

An Introduction to RTL-SDR

Ultra cheap software defined radio

Who Am I?

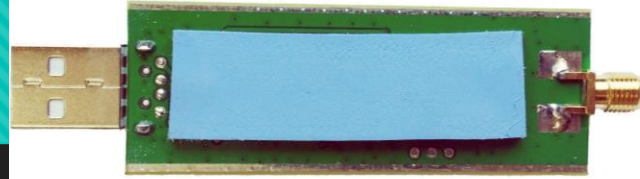
- Running the RTL-SDR.com blog since 2013
- Collecting stories relating to ultra cheap radio
- Started sigidwiki.com, a collection of signal sounds and spectrum analyzer/waterfall images.
- Redesigned the RTL-SDR dongle for improved SDR performance
- www.rtl-sdr.com

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

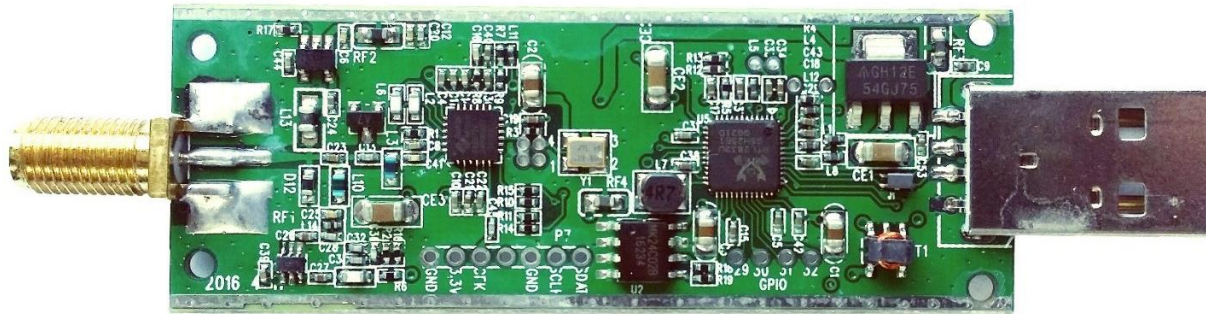


○ Problems with "Generic" dongles

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



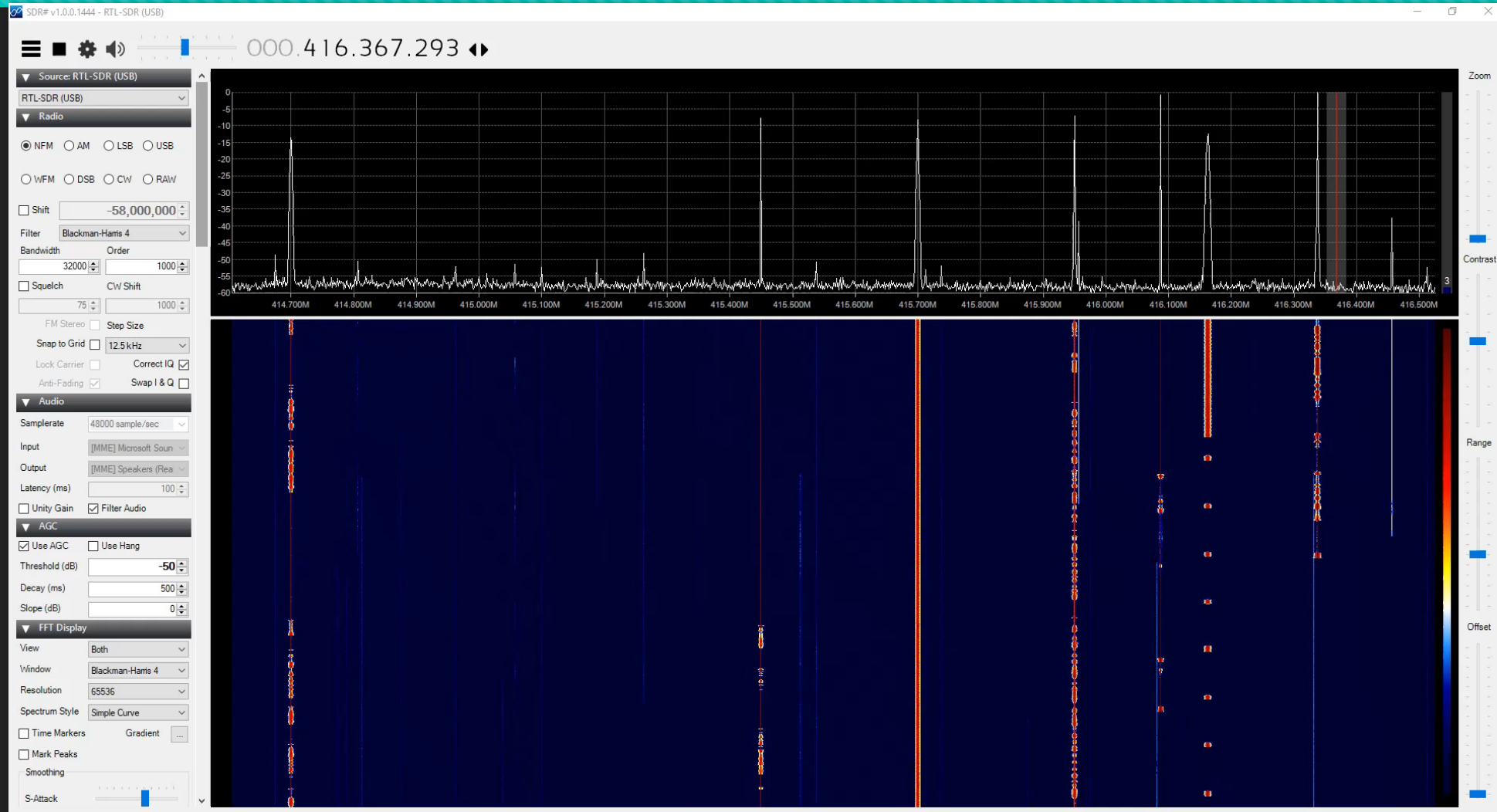
Different Types of RTL-SDR Dongles



How to set up an RTL-SDR (Windows)

- Not plug and play, but extremely easy to set up
- www.rtl-sdr.com/qsg
- Works on Windows, Linux, Raspberry Pi's/Odroids etc, MacOS
 - Windows: SDR#, SDR-Console, HDSDR
 - Raspberry Pi: Command line tools, GQRX
 - Linux/MacOS: GQRX

RTL-SDR Software: SDR#



Applications

Digital Voice Monitoring

- A program called “DSD+” can be used to decode P25 and DMR
 - Only unencrypted comms of course
 - dsdplus.com
- Another version of DSD can be used to listen to D-STAR amateur radio comms.
- Two dongles can be used to ‘follow’ trunked radio conversations.
 - One dongle decodes the control channel
 - The other dongle listens to the voice channel.
 - Unitrunker.com

LCN	Frequency	Audience	Target	T	Source	Source Label	Svc
335	859.38750		9744	G	86140		
355	859.88750						
395	860.88750		8080	G	2188		
423	861.58750		13648	G	7800		
495	863.38750						
515	863.88750						

Stamp	Source ID	Source Label	Action	Target ID	Target Label	Svc
12:13:32	7800		Call	13648		-
12:13:33	2188		Call	8080		-
12:13:34	56140		Call	9872		-
12:13:38	7709		Call	13648		-
12:13:40	7800		Call	13648		-
12:13:41	15432		Call	9744		-
12:13:41	2188		Call	8080		-
12:13:42	7709		Call	13648		-


```
23:59:55 Voice call: Tgt=701 Src=7242 Ch=9 13h
00:00:09 Voice call: Tgt=701 Src=7250 Ch=17 27s
00:00:18 Voice call: Tgt=4301 Src=43002 Ch=18 27s
00:00:38 Voice call: Tgt=701 Src=7222 Ch=2 27s
00:00:41 Voice call: Tgt=3101 Src=31008 Ch=4 7s
00:00:48 Voice call: Tgt=3101 Src=31008 Ch=4 6s
00:01:06 Voice call: Tgt=701 Src=7238 Ch=9 19s
00:01:26 Voice call: Tgt=701 Src=7222 Ch=20 8s
00:02:02 Voice call: Tgt=4401 Src=44007 Ch=4 KeyID=1 Alg=EP 7s
00:02:11 Voice call: Tgt=4401 Src=45001 Ch=7 16s
00:02:30 Voice call: Tgt=701 Src=7222 Ch=17 10s
00:02:45 Voice call: Tgt=701 Src=7245 Ch=19 7s
00:03:01 Voice call: Tgt=4401 Src=44031 Ch=4 KeyID=1 Alg=EP 7s
00:03:09 Voice call: Tgt=4401 Src=45001 Ch=7 10s
```

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

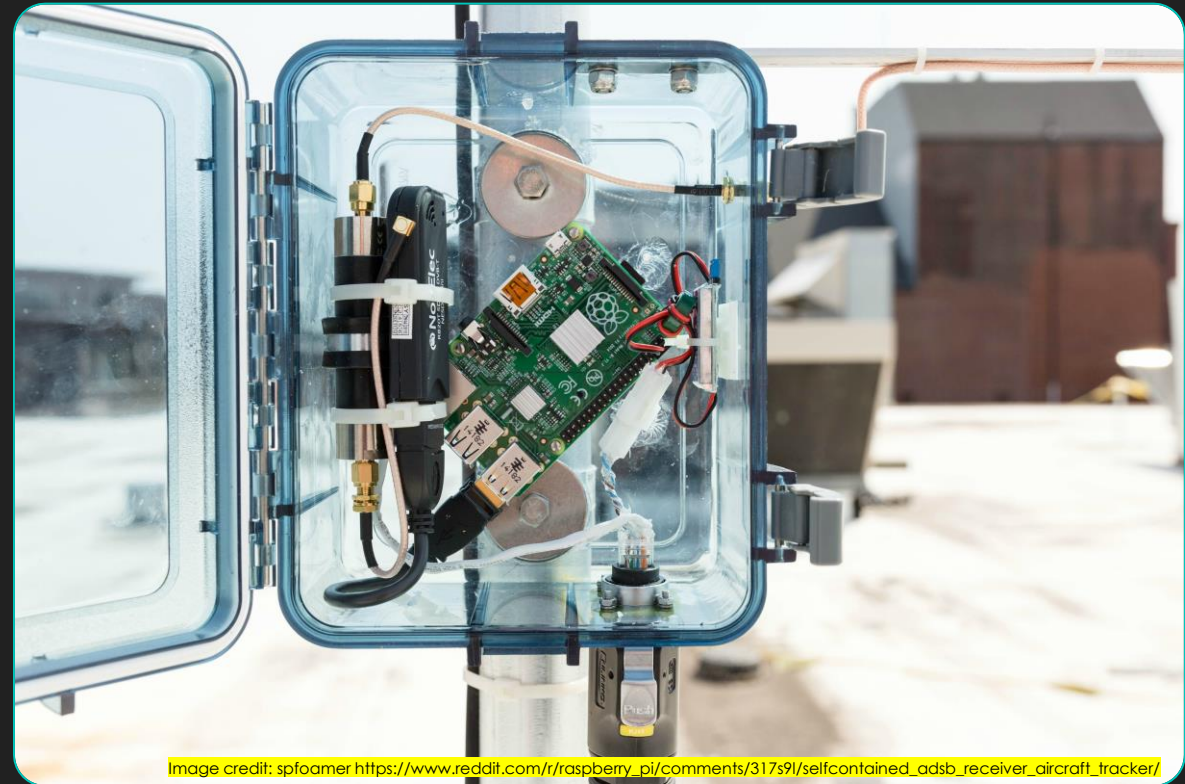


image credit: spfoamer https://www.reddit.com/r/raspberry_pi/comments/317s9l/selfcontained_adsb_receiver_aircraft_tracker/

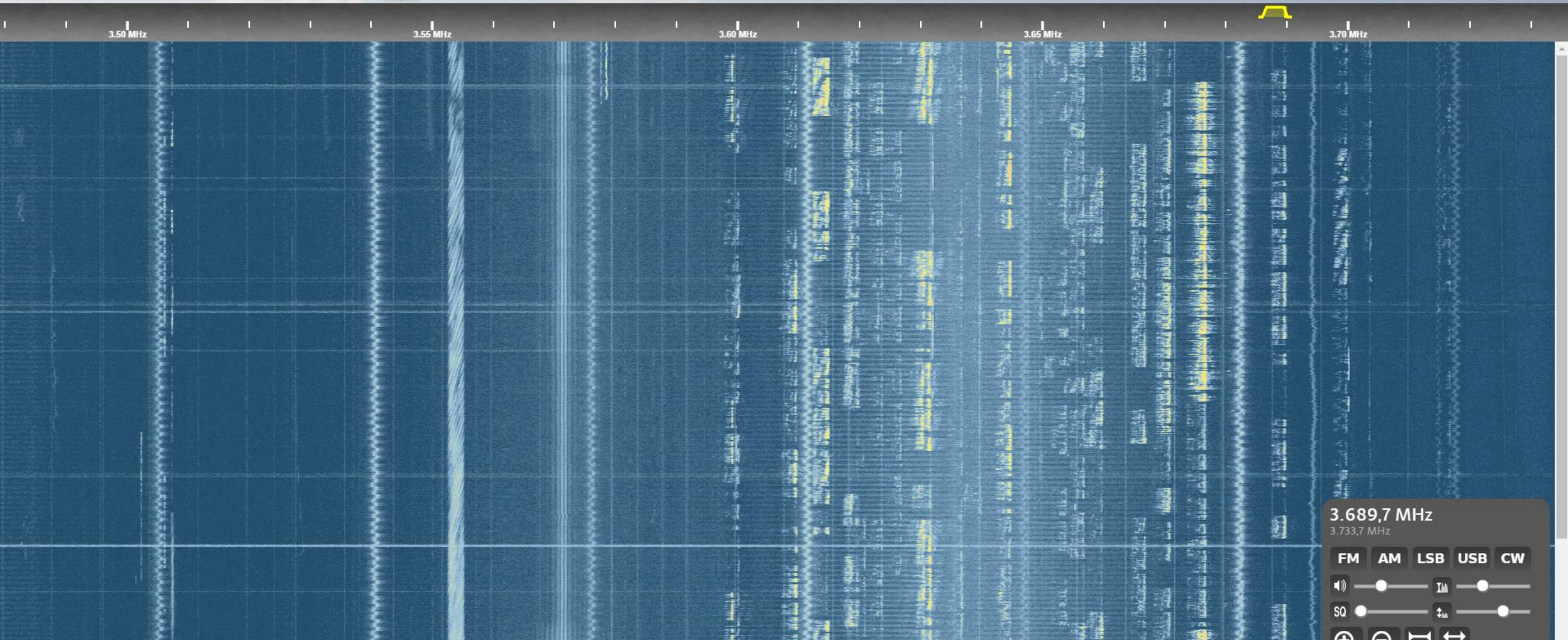
SDR.HU Example

OpenWebRX



SDR RECEIVER 80M KHERSON
Kherson, Ukraine | Loc: KN66IQ, ASL: 46 m. [maps]

Status Log Receiver HASKFU



3.689,7 MHz
3.733,7 MHz

FM AM LSB USB CW

Volume slider

SQ slider

Gain slider

Search, Zoom, and other controls

-51.0 dB

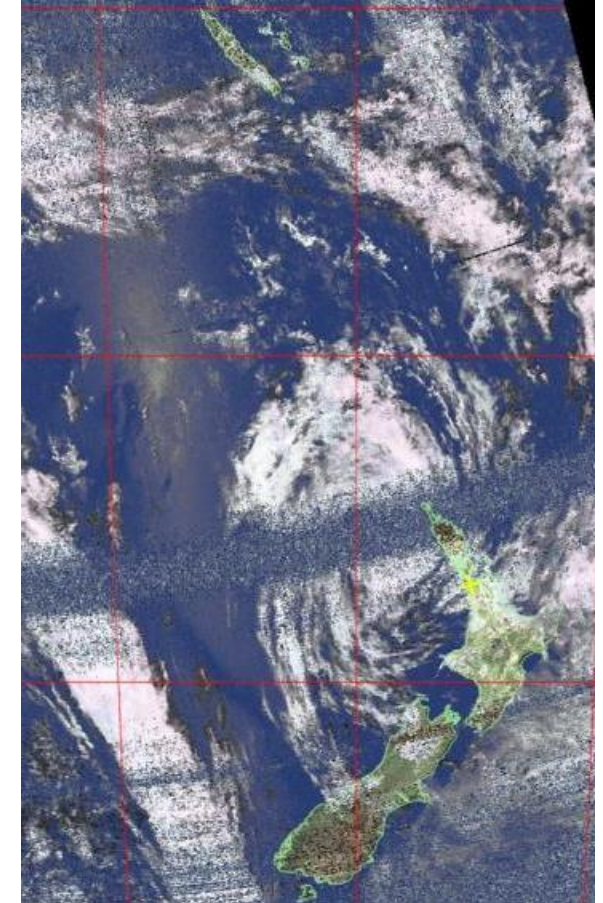
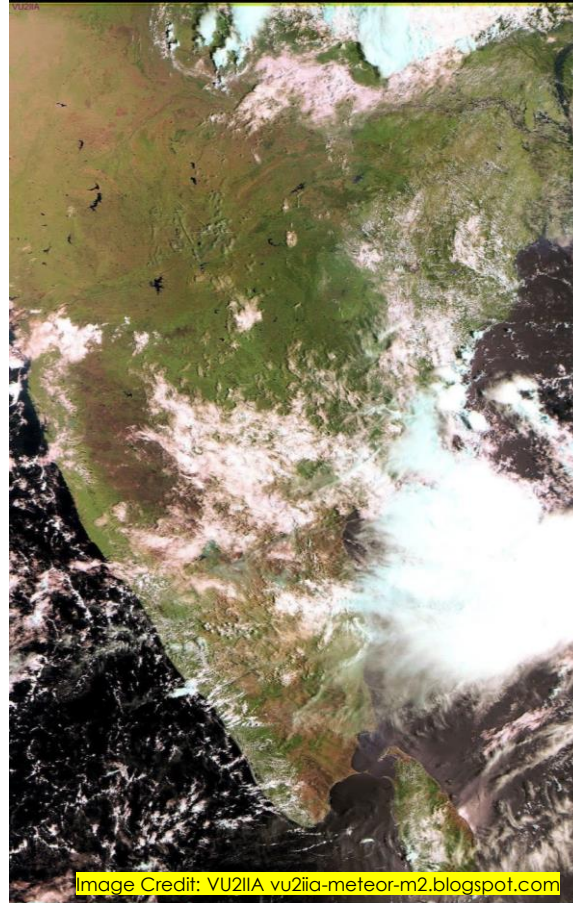
Audio buffer [1.1 s] Audio output [48.1 kbps] Audio stream [66 kbps]
Network usage [350.7 kbps] Server CPU [52%] Clients [1]

ADS-B: Track Aircraft

- Automatic Dependant Surveillance – Broadcast
- ADS-B Broadcasts packets containing positional information
- Commercial flight tracking websites like flightaware.com and flightradar24.com use data submitted by RTL-SDR users

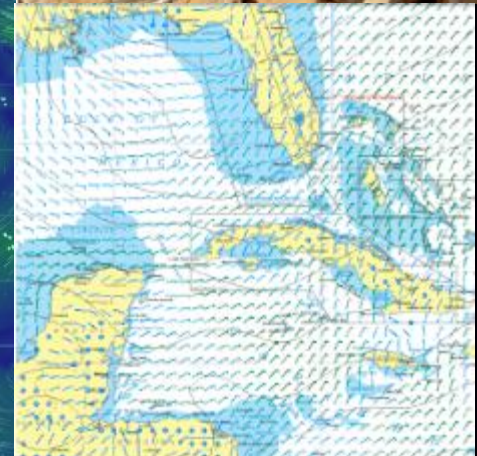
NOAA + Meteor Weather Satellites

- Receive live weather images
- NOAA active satellites
 - NOAA 15 – 137.6200 MHz
 - NOAA 18 – 137.9125 MHz
 - NOAA 19 – 137.1000 MHz
- Transmits an analogue “APT” (Automatic Picture Transmission) signal
- Will pass over every location on earth several times in one day
- Meteor M-N2 Russian Weather Satellite
 - Higher resolution LRPT digital images
 - 137.9 MHz



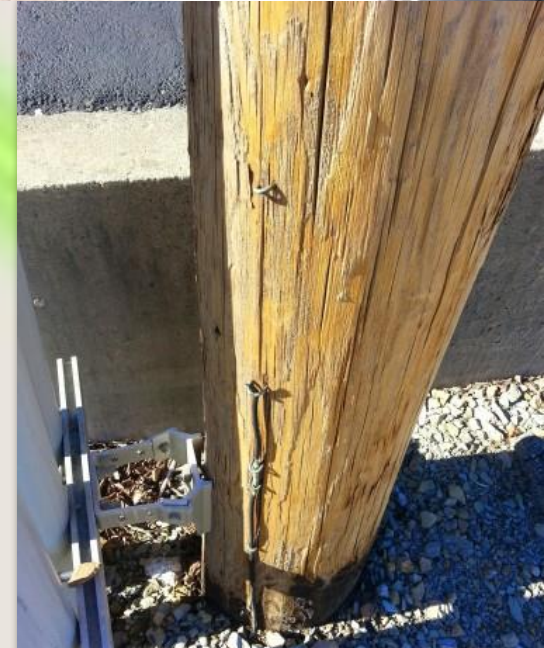
Receiving The Outernet

- One way (download only) satellite filecasting service
 - Uses Iridium/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.
- Uses an RTL-SDR for reception





























QRM/Noise Detection and Locating

- Tim Havens “Driveby” System: QRM Detector
- Uses multiple RTL-SDR dongles running on an Odroid XU3
 - Scans multiple bands
- Log QRM levels together with GPS data
 - Find the hotspots on a heatmap
- Source found: Power pole with broken ground connection



Disney's EM Sense

- A watch that knows exactly what the wearer is touching
- Works by classifying EMI
- RTL-SDR Based

C		Black & Decker Sander	
D		Door Handle w/ MagLock	
E		Fixed Steel Ladder	
F		Sub-Zero Refrigerator	
G		ArmorActive Conf. Screen	
H		Flourescent Desk Lamp	
I		DDRUM Power Adapter	
J		Honda CM250 Motorycle	
K		T-Fal Avanté Classic Toaster	
L		FitBit Aria Scale	
M		Sonicare Elec. Toothbrush	
N		Kenmore Elite Refrigerator	
O		Samsung Gas Range	
P		Incandescent Floor Lamp	

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”.
 - If you’re coming to the TAPR banquet talk, I will show many more applications in that talk.
- 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