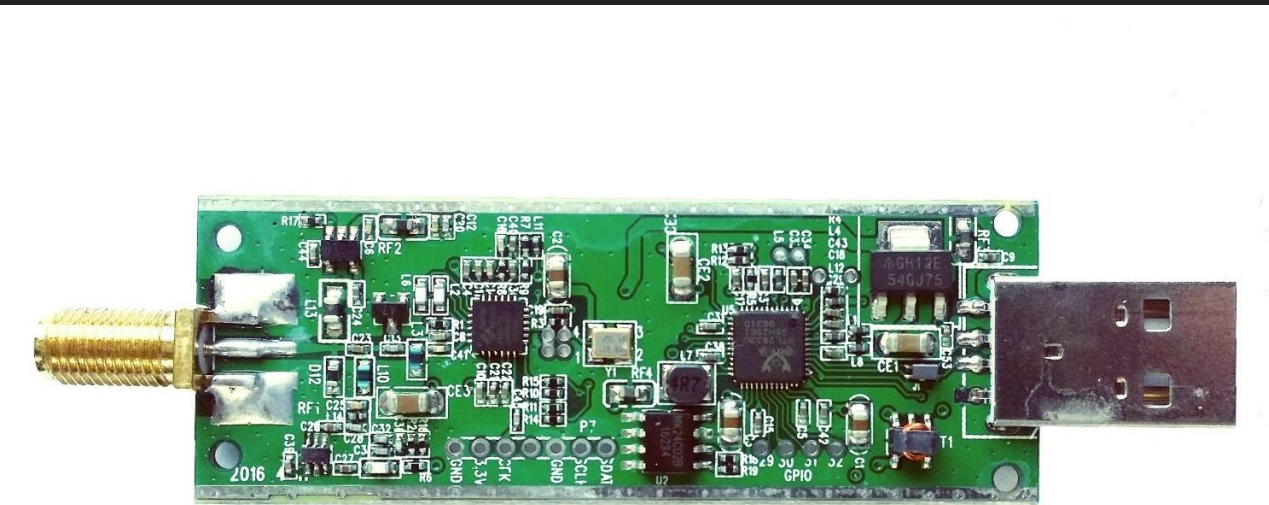
Redesigned RTL-SDR V3

○ Problems with "Generic" dongles

1. Drifting oscillator (unstable frequency)
2. No shielding
3. Many spurs
4. Problems with L-band reception
5. Uncommon MCX RF connector

○ RTL-SDR.com V3 fixes and added features

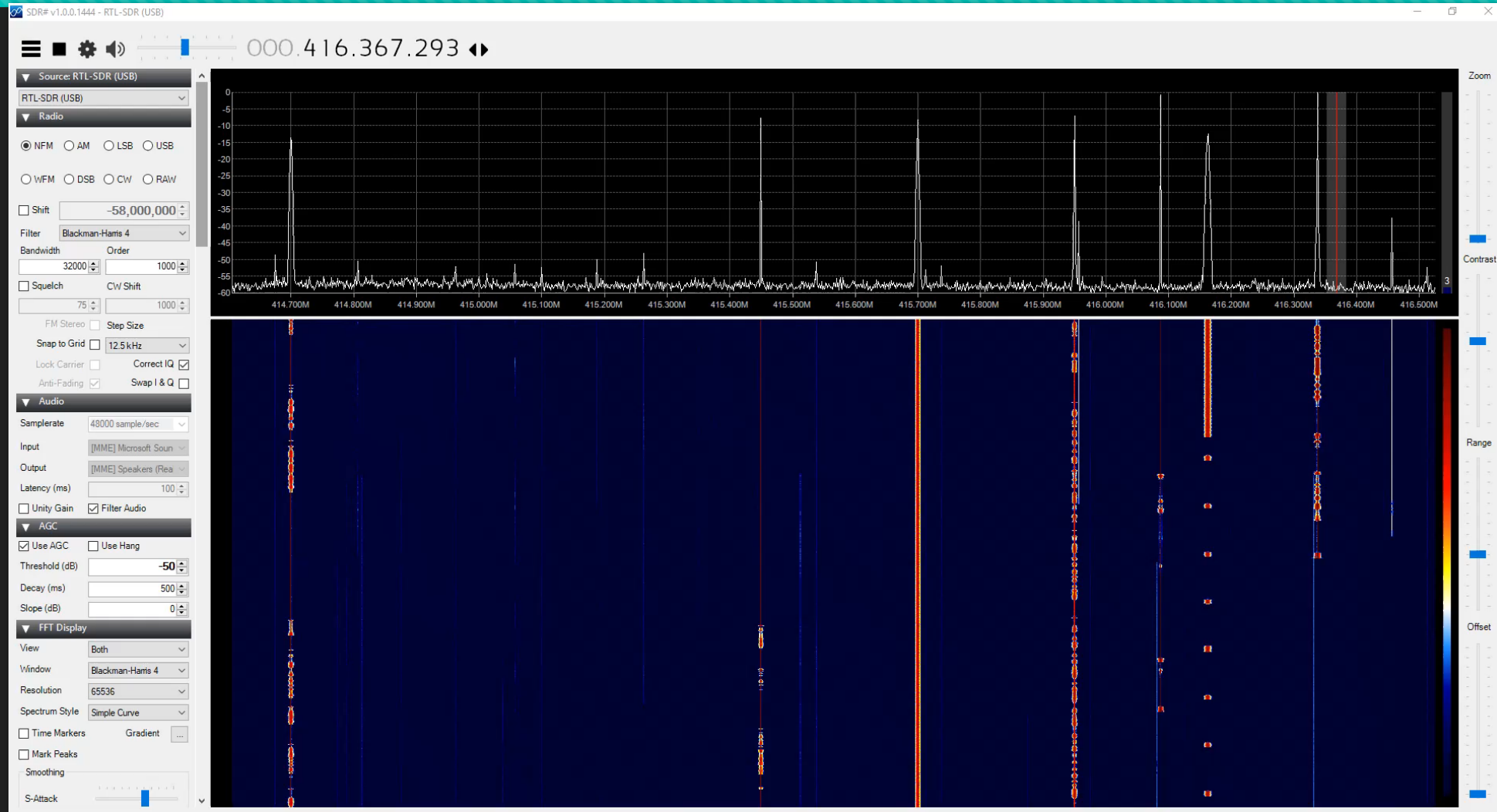
1. TCXO Oscillator
2. Metal case shielding
3. Redesigned PCB, and additional noise filtering
4. Thermal pad to metal case heat sink
5. SMA connector
6. Bias tee
7. HF reception via direct sampling



Different Types of RTL-SDR Dongles

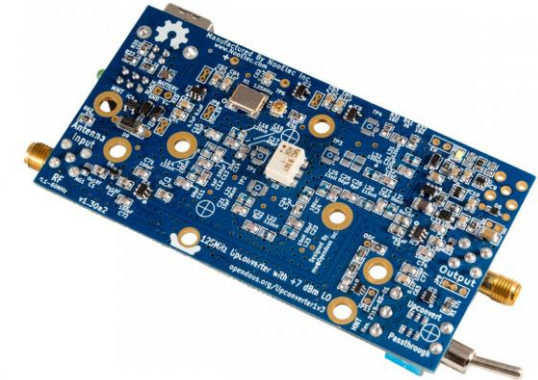


RTL-SDR Software: SDR#



How to Receive HF with an RTL-SDR?

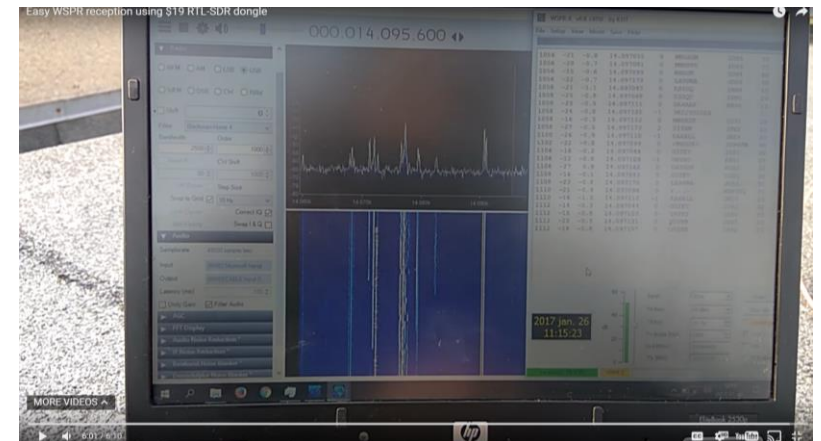
- Typical RTL-SDR tunes down to 24 MHz at the lowest
- The RTL-SDR.com V3 dongle tunes down to 500 kHz in 'direct sampling mode'
 - Activated in software
- You can also use an 'upconverter'
 - SpyVerter is probably the best choice
 - Alternatives like the ham-it-up of SV1AFN are also okay



Applications

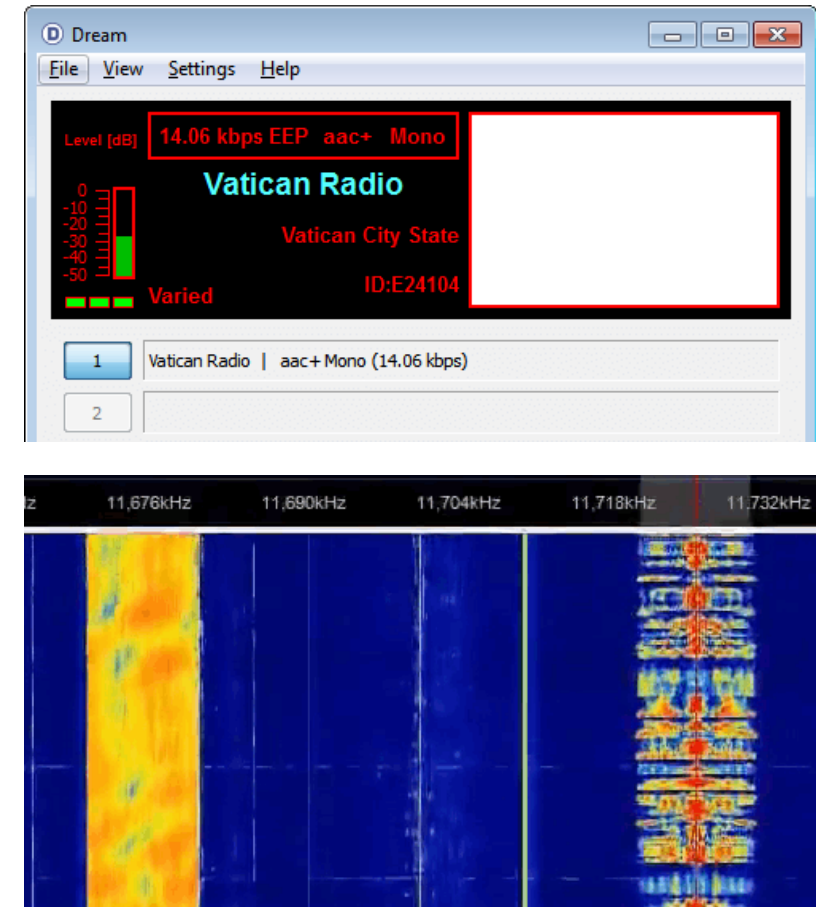
Monitoring WSPR

- Can monitor WSPR with a \$20 USD RTL-SDR.com V3 dongle
 - One of the cheapest ways to monitor WSPR
- Steps include:
 - Sync your PC clock to NTP
 - Plug in RTL-SDR, and tune to WSPR frequency in SDR# or alternative
 - Pipe WSPR audio to WSPR-X.
 - Done!
- Check out 'veryokay' on YouTube, shows it in action.



Digital Radio Mondiale: DRM

- Receive digital DRM broadcast
- Similar to WSPR, just tune to it, and pipe audio into a decoder
- Decoder is called 'Dream'.
 - Full set up on the blog
- DRM capable Receivers are expensive and rare
 - PantronX Titus II may change that?



MultiPSK

- Popular multi mode decoder 'MultiPSK' supports the RTL-SDR directly.
- No need to open up SDR# or any other software first, and no need to pipe audio.
- Dozens of digital modes instantly accessible

BPSK31	63	125	250	FEC31	PSK10	MT63	SITOR A	Amtor ARQ	1382	ACARS (VHF)
QPSK31	63	125	250	CHIP	PSK63F	DIGISSTV	RTTY 100	110/150/200	DGPS	SYNOP / SHIP
PSKAM10	31	50		PSK220F	CW/CCW	QRSS	SELCAL	110A	4285	COQUELET
PACKET+APRS				Amtor FEC-Navtex	ASCII		ARQ-E(3)	IEC 870-5	HFDL	NWR (SAME)
RTTY 45	50	75		LENTUS	Pactor1	DoF THOR	POCSAG	AIS	BIIS	GMDSS / ATIS
THROBX	THROB			MFSK+PIC	MFSK8	DominoEX	FM/RDS	EPIRB	VDL2	ARGOS
PAX/PAX2	DTMF	VOICE	JT65	OLIVIA	Contestia				ADS-B	ORBCOMM
FM HELL	PSK H	FELD HELL	HELL 80	RTTYM						
Filters	Analysis	Binaural	ALE400	141A (ALE)						
AUTEX			FAX	SSTV						
Amateur modes							Professional modes			

* MULTIPSK - THE MULTIMODE DIGITAL TRANSCEIVER * Version 4.31.2 Configuration

Lang(u)age Translation file Help and licence PC Options for serial ports Serial port Serial port for GPS
 Serial port for KISS Sound Card (Input) Sound Card (Output) Auxiliary Sound Card (from an input)
 Auxiliary Sound Card (to speaker) Mixer Sequence (long macro) Fonts Your Logbook
 Asiatic charsets (Japanese) Actions Exit to RX/TX screen

Help Deutsche Hilfe

I/Q interfaces for SdR transceivers
 Direct via the sound card +Speaker
 Softrock FUNcube RTL/SDR key
 By Multidem RTL and mode selection

Parameters
 Default Parameters
 Save Parameters
 Load Paramètres

Screen open after start-up
 Open "Configuration" screen after start up
 Open RX/TX screen after start up

Decoding: from the sound input or a file
 EXAMPLE_BPSK31
 Load a new playing sound file
☒ Sound input ☐ Play ☐ Stop ☐ Sound file
 Repeat the recording Minutes 1 3 10

Recording on a .WAV sound file
 RECORDING
 Load a new recording sound file
☒ No recording ☐ Recording
 Tracking recording on ☐ 15 sec ☐ 1 minute
 Recording duration minutes 240

Beacon mode (all modes)
☒ No ☐ Yes
 Odd message Even message
 Sequence 1 Sequence 1 Interval Pause 10 s Duration 15 min
 Prior serial number
 10/05/17 06:21:42 UTC
 UTC correction in hours 0
 UTC start time for record or beacon ☒ No ☐ Yes 00:00

XIT (for PSK modes, THROB(X), MFSK, CW and CCW) and initial RX/TX freq. (200 to 4300 Hz)
☒ XIT as an offset (Hz) XIT: 0 RX Fr.: 1000 TX Fr.: 1000
☐ XIT as a coefficient (0.0001 * Hz/Hz) x1 x10 x1 x10

"RX/TX" for "main"
 RX/TX screen

Panoramics
 PSK Panoramic
 CW Panoramic
 RTTY Panoramic

Miscellaneous
 TCP/IP server "On"
 Initial RX/TX modes
 Personal data
 Checking serial port
 PC ID: VMVZAV5VDV1R
 Full-duplex sound card
 Mixer control
 Log book
 Reading a QSO

TNT receiver detected and connection done, via RTL DLL
 This software is a "freeware" with limitations, for non-commercial use

VERSION 4.31.2 of (du) 01/09/2016
 * port choice (14580 or 10152) for APRS-IS servers (choix du port (14580 ou 10152) pour les serveurs APRS-IS),
 * Pocsag: display of numeric messages in alphanumeric (affichage des messages numériques en alphanumériques),
 * possibility to introduce an offset in case of SdR used (possibilité d'introduire un décalage si SdR utilisé),
 * Alt or Esc key to send a message in ARQ mode (Touche Alt ou Echapement pour envoyer un message en mode ARQ),

Raspberry Pi 3: Remote Monitoring

- The RTL-SDR can be used as a locally networked receiver.
- Software like rtl_tcp and spyserver enables this.
- You need a decent network connection.
- Other software like OpenWebRX enables internet web browser based streaming.
 - sdr.hu

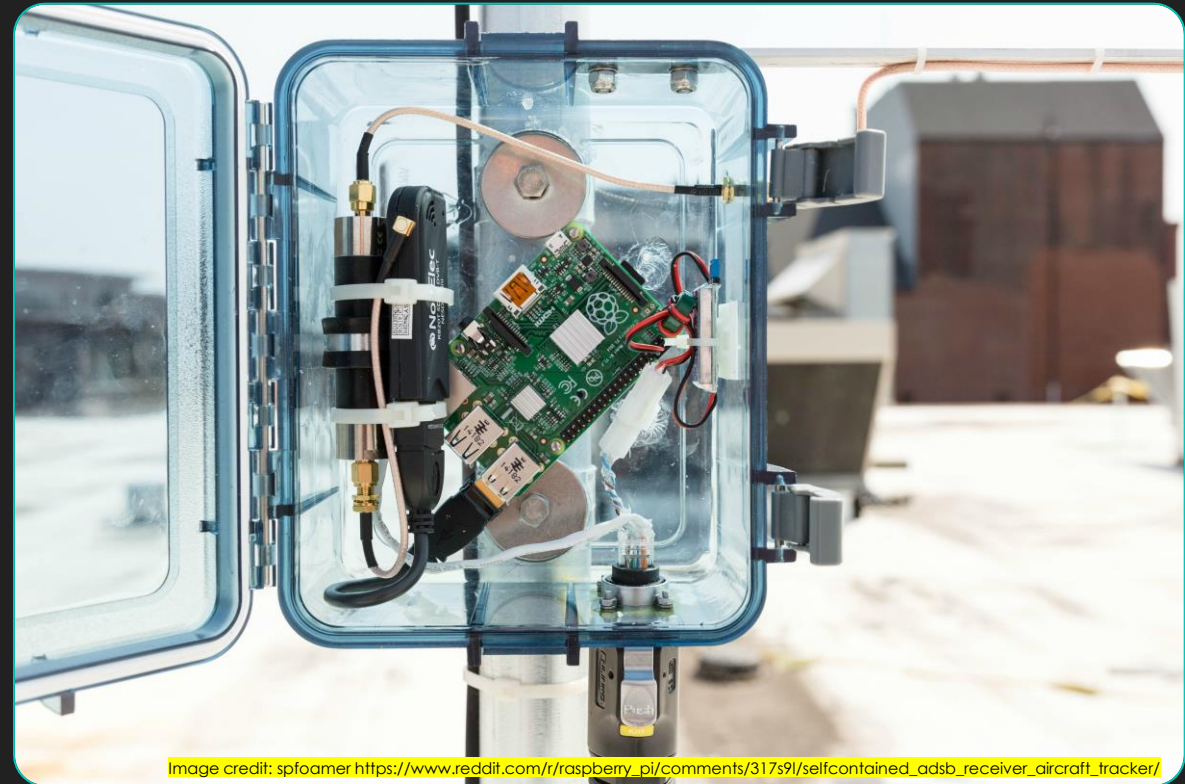


image credit: spfoamer https://www.reddit.com/r/raspberry_pi/comments/317s9l/selfcontained_adsb_receiver_aircraft_tracker/

SDR.HU Example

OpenWebRX



SDR RECEIVER 80M KHERSON

Kherson, Ukraine | Loc: KN66IQ, ASL: 46 m. [\[maps\]](#)



Status



Log



Receiver



HASKFU

3.50 MHz

3.55 MHz

3.60 MHz

3.65 MHz

3.70 MHz

3.689,7 MHz

3.733,7 MHz

FM AM LSB USB CW

Speaker icon Volume slider

SQ slider

Zoom in Zoom out Rotate 90° Rotate 180°

-51.0 dB

Audio buffer [1.1 s]

Audio output [48.1 kbps]

Audio stream [66 kbps]

Network usage [350.7 kbps]

Server CPU [52%]

Clients [1]

Digital Voice Monitoring

- A program called “DSD+” can be used to decode P25 and DMR
 - Only unencrypted comms of course
- Can also decode LRRP on DMR
- Another version of DSD can be used to listen to D-STAR amateur radio comms.

The screenshot displays the DSD+ software interface with four main windows:

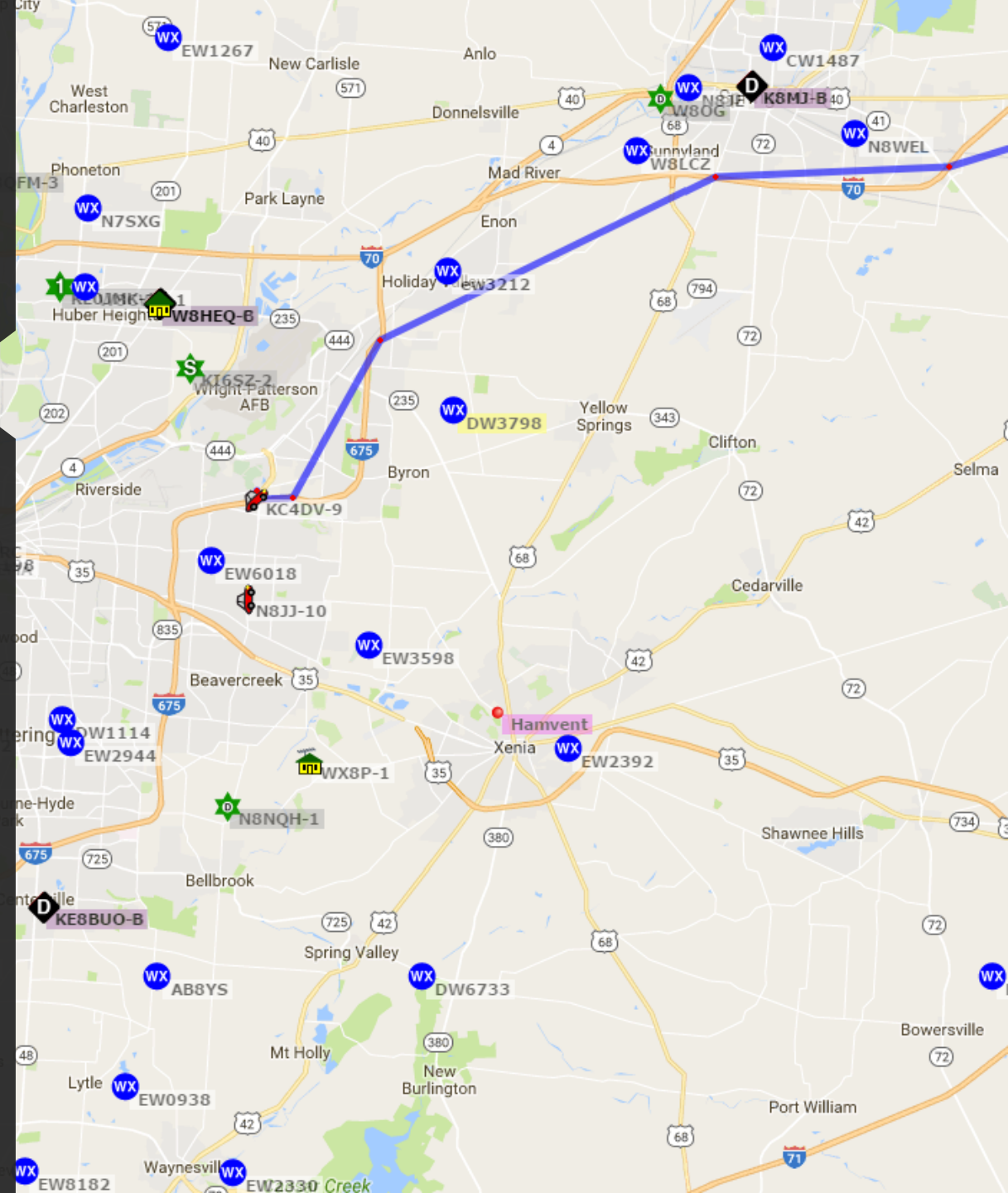
- DSD+ Source Audio:** A window showing a real-time audio waveform on a blue background.
- DSD+ Con+ Channel Activ...:** A table showing channel activity. The visible data is as follows:

Ch	TX Freq	Target	Source
1			
2			
3		CC	
4		4301	43002
7			
8			
9			
17			
18			
19			
20			
- DSD+ VOICE >>:** A list of decoded voice frames. Each entry shows the mode (DMR), slot(s), base station (BS), type (DATA, UC, VOICE), and call sign (CC=1 CSBK, CC=1 TLC, etc.).
- DSD+ Event Log:** A log of voice calls with timestamps, target/source IDs, and channel numbers. The log shows multiple voice calls between 00:00:09 and 00:09:19.

At the bottom of the interface, the status bar displays: Con+ NID:214 Site:1 DCC:1

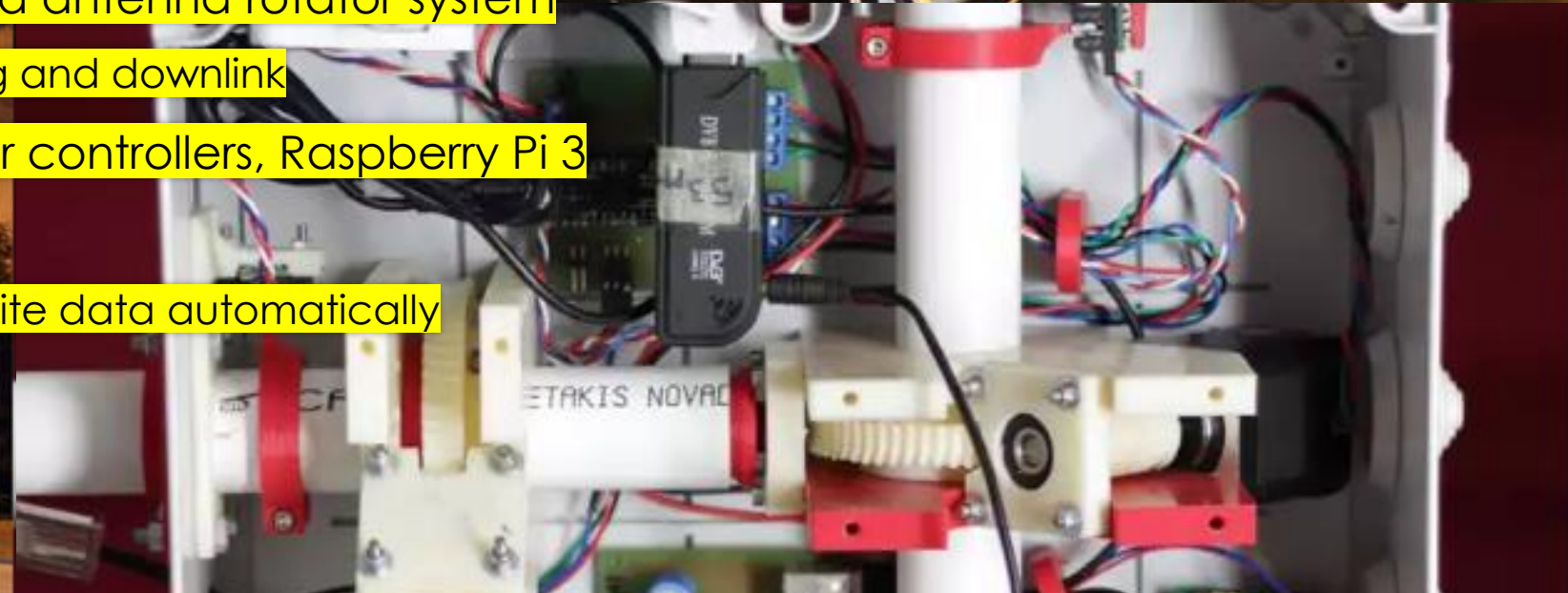
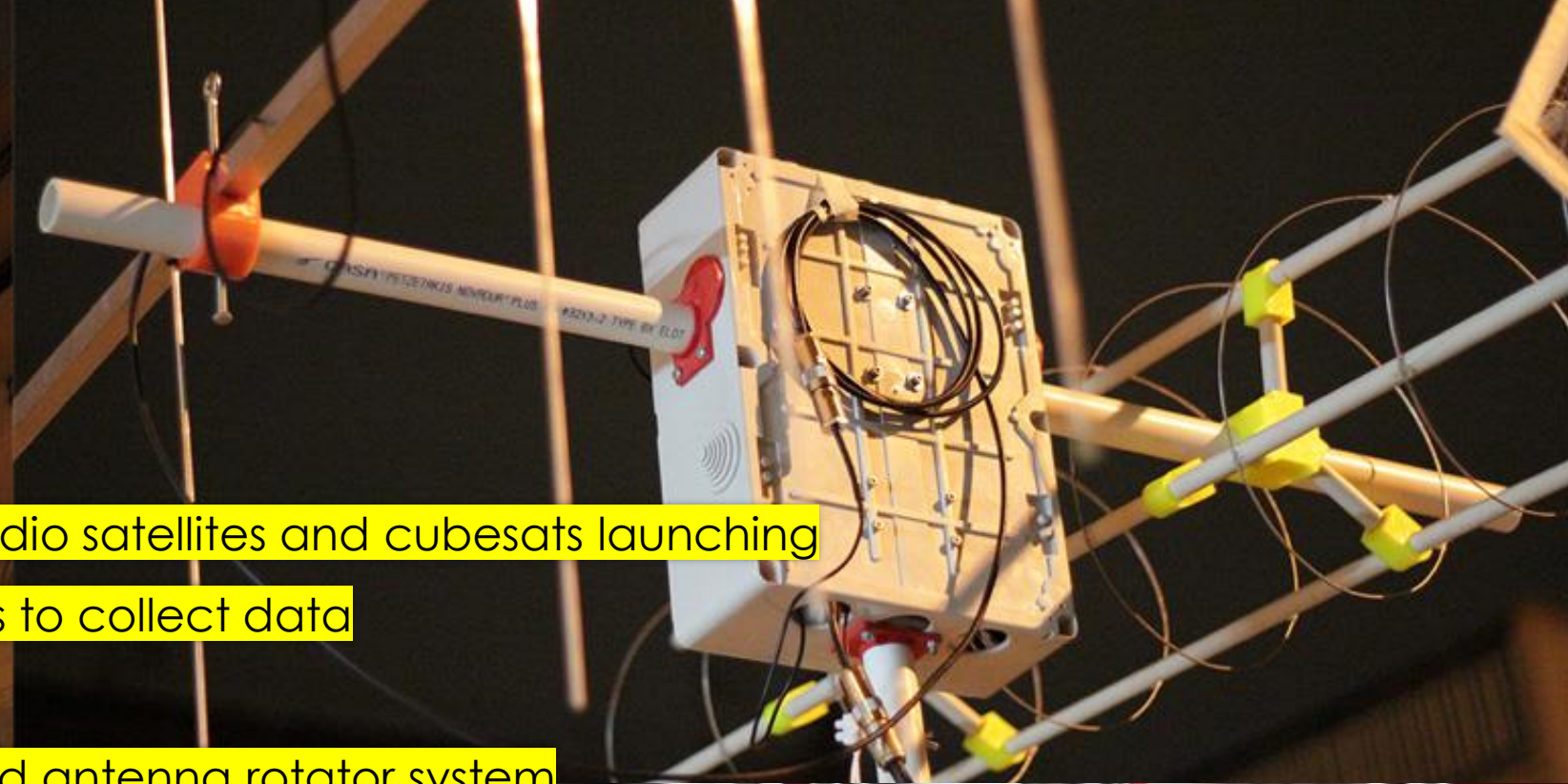
Setting up an APRS iGATE

- The RTL-SDR can be used to set up a low cost APRS iGATE
 - RX Only
- Simply combine with a Raspberry Pi and the “Dire Wolf” software and you’re good to go



SatNOGS

- Vast increase in amateur radio satellites and cubesats launching
- Not enough ground stations to collect data
- **SatNOGS solution:** 3D printed antenna rotator system
 - Automatic satellite tracking and downlink
- Inside: RTL-SDR, gears, motor controllers, Raspberry Pi 3
- Connected to internet
 - Collects and uploads satellite data automatically



Receiving The Outernet

- One way (download only) satellite filecasting service
 - Uses Inmarsat/Alphasat satellites on L-band
- What data can you receive?
 - Latest News
 - Weather Updates
 - Amateur Radio repeater repeats (ISS APRS, AMSAT etc)
 - Wikipedia Articles
 - Grib files (for mariners at sea)
 - Free books
- Good for disaster preppers, sailors, remote areas, countries with censored internet, third world countries.
- Outernet use RTL-SDR based receivers



Conclusion

- The RTL-SDR is an extremely cheap, yet highly versatile receiver
- Hundreds of applications
 - See the rtl-sdr.com blog history for many more applications.
 - I have a book on Amazon called “The Hobbyists Guide to RTL-SDR”.
- Where can I buy RTL-SDR V3 Dongles at Hamvention?
 - TAPR booth 5001-5003 Building 5
 - R&L Electronics in Building 1
 - SDRguys at Booth #7919 in the Flea Market (west end) – also selling Outernet antennas and LNA's