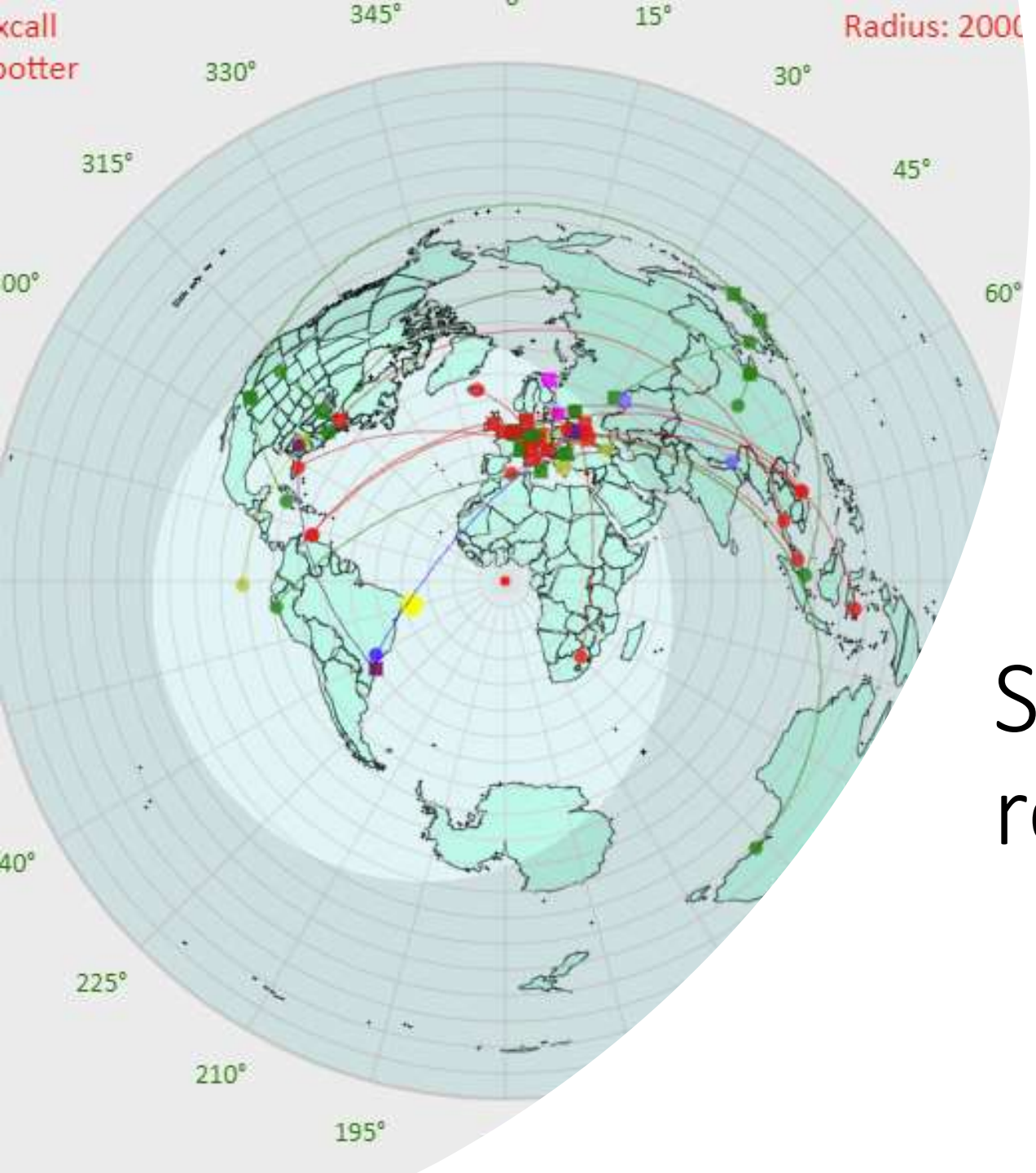


Shortwave robots and reverse beacons

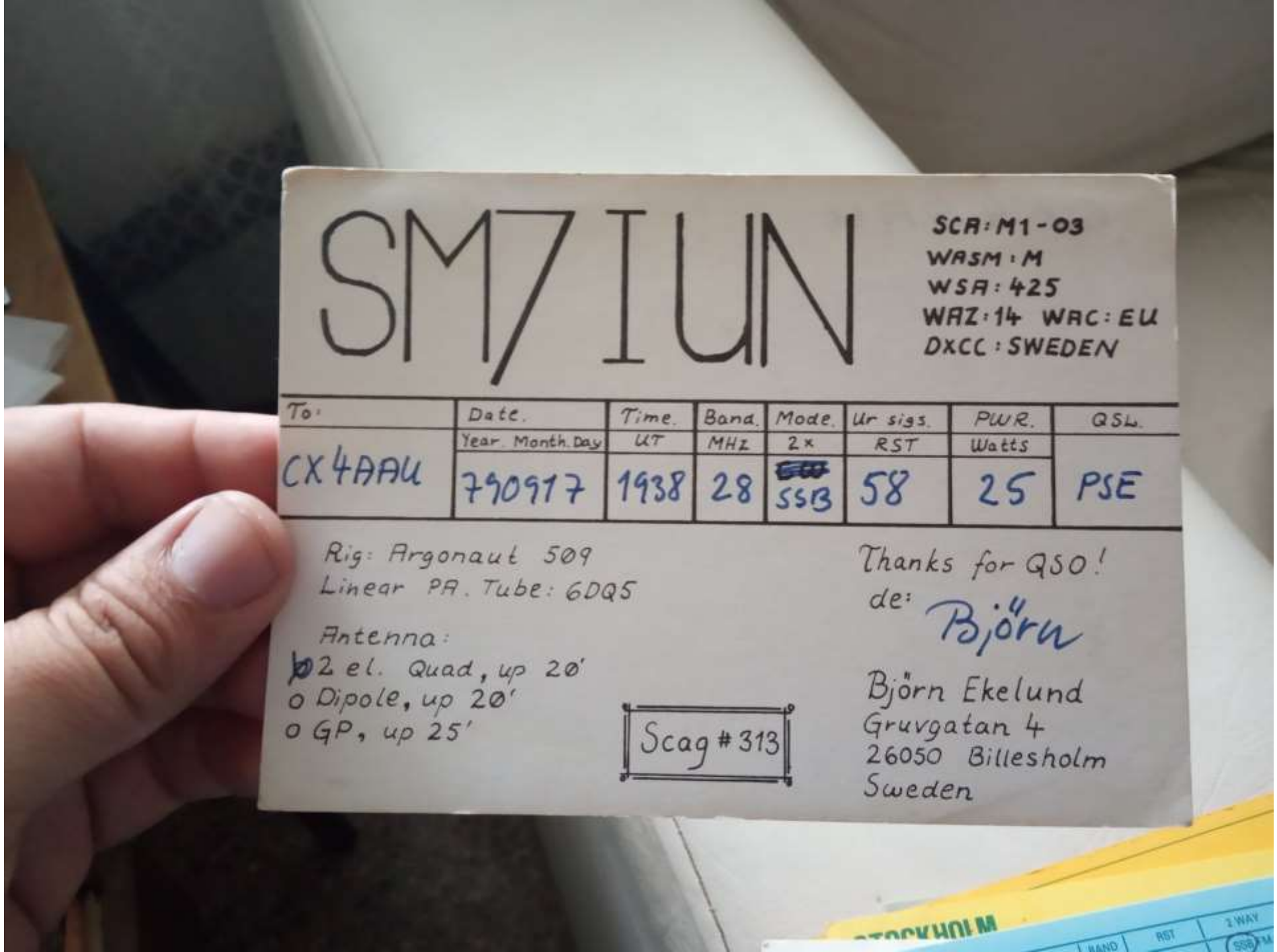
Björn Ekelund - Ericsson Research

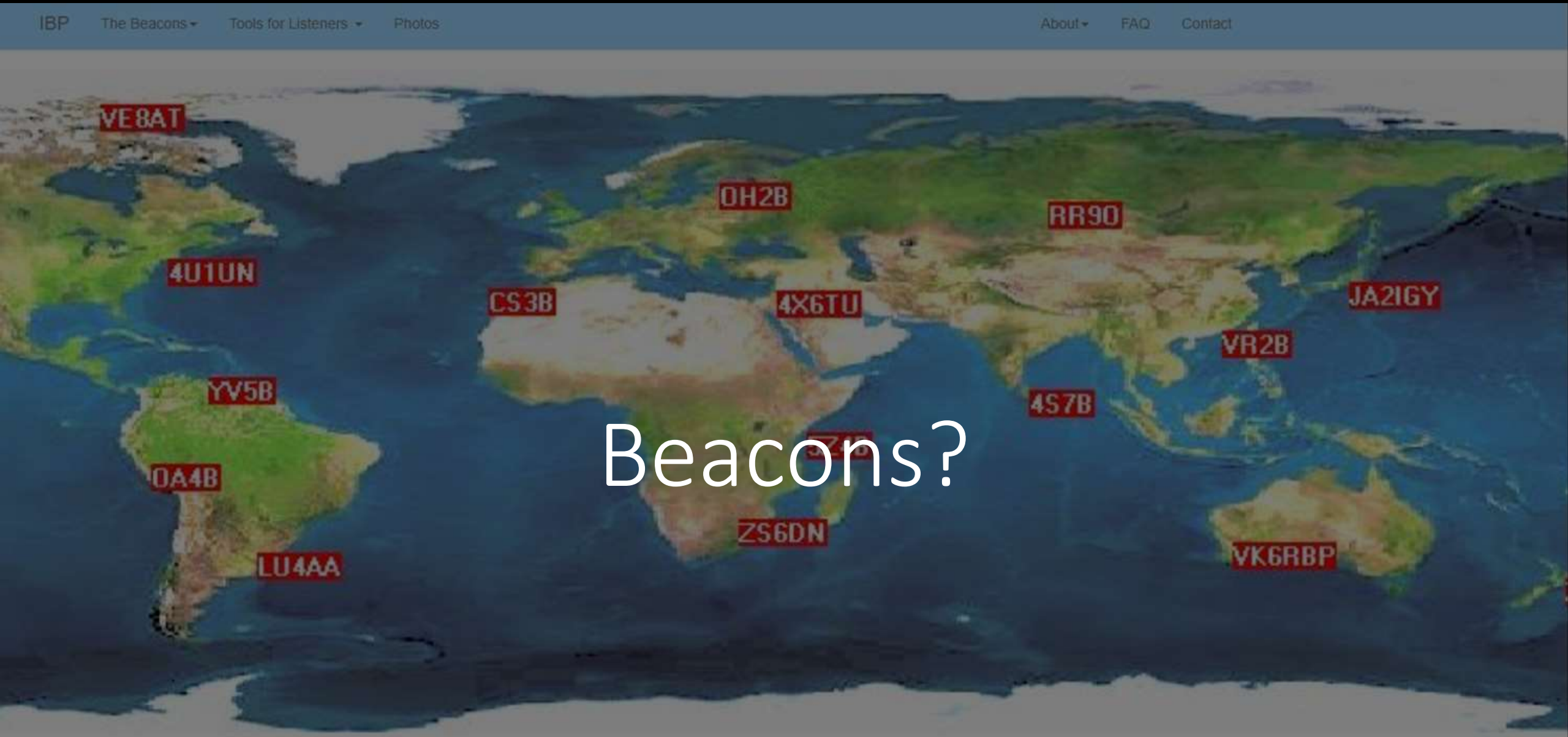
A P R
@apr

My friend CX4AAU searching @bjornekelund SM7IUN's QSL from the 70s

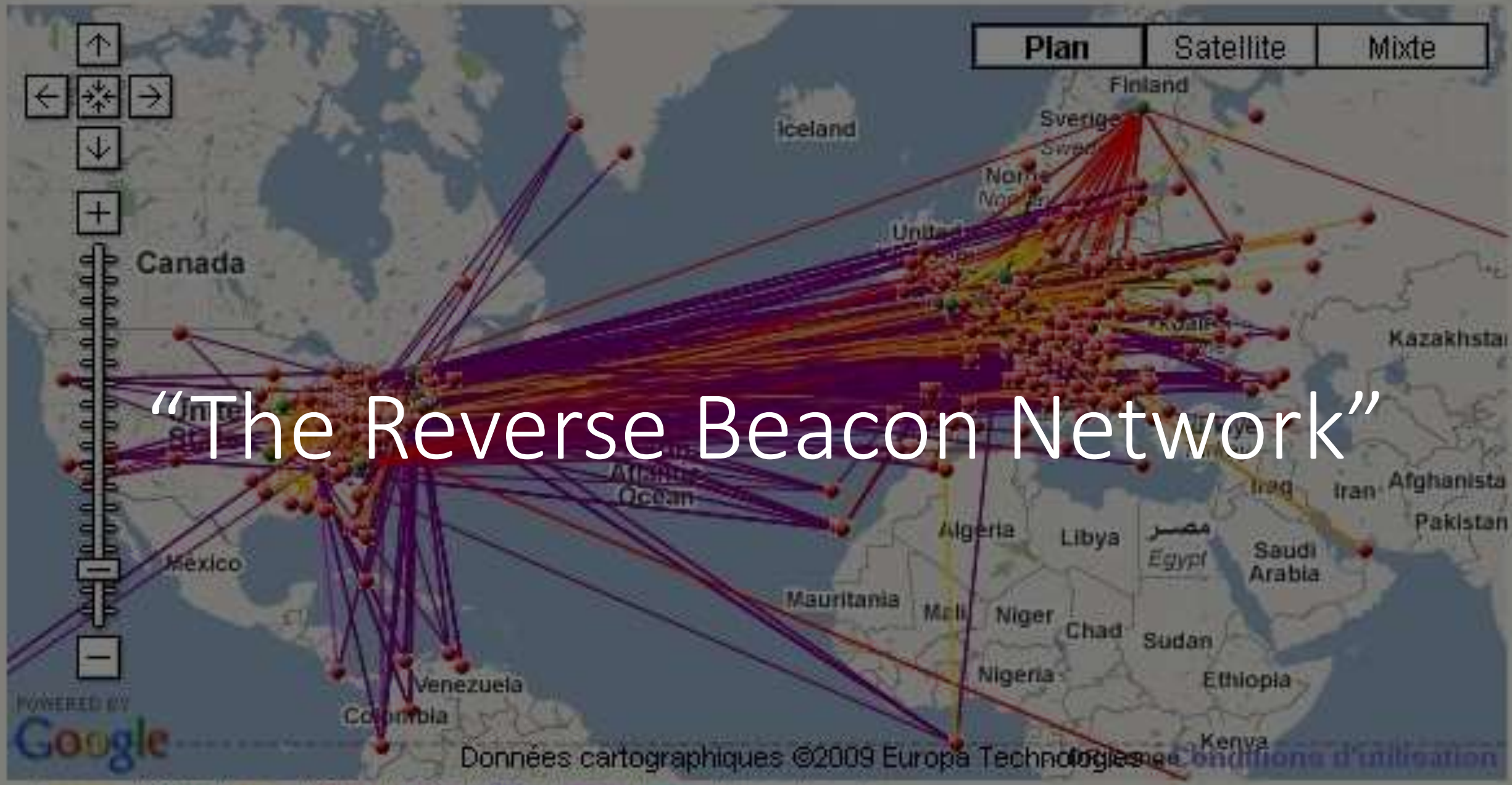
Översätt tweeten

Tweeta ditt svar


SM7IUN
SCR: M1-03
WASM: M
WSA: 425
WAZ: 14 WAC: EU
DXCC: SWEDEN
To: CX4AAU
Date. Year Month Day: 790917
Time. UT: 1938
Band. MHz: 28
Mode. 2x: SSB
Ur sigs. RST: 58
PWR. Watts: 25
QSL: PSE
Rig: Argonaut 509
Linear PA. Tube: 6DQ5
Antenna:
2 el. Quad, up 20'
o Dipole, up 20'
o GP, up 25'
Scag # 313
Thanks for QSO!
de: Björn
Björn Ekelund
Gruvgatan 4
26050 Billesholm
Sweden


IBP
The Beacons
Tools for Listeners
Photos
About
FAQ
Contact
VE8AT
OH2B
RR9O
4U1UN
CS3B
4X6TU
JA2IGY
VR2B
YV5B
4S7B
OA4B
ZS6DN
VK6RBP
LU4AA
NCDXF/IARU International Beacon Project
Transmission Schedule

Beacons?



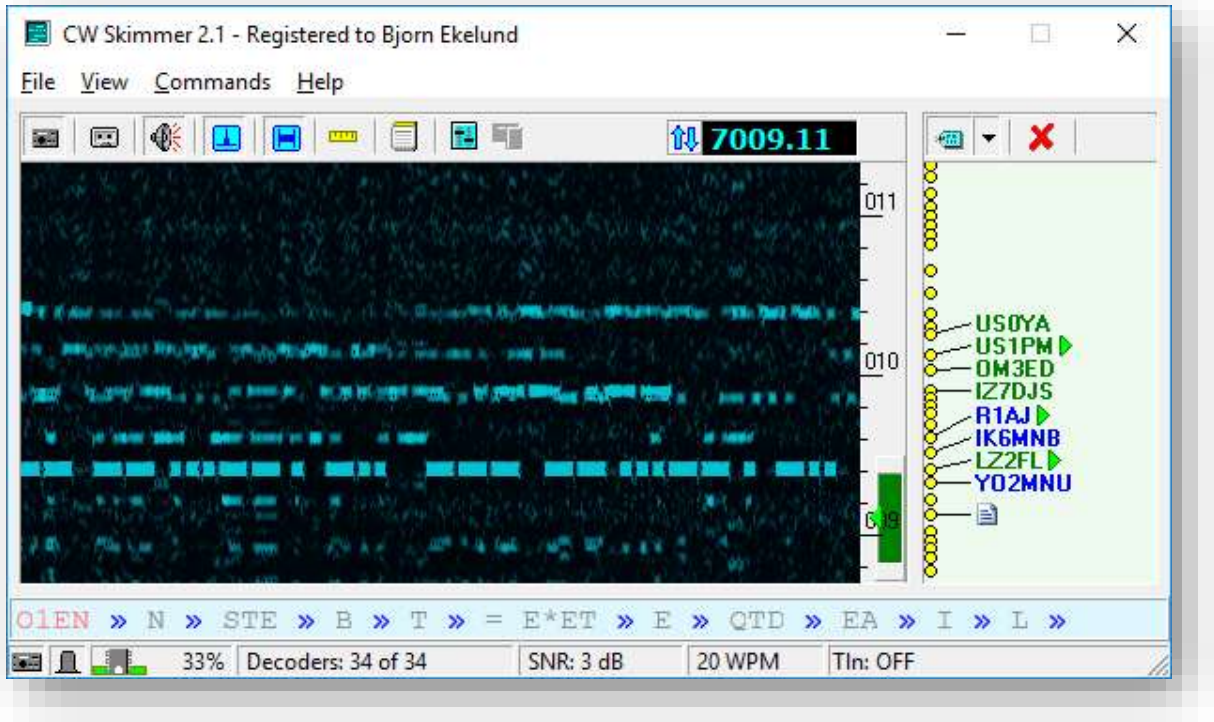
"The Reverse Beacon Network"

It started with one brilliant engineer…

Alex Shovkoplyas, VE3NEA (b. 1965, ex-UR5EMI, Canadian resident since 1998)

”Canadian ham of the year” 2014

Morse code decoder ”CW Skimmer”

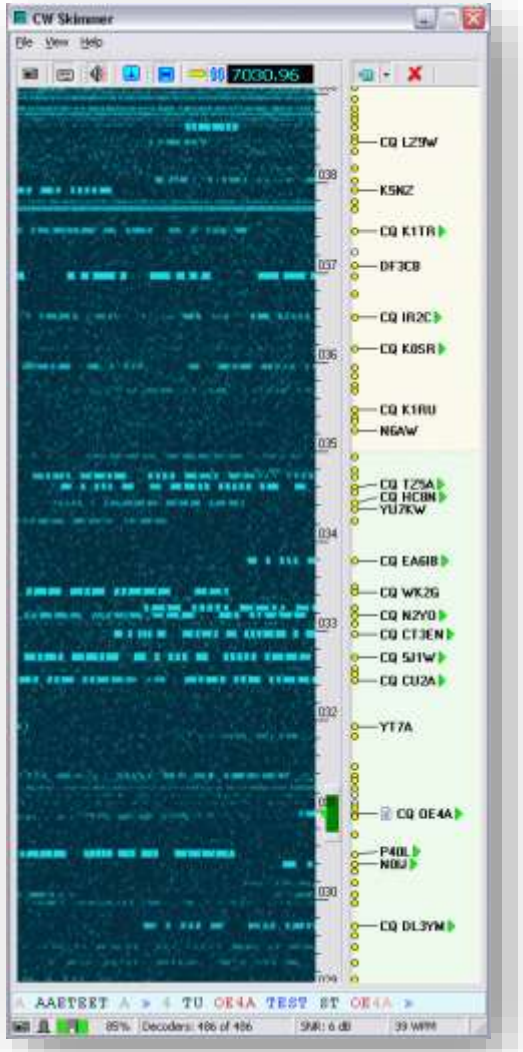


Published by Alex in 2008 after “seven years of thinking”.

Based on Bayesian statistics, a “kind of” AI.

Originally intended as a tool to manage DX pile-ups.

“CW Skimmer”



- Works with a range of SDR front-ends
- Parallel decoding of Morse code signals across an entire passband
  - Standard 3.5kHz audio
  - Wideband I-Q up to 192kHz bandwidth
- Graphical “waterfall” illustration of signals
- Uses a recognized call sign data base for sanity checking

2008: The planets lined up…

Alex VE3NEA

Felipe PY1NB

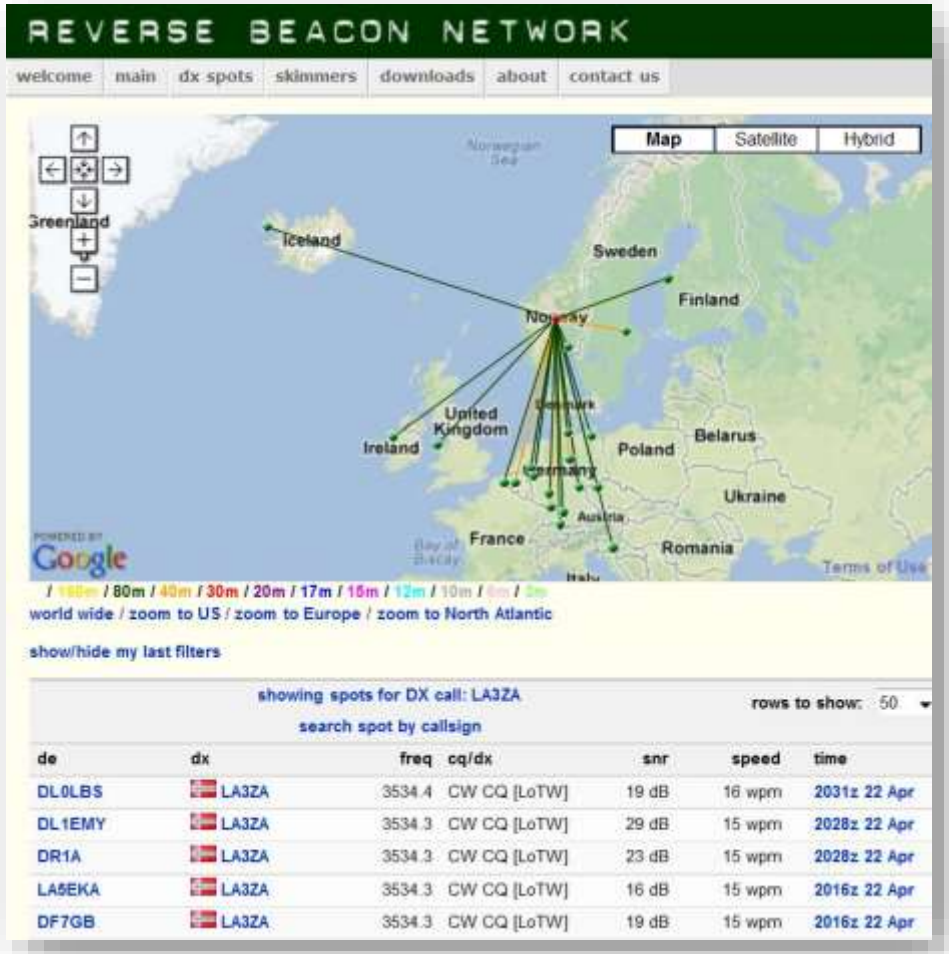
DX WATCH

Dick W3OA

Nick F5VIH

Pete N4ZR

Phil N8VB

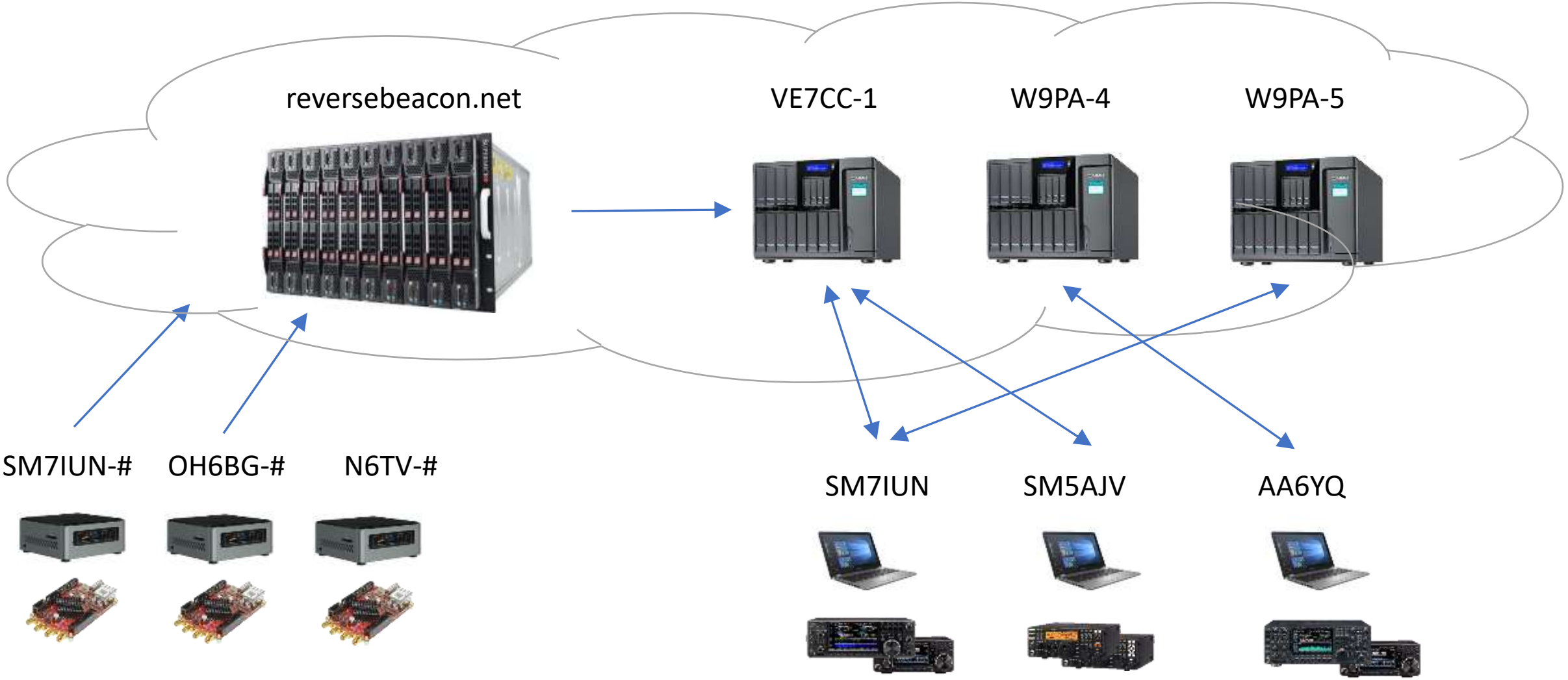


The Reverse Beacon network

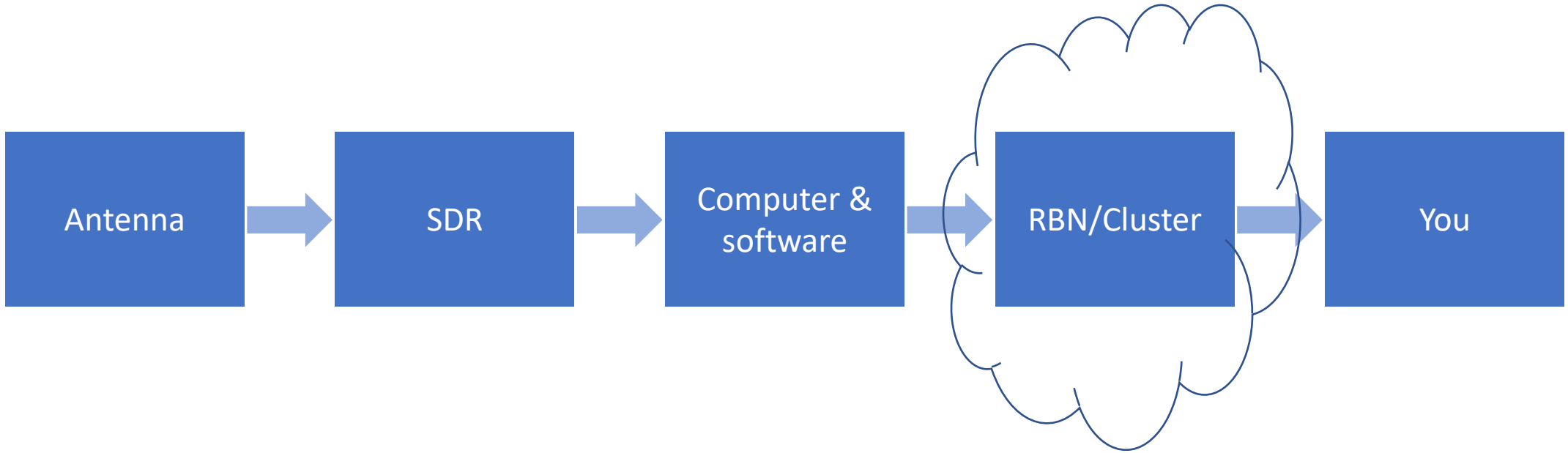
- A global network of skimmer receivers for both Morse code and digital protocols
- ~200 24/7 “skimmers”
- Global coverage
- Highest density in EU & NA

http://www.reversebeacon.net

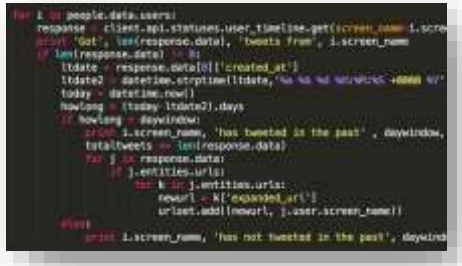
Reverse beacon network & The DX cluster

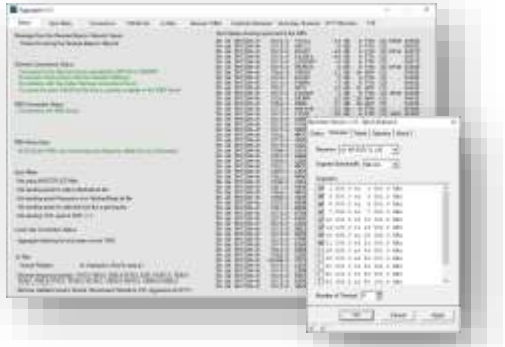


The whole chain

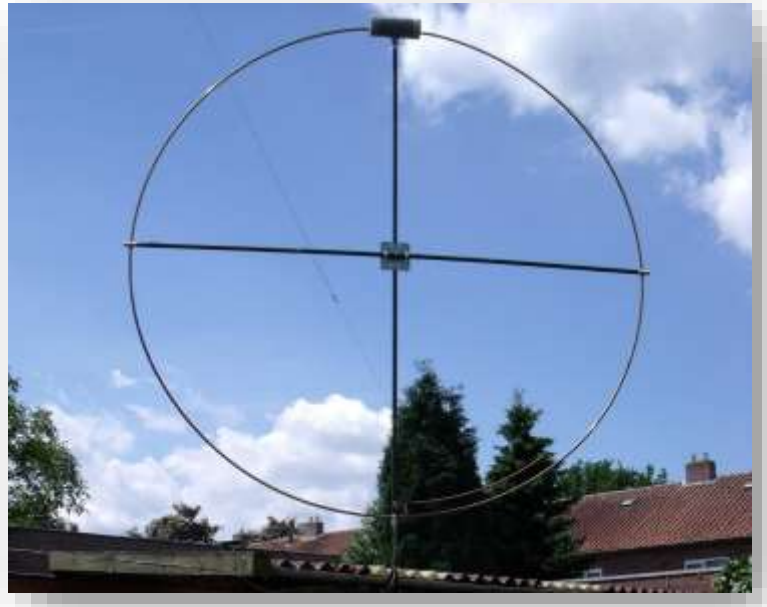


What are the parts in a skimmer?





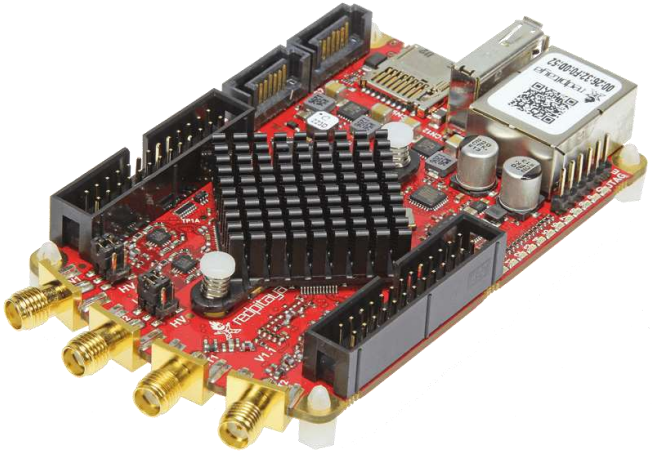
#1 Antenna



- Should be
  - broadband, preferably 1.8-50MHz
  - always connected
  - be immune to local noise or in a low noise environment
- Does not need
  - to work for transmission
  - to be very efficient, SNR is more important than RSSI
  - to be large

#2 Receiver

- Should
  - have a digital quadrature output sampled at 48, 96 or 192kHz
  - be wideband, preferably 1.8-50MHz
  - be support multiple receiver instances
  - preferably be networked (Ethernet)



- Does not need
  - knobs and buttons
  - an audio chain

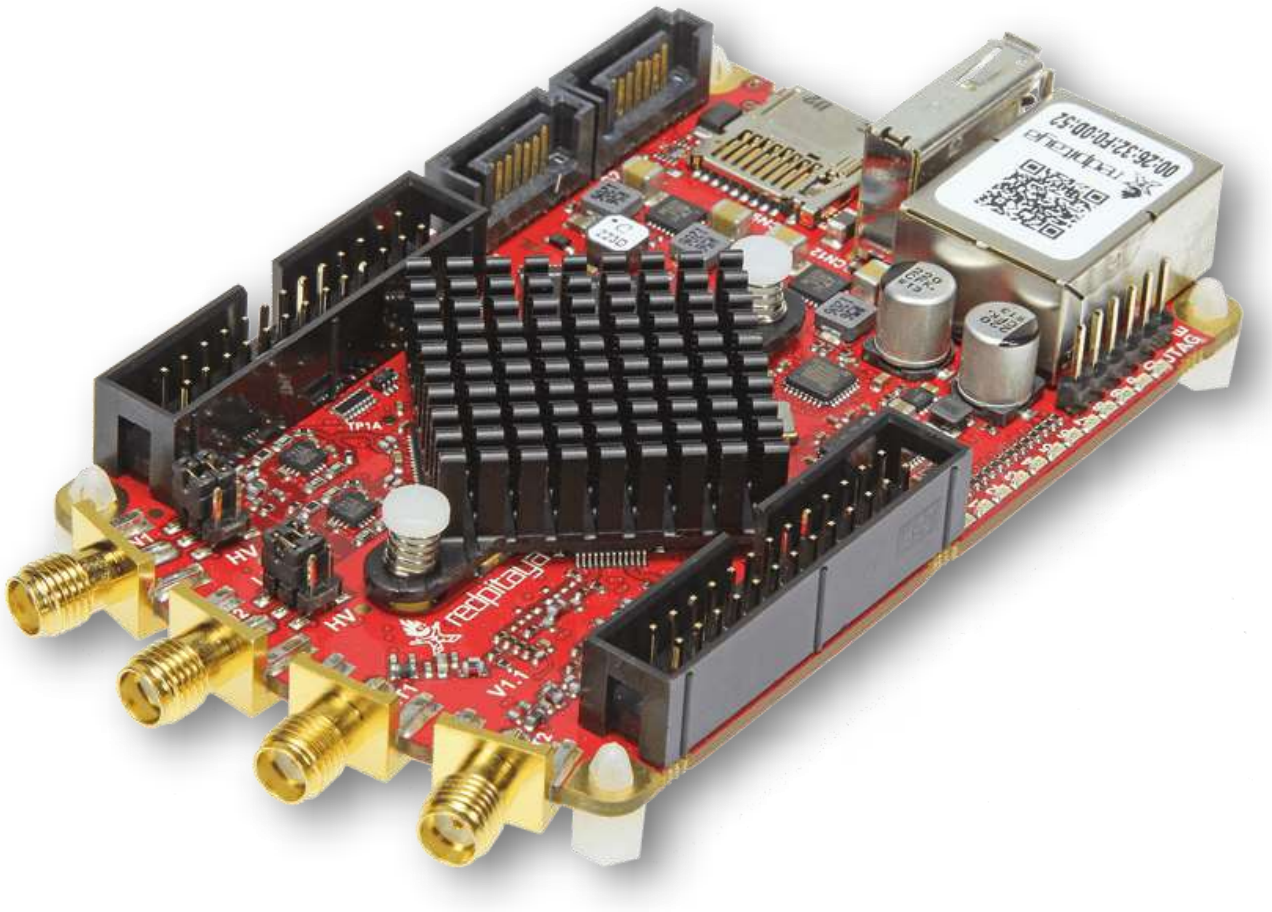
SDR receivers

“The Raspberry Pi of DSP”

Red Pitaya 125-14

- Based on Xilinx Zynq 7010
- 28,000 logical cells FPGA
- 80 programmable DSP slices
- 100 GMAC/s performance
- 667MHz Cortex A9 MPcore with Neon and CoreSight
- Two 125MHz 14 bit ADC/DAC
- Four 100kHz ADC/DAC
- 16 GPIO

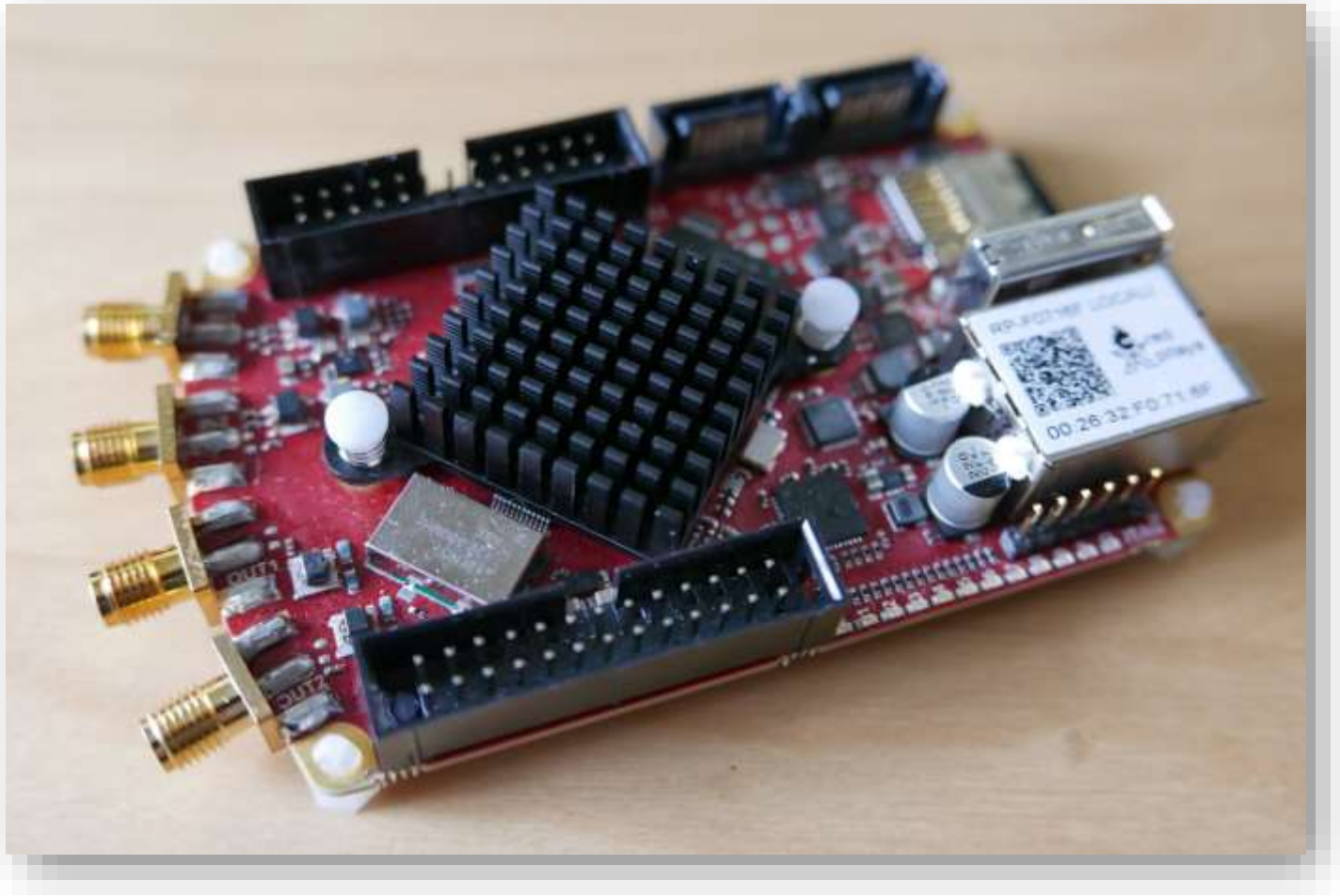
- Started as a Kickstarter project
- Over 30,000 sold
- Base ports for Ubuntu and Alpine Linux
- Free Xilinx Vivado tool suite



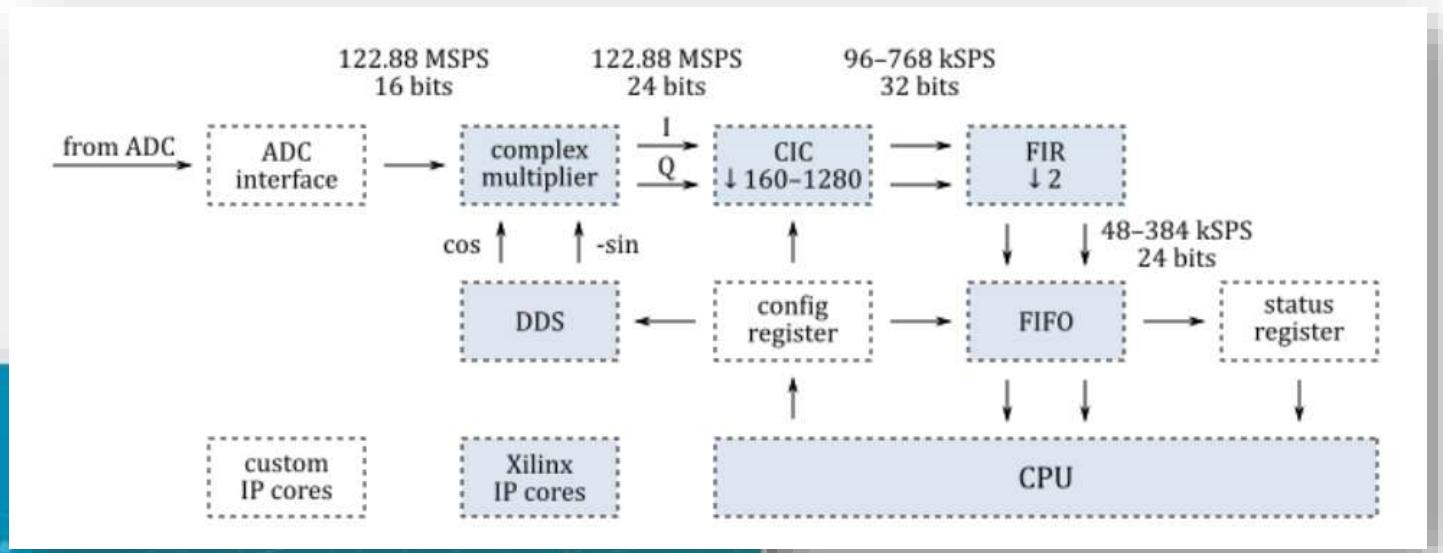
“The Raspberry Pi of DSP”

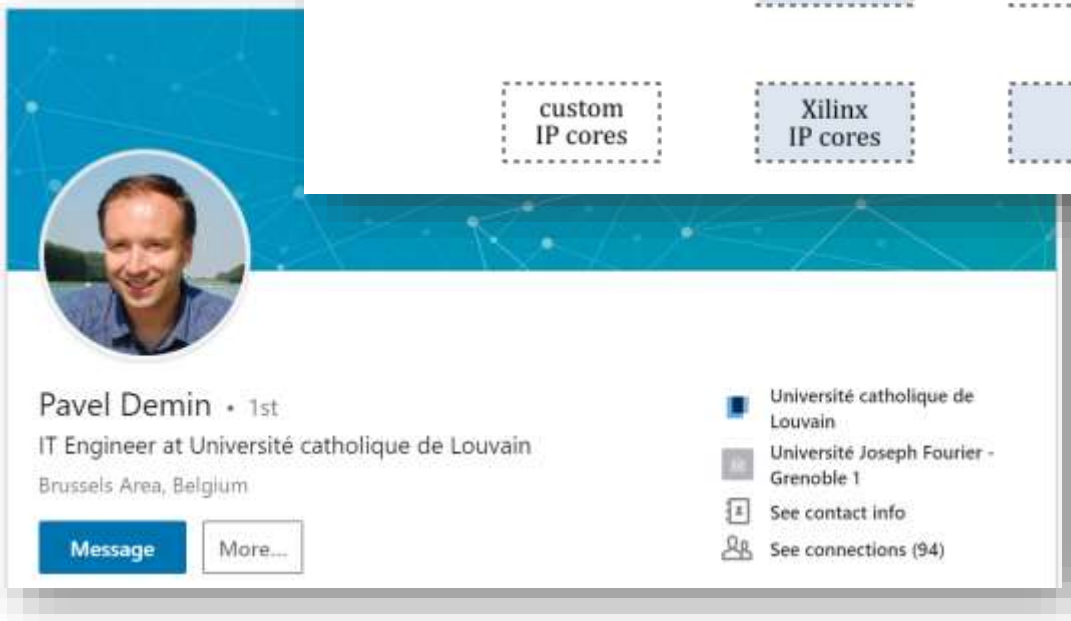
Red Pitaya 122.88-16

- Based on Xilinx Zynq 7020
- 85,000 logical cells FPGA
- 220 programmable DSP slices
- 276 GMAC/s performance
- 667MHz Cortex A9 MPcore with Neon and CoreSight
- Two 122.88MHz 16 bit ADC/DAC
- Four 100kHz ADC/DAC
- 16 GPIO
- ABLNO XO <50fs jitter



Pavel Demin @ KU Leuven





1. List of components
2. Links
3. Development machine
4. LED blinker
5. SDR receiver
6. SDR transceiver
7. SDR transceiver compatible with HPSDR
8. SDR receiver compatible with HPSDR
9. Embedded SDR transceiver
10. Wideband SDR transceiver
11. Multiband WSPR transceiver
12. Multiband FT8 transceiver
13. Pulsed Nuclear Magnetic Resonance
14. Multichannel Pulse Height Analyzer
15. Scanning system
16. Vector Network Analyzer
17. Alpine with pre-built applications

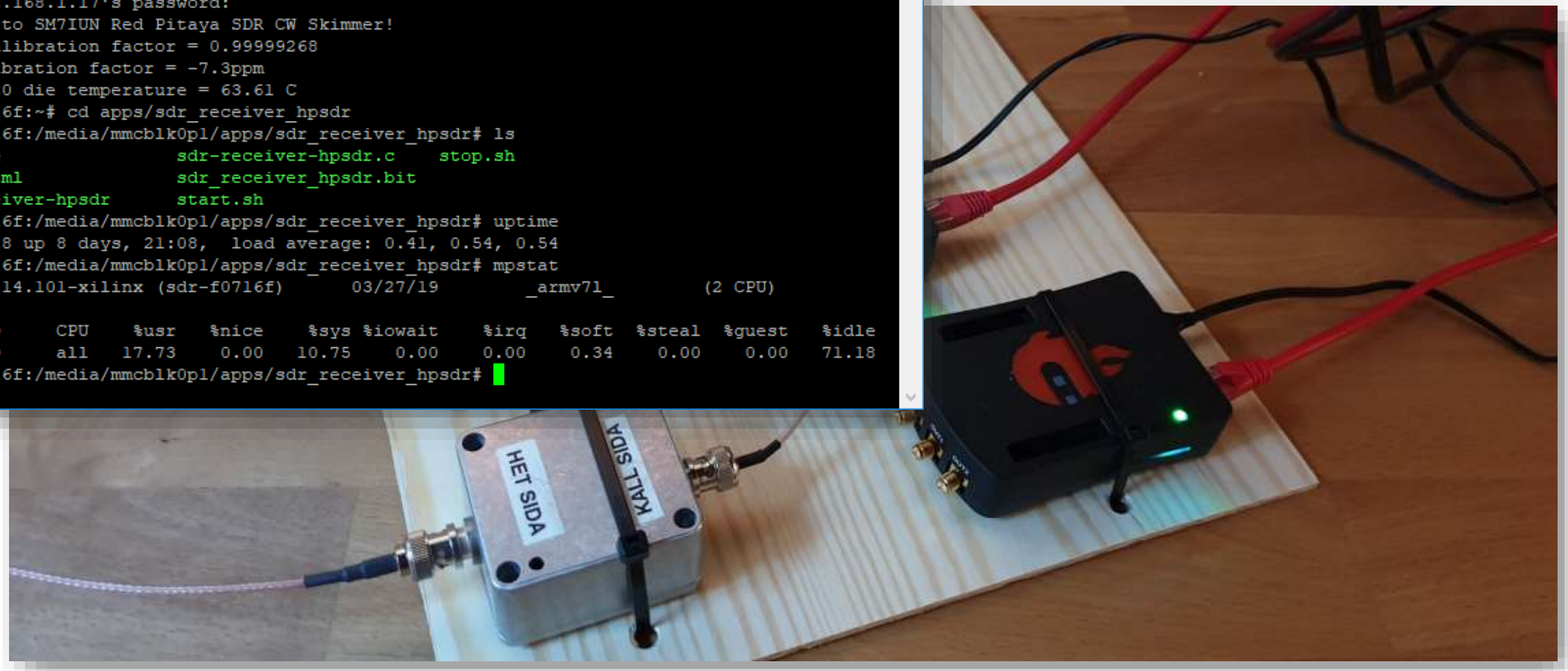
http://pavel-demin.github.io/red-pitaya-notes/

CW and FT8 skimmers @ SM7IUN

192.168.1.17 - PuTTY

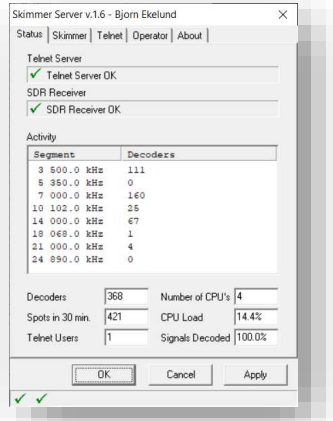
```
login as: root
root@192.168.1.17's password:
Welcome to SM7IUN Red Pitaya SDR CW Skimmer!
HPSDR calibration factor = 0.99999268
FT8 calibration factor = -7.3ppm
Zynq 7020 die temperature = 63.61 C
sdr-f0716f:~# cd apps/sdr_receiver_hpsdr
sdr-f0716f:/media/mmcblk0p1/apps/sdr_receiver_hpsdr# ls
Makefile                sdr-receiver-hpsdr.c    stop.sh
index.html              sdr_receiver_hpsdr.bit
sdr-receiver-hpsdr      start.sh
sdr-f0716f:/media/mmcblk0p1/apps/sdr_receiver_hpsdr# uptime
 12:20:18 up 8 days, 21:08,  load average: 0.41, 0.54, 0.54
sdr-f0716f:/media/mmcblk0p1/apps/sdr_receiver_hpsdr# mpstat
Linux 4.14.101-xilinx (sdr-f0716f)      03/27/19        _armv7l_        (2 CPU)

12:20:19     CPU    %usr   %nice    %sys %iowait    %irq   %soft  %steal  %guest   %idle
12:20:19     all   17.73    0.00   10.75    0.00    0.00    0.34    0.00    0.00   71.18
sdr-f0716f:/media/mmcblk0p1/apps/sdr_receiver_hpsdr#
```

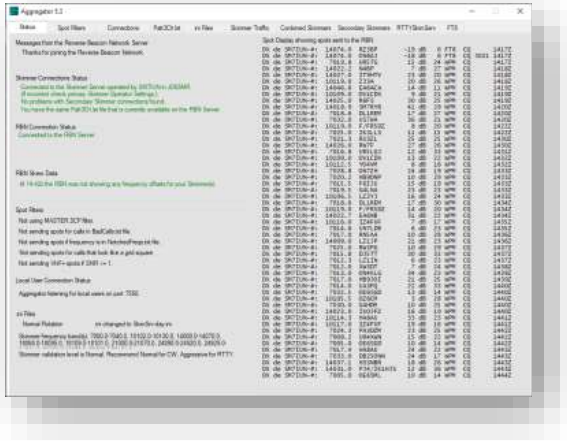


#3 Host computer and software

- **“CW Skimmer Server” or “RTTY Skimmer Server”**
  - Decodes the Morse code transmissions in the passband of the radio front end
  - Computationally intense. RTTY more than CW.
  - CW is 5-25% on 2GHz Core i5 depending on bandwidth

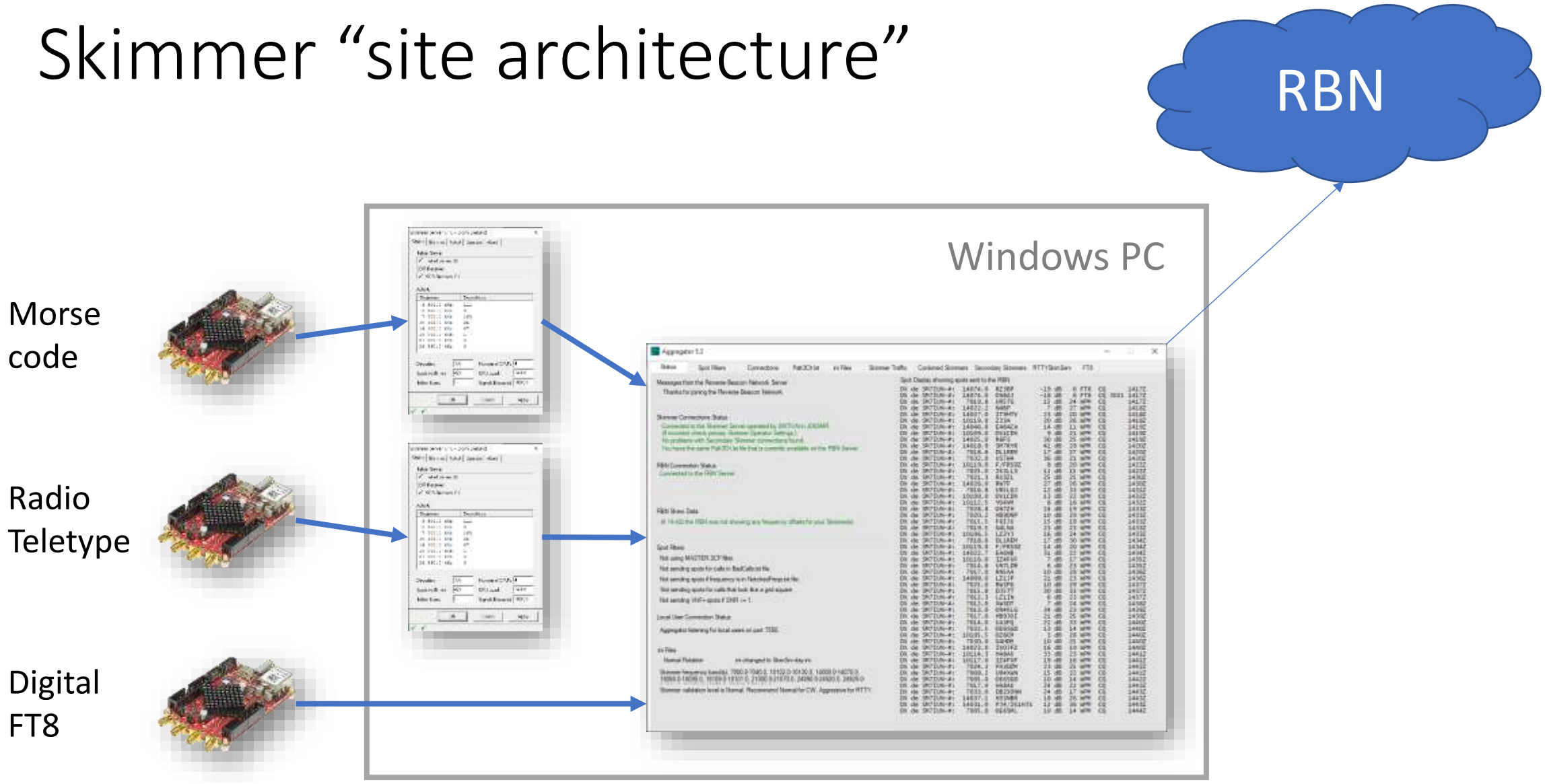


- **“RBN Aggregator”**
  - Consolidates and curates streams of decoded call signs from several radio front ends
  - Adds origin information
  - Controls daylight/twilight/night cycle
  - Etc. housekeeping



- Decoding of the FT8 digital transmission protocol is much less computationally intense and can be done in the radio front end.

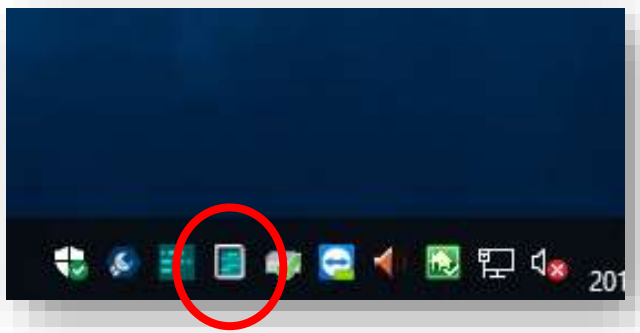
Skimmer “site architecture”



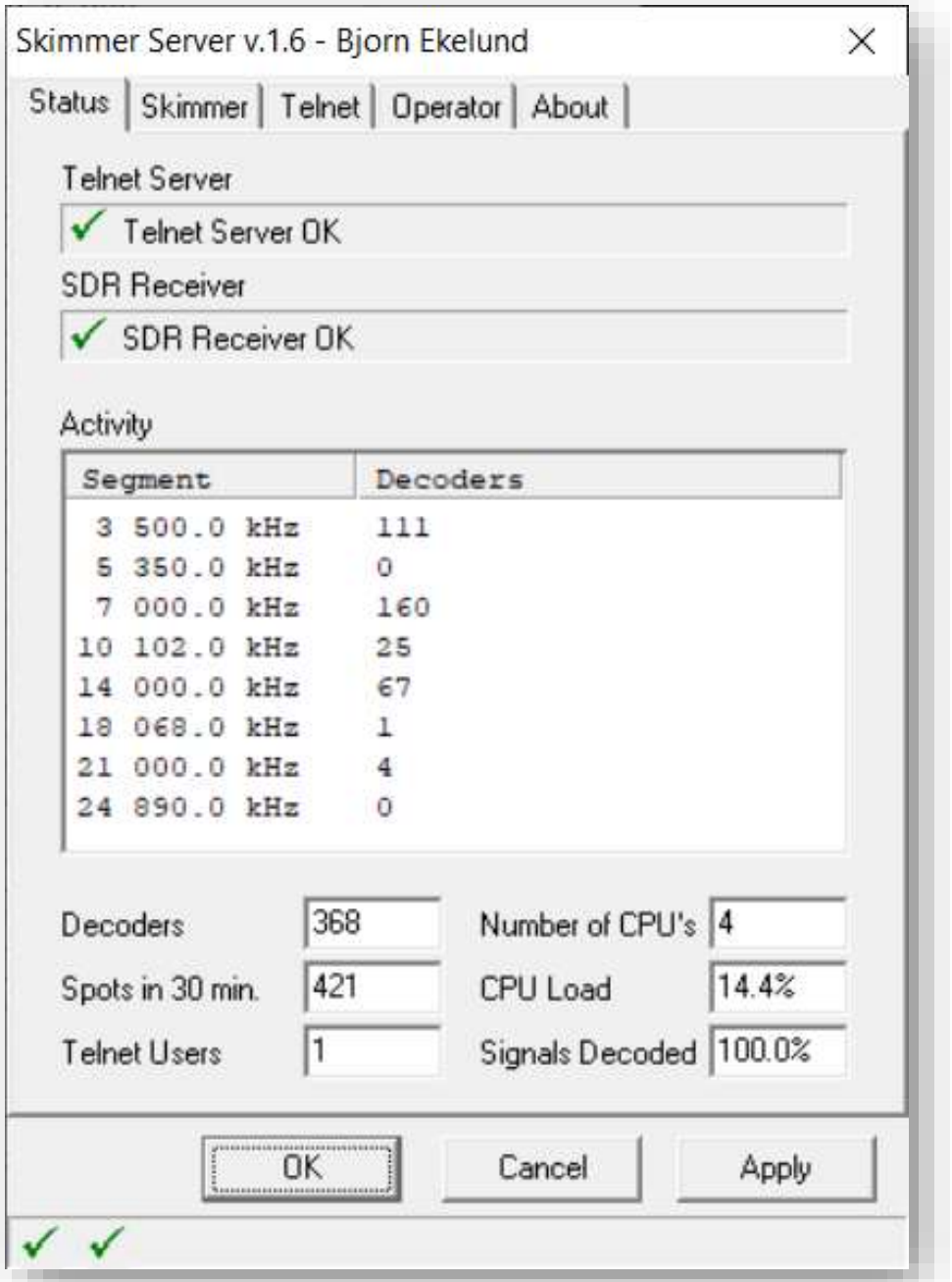
CW Skimmer Server

An “embedded” CW Skimmer with Telnet interface for RBN Aggregator or a DX cluster node

8 × 91kHz segments shortwave
bands = 10-15% CPU load on 2GHz Core i5

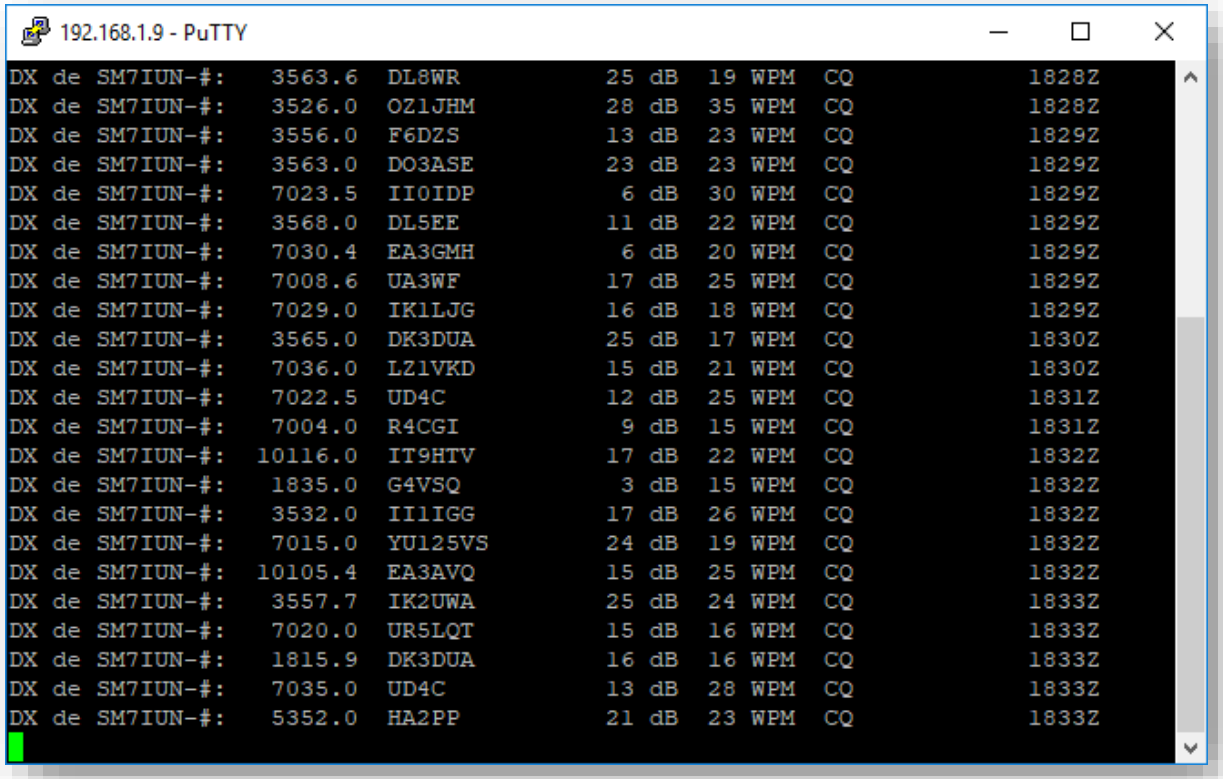


http://www.dxatlas.com/SkimServer



CW Skimmer Server

Simple Telnet feed with frequency, call sign, SNR, transmission speed and time

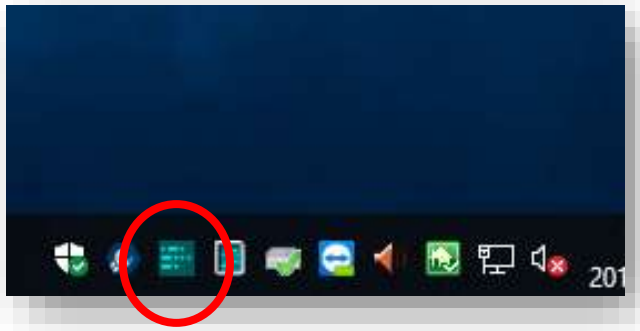


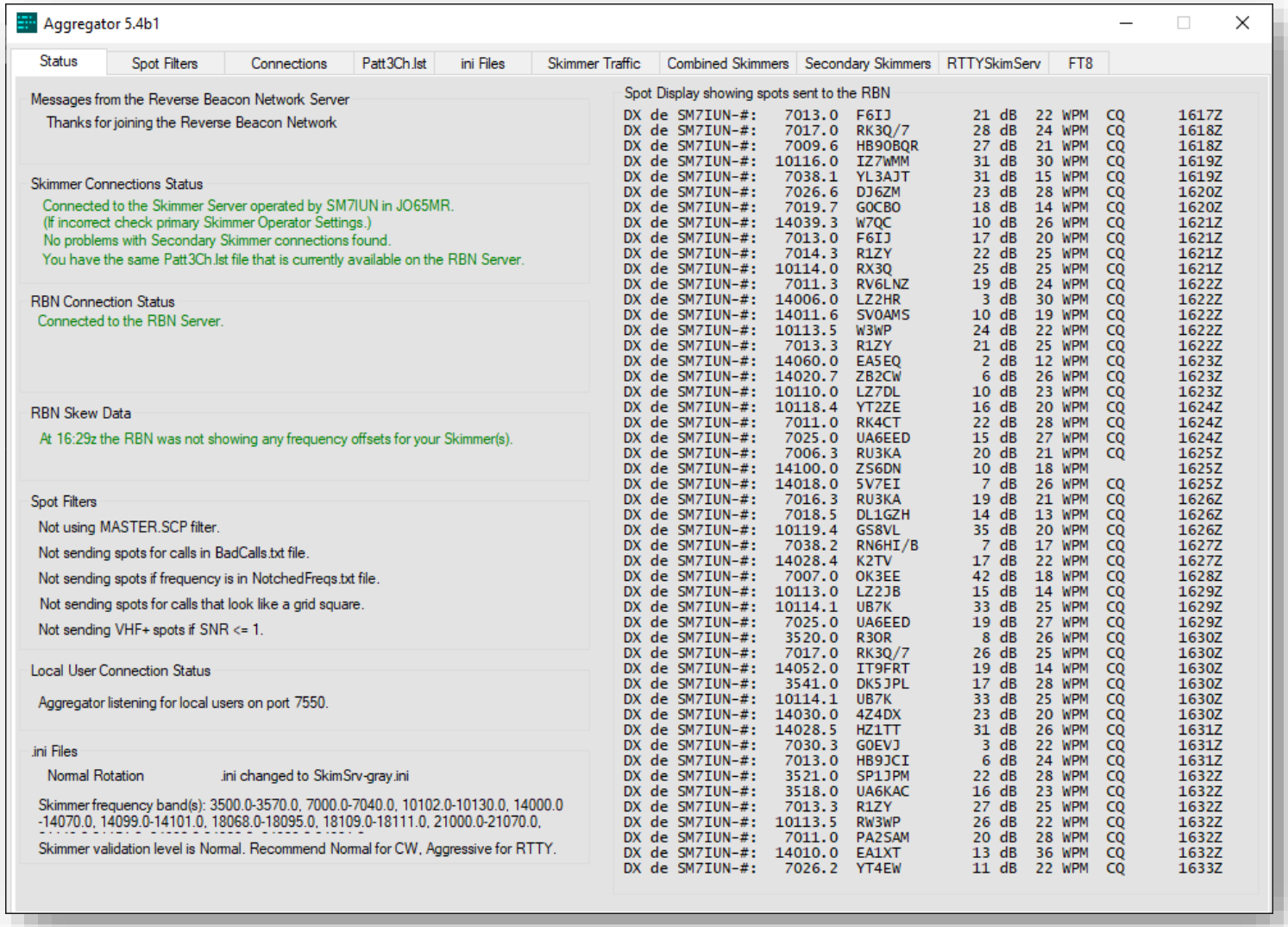
- Typically CW Skimmer Server does not report party stations, only “CQ-ers”
- Spotting keywords:
  CQ QRZ TEST NA SS FD UP
- Short call signs (e.g. SE5E) should be repeated for secure spotting
- Remember that spotting is not guaranteed even if propagation is sufficient, e.g. due to interference

RBN Aggregator

Curates and aggregates spots before uploading to RBN cloud. Negligible CPU load on host.

Telnet client for CW and RTTY skimmers. UDP broadcast listener for FT8 skimmers.

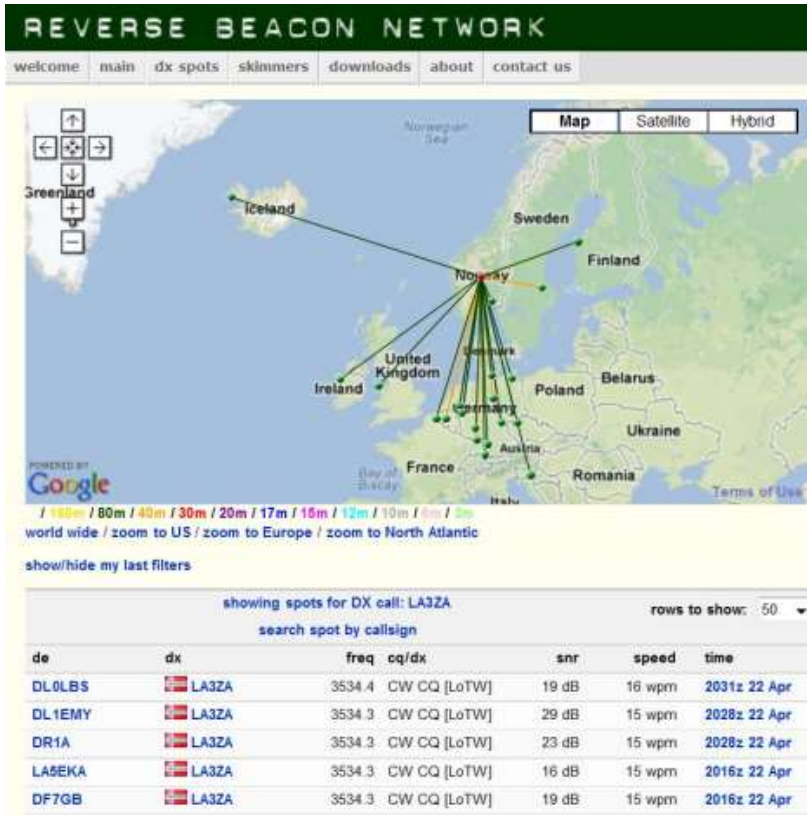


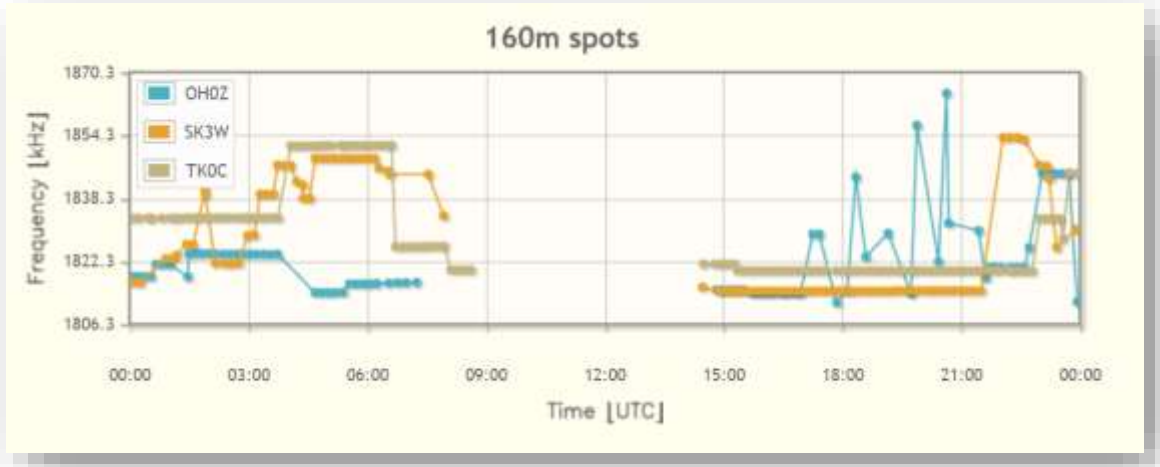


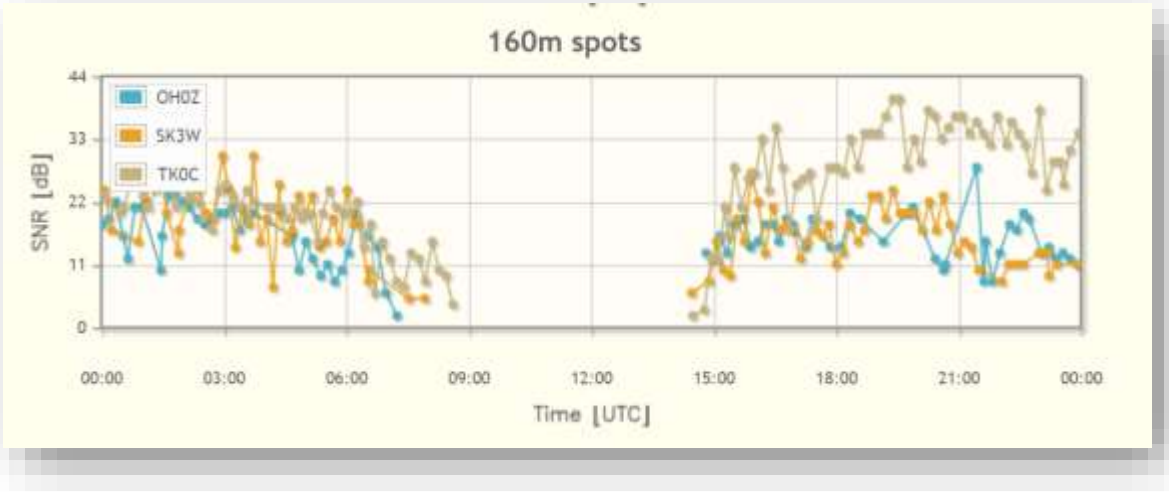
http://www.reversebeacon.net/pages/Aggregator+34

The Reverse Beacon network

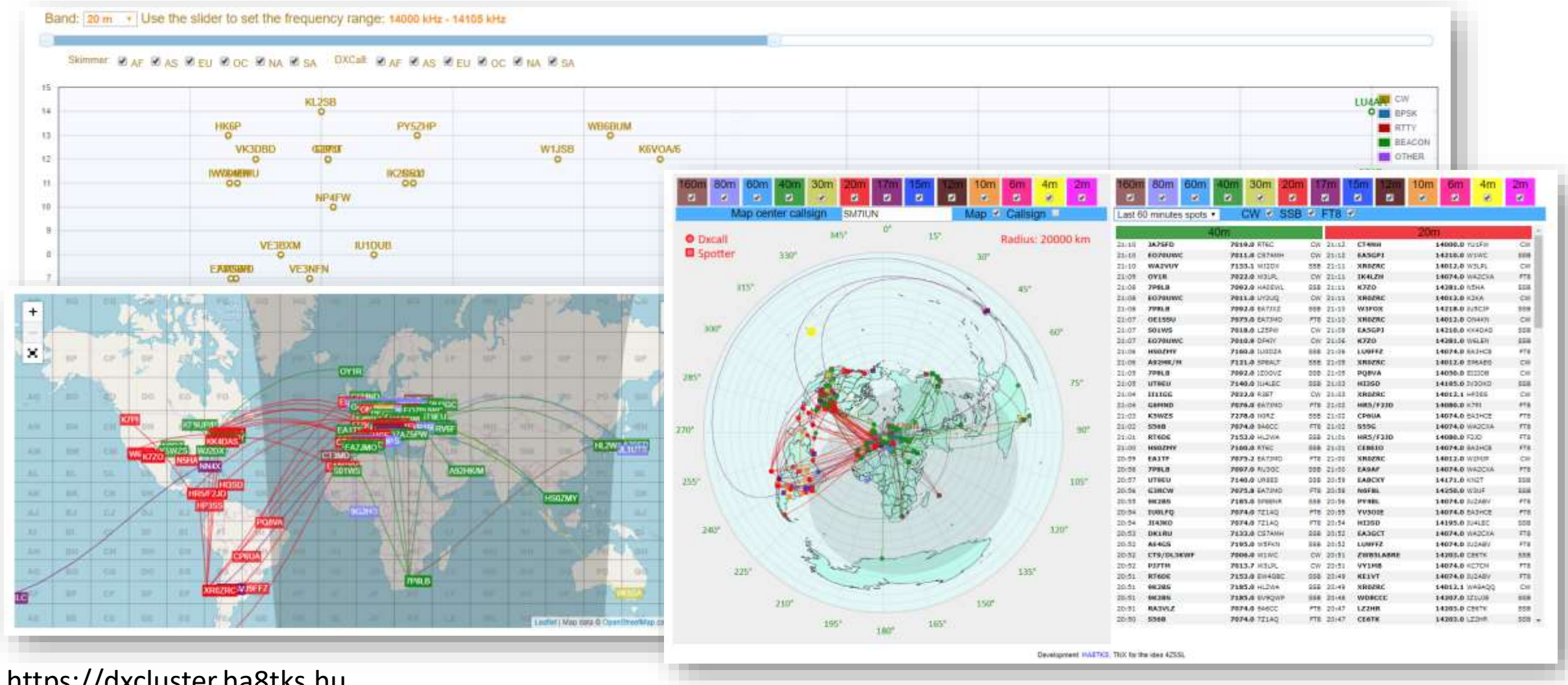
- A cloud service
- “A shortwave communications data lake”
  - All data available for download
- 300,000,000+ data points collected since 2009
- Extensive suite of online analysis tools





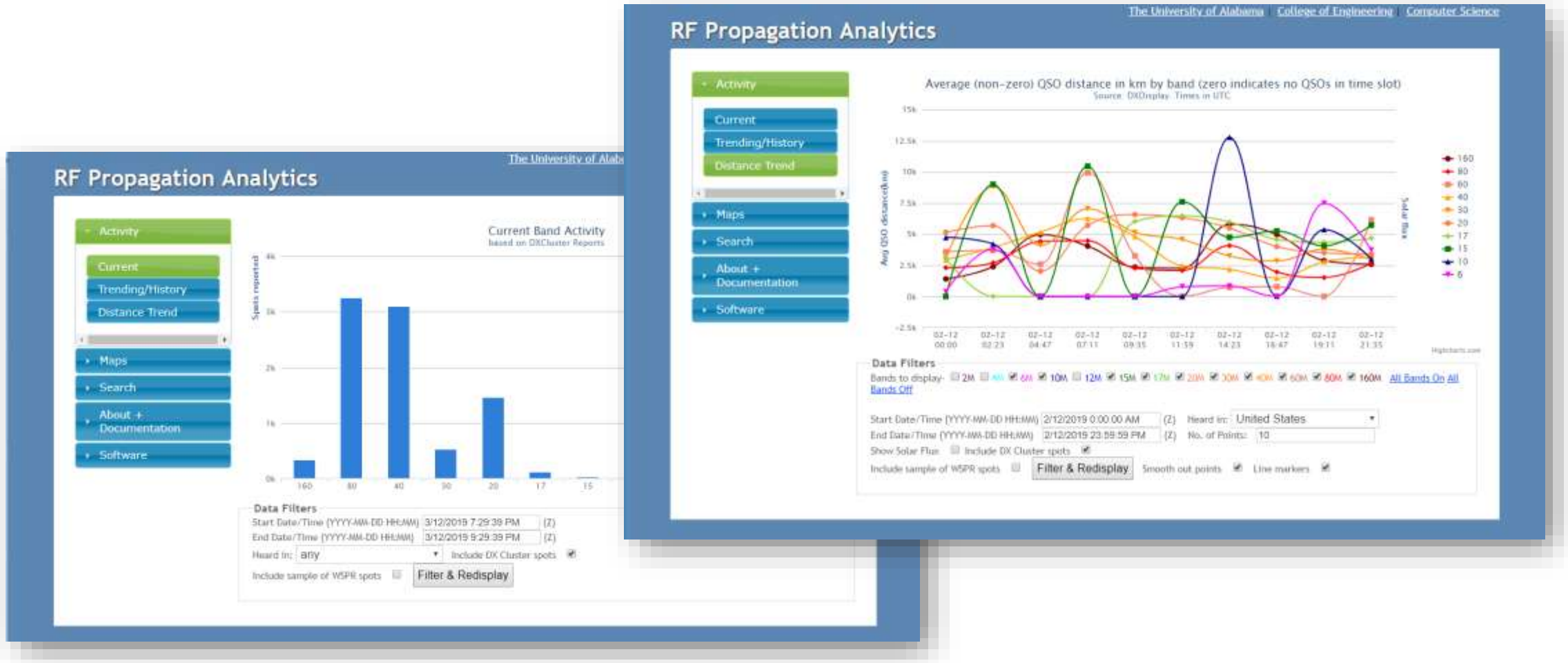


Cloud-to-cloud: HA8TKS



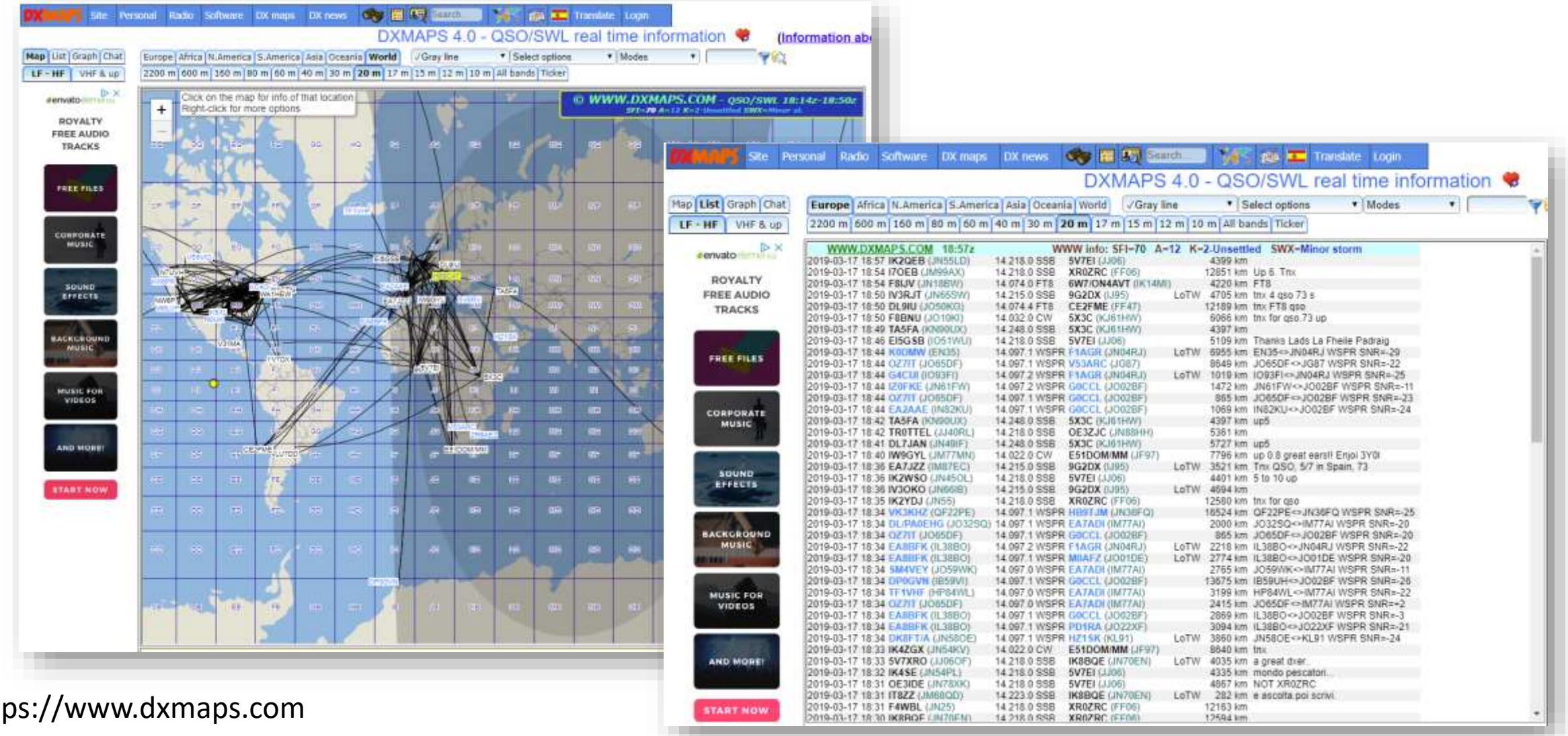
https://dxcluster.ha8tks.hu

Cloud-to-cloud: University of Alabama



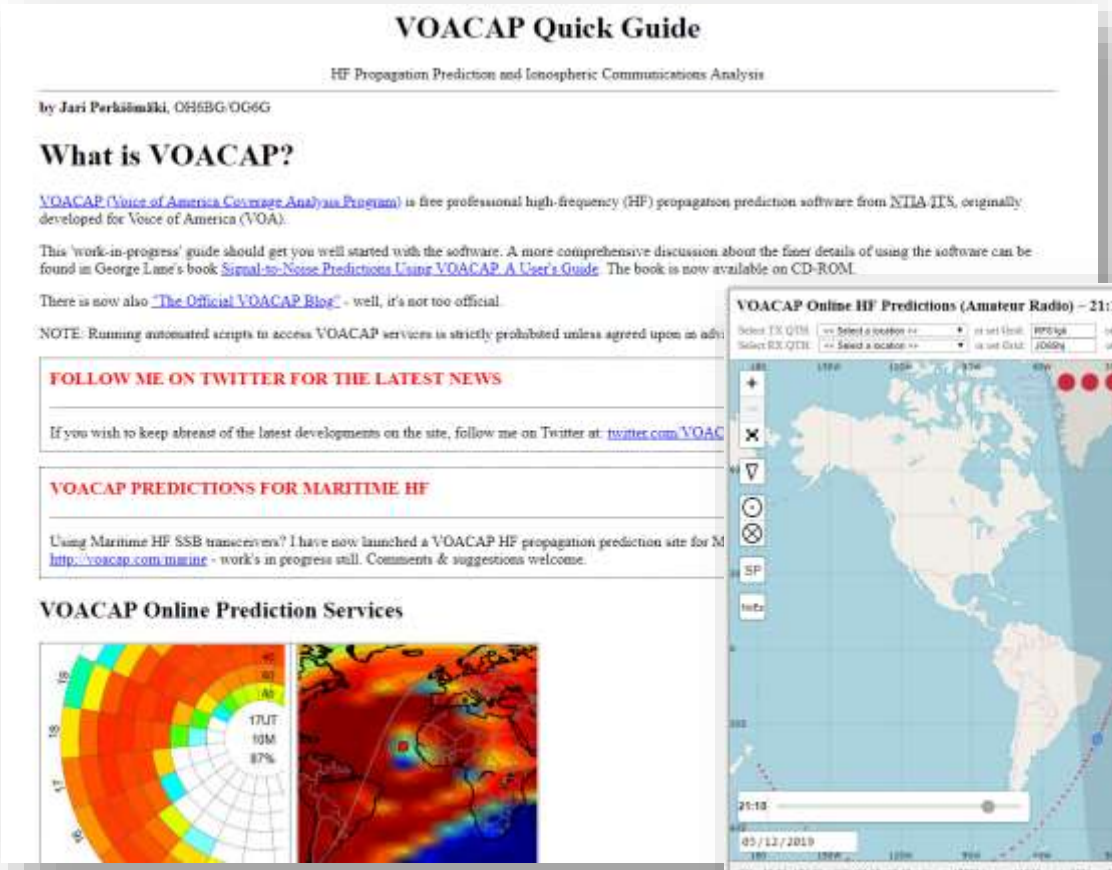
https://dxdisplay.caps.ua.edu

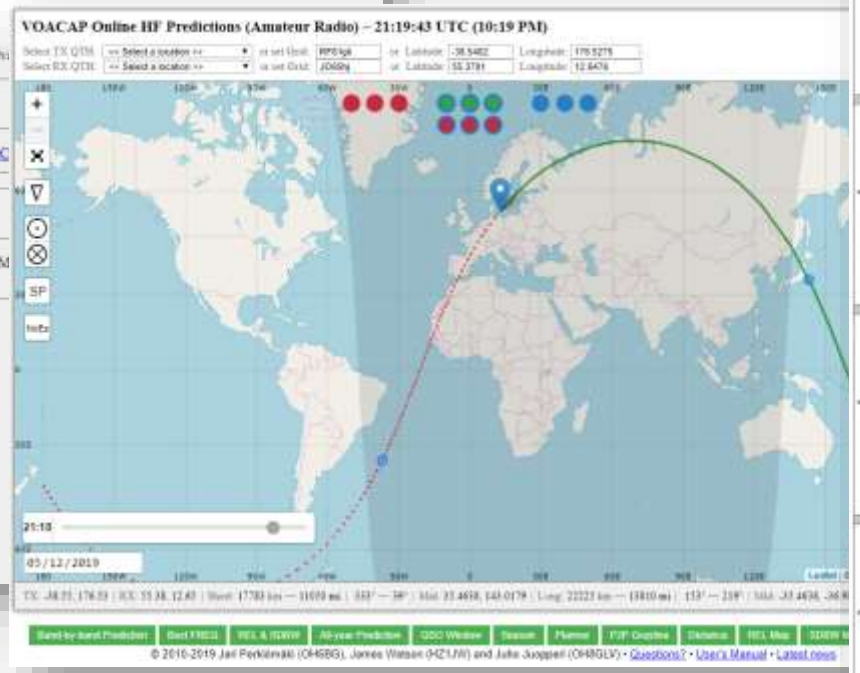
Cloud-to-cloud: DX maps

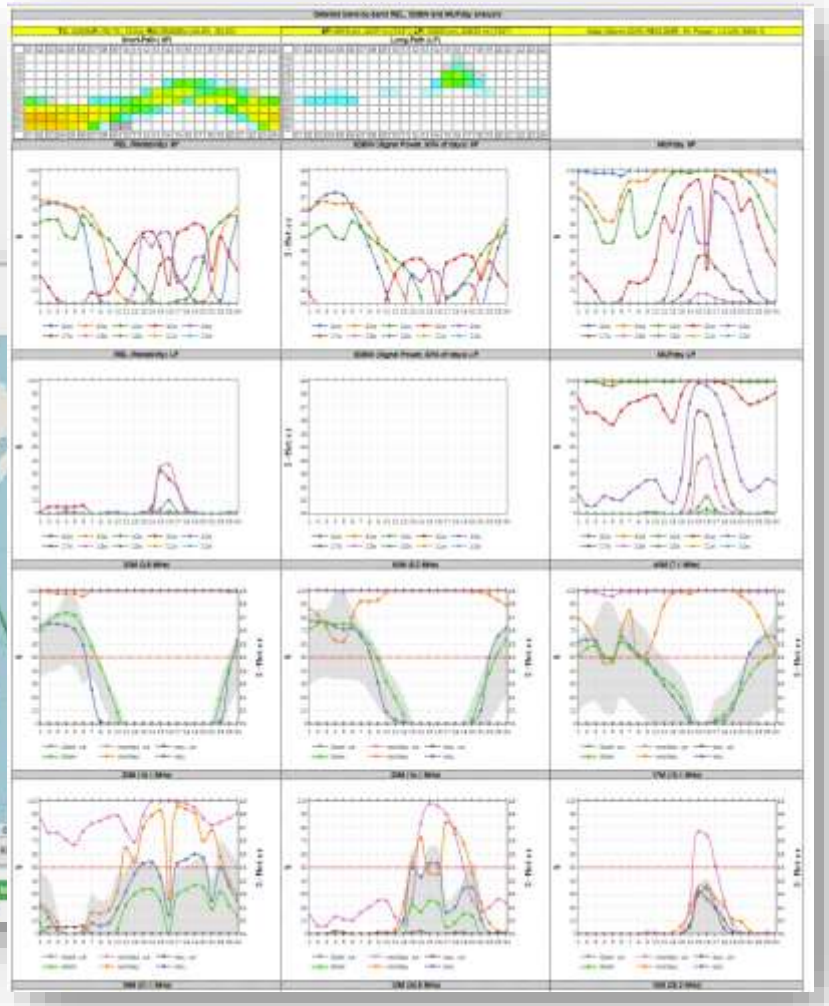


https://www.dxmaps.com

Cloud-to-cloud: VOACAP



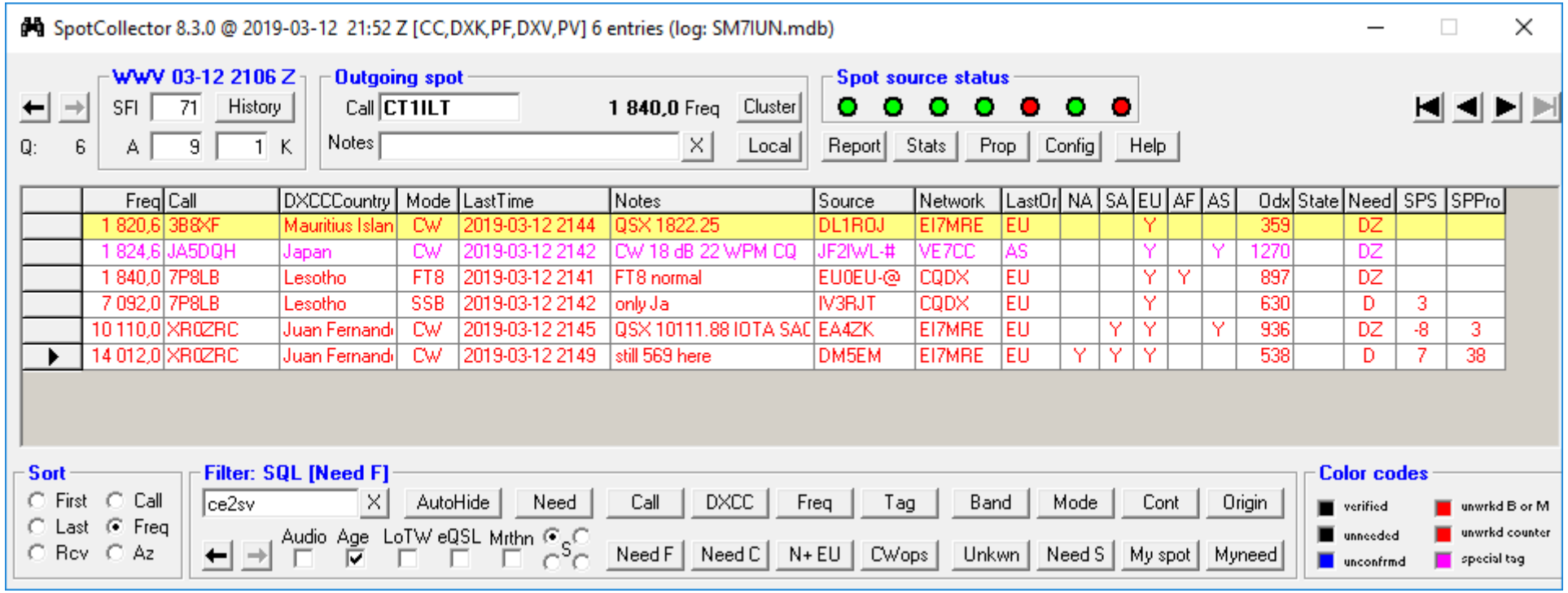




http://www.voacap.com

Client software: SpotCollector

Part of the larger DXLab radio station management suite.
Integration with propagation prediction tools, call sign data base, station logbook, awards rule base, etc.



http://www.dxlabsuite.com

What use is the RBN for me?

Contesting

- Band openings
- Band-map filler
- Spots you
- Find clear spots
- Strategizing
- Benchmarking competition

DX-ing

- Band openings
- Alerts for rare stations
- Propagation reports

Antenna experiments

- Antenna directivity
- Radiation angle
- A-B testing