

Initial Observations - characterising keyboards

This node contains notes that tracks adhoc progress

2018-12-25

Set up and conditions

SDR: Airspy

Antenna: About 3m wire

Distance between keyboard/cables to antenna: about 1m

Two computers were used:

1. The **observation laptop** - Airspy is attached to this laptop. We use it primarily for observing emissions
2. The **target desktop** - this is the desktop to connect the 4 target USB keyboards to.

USB charger in room was disconnected. The fan was switched off. Only lamp and desktop (for connecting target keyboard) were switched on

Observation laptop was disconnected from the power supply. The LAN cable was also unplugged.

Observations

- Noise floor around 36-37MHz region seemed to rise by about 3-5 dB when the keyboard was connected to the USB port (I used a USB cable extender). This is true for all 4 keyboards tested, with certain ones producing a more pronounced rise. **[TODO - attach screenshots to show subtle before and after]**
- Keyboard-01 produced **very strong spikes** at 4 frequencies from 34-40 MHz range the moment it was connected. **[TODO - attach screenshots]**
- The LAN cable (which I get internet connection from) on my observation laptop actually interferes with observations. It was noticed that the noise floor around 36-37MHz was raised and flattened when the LAN cable was connected to the observation laptop. **[To note for future observations]**

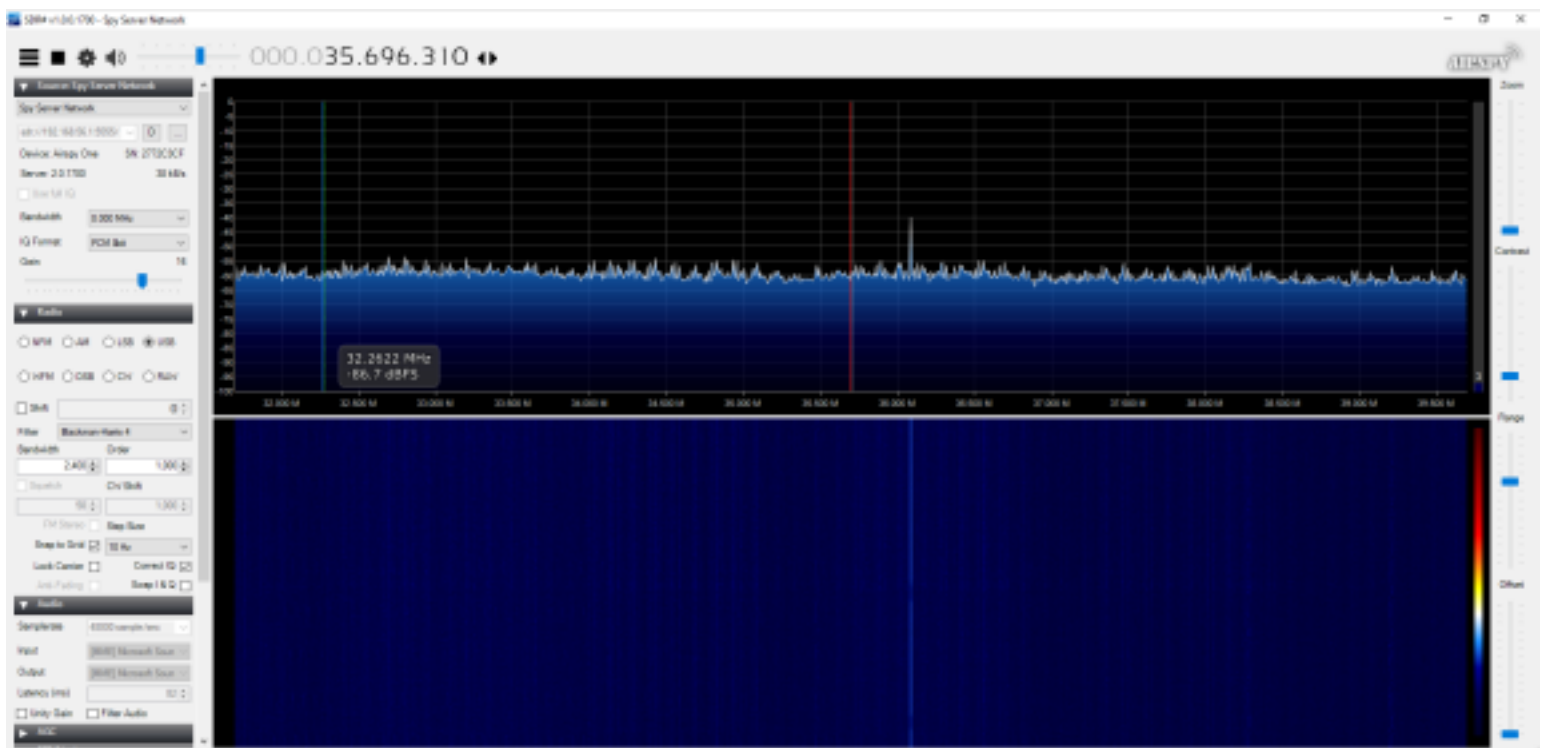
2018-12-30

Test Conditions

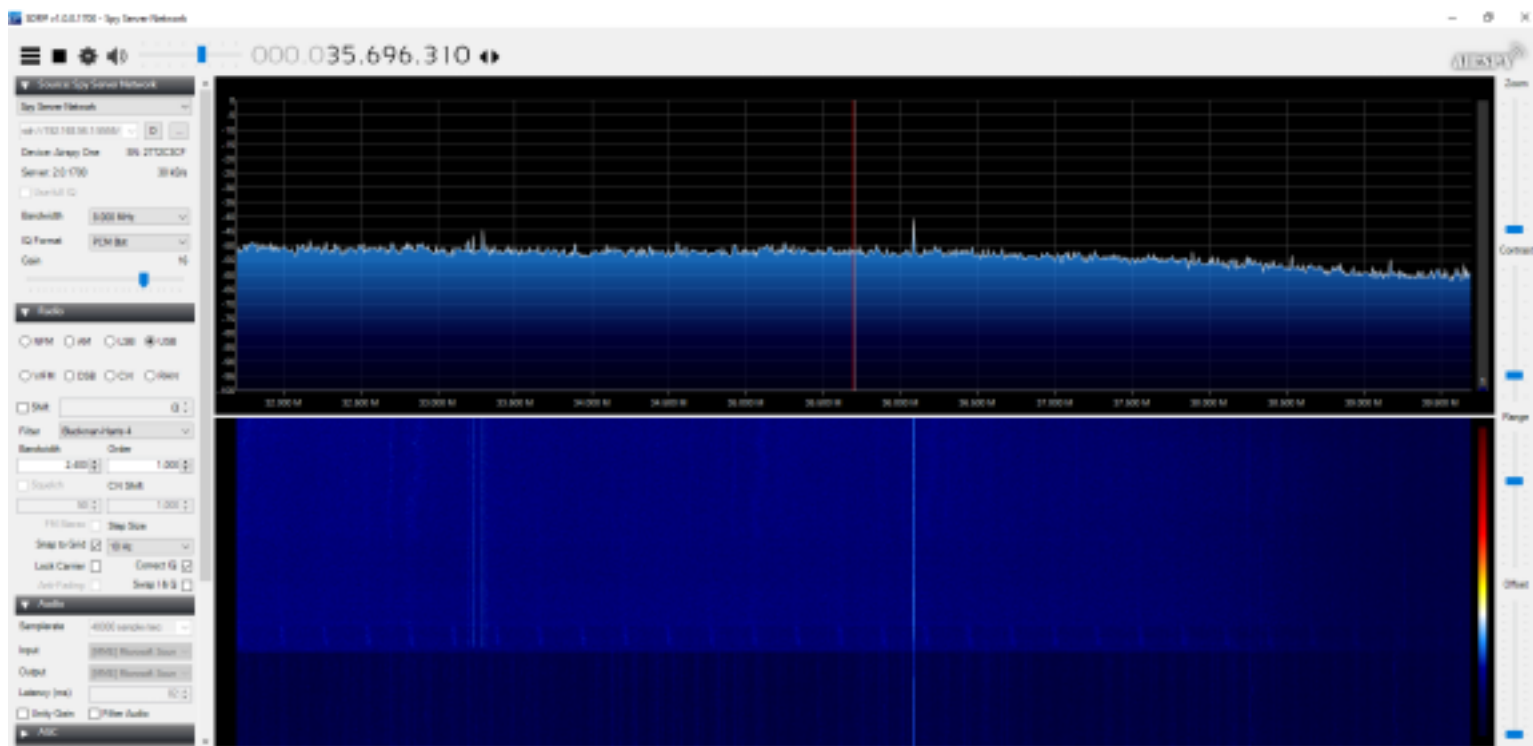
No USB charger in room.
Fan turned off
Air conditioning turned off
All LAN cables unplugged.
3m wire antenna was used with AirSpy SDR

Turning on the desktop alone contributes quite a bit to the noise floor. **[TODO: use a standalone laptop for the target keyboard perhaps?]**

Before turning on desktop



After turning on desktop



This is **an increase of about 5-10 dB in the noise floor in the range of 32-39 MHz.**

Random observation: Me bringing my hand close to the mouse on the observation laptop seems to suppress signals overall, especially around 66-76MHz

Keyboard-02

The machine Keyboard-02 was connected to is a **desktop** in a metal chassis, with power drawn from the mains and a monitor attached. Keyboard-02 uses USB 1.

[Perhaps we should use a standalone laptop instead for the target keyboard, so as to get a less noisy environment]

Conditions

No USB charger in room.
Fan turned off
Air conditioning turned off
All LAN cables unplugged.
3m wire antenna was used with AirSpy SDR

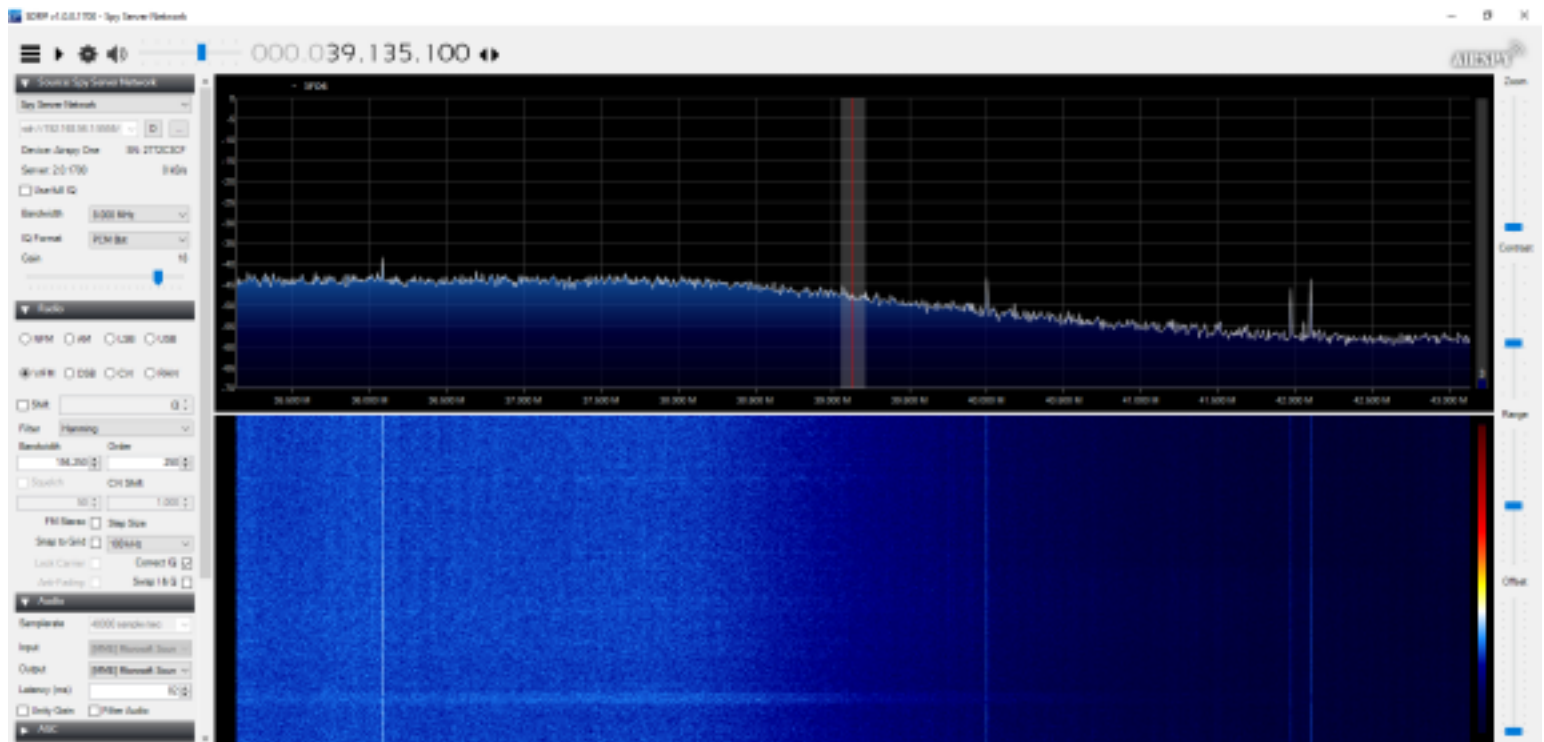
Turning on the desktop alone contributes quite a bit to the noise floor. See parent node

Done at 2-4pm

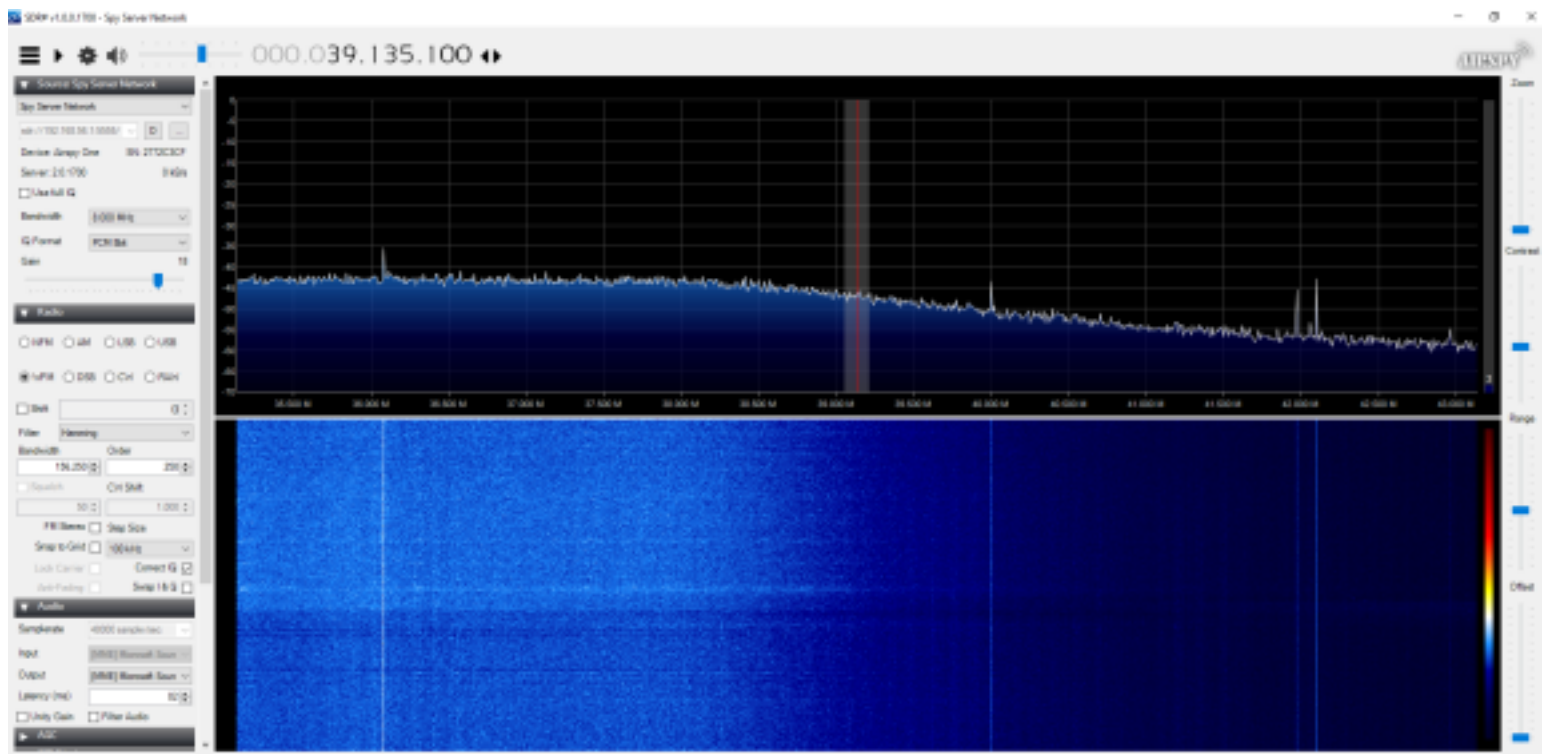
Increase in noise floor

Increased noise floor on plugging in the keyboard observed at 36-41MHz

Before plugging in Keyboard-02:



After plugging in Keyboard-02 - the band in the middle of the spectral plot correlates to the plugging in event. It's only a few dB's increase.



Other not very interesting observations up to 300MHz

Plugging in seems to suppress noise from 40-65MHz - not much effect except during a window during plug in and plug out

Very noisy and a lot of other signals in the 60-70MHz ranges

Don't see much change in 70-87Mhz range
87-109MHz is the FM radio range - avoiding this

Saw some changes in noise floor from 108-114MHz, but not too significant

122.87MHz seems to get more active whenever keyboard is plugged in

Nothing very interesting up to 130MHz
One broadband signal at 133MHz

There are some spot frequencies that appear/disappear on connection and disconnection
130-145

140.5 seems to be, but it is inconsistent

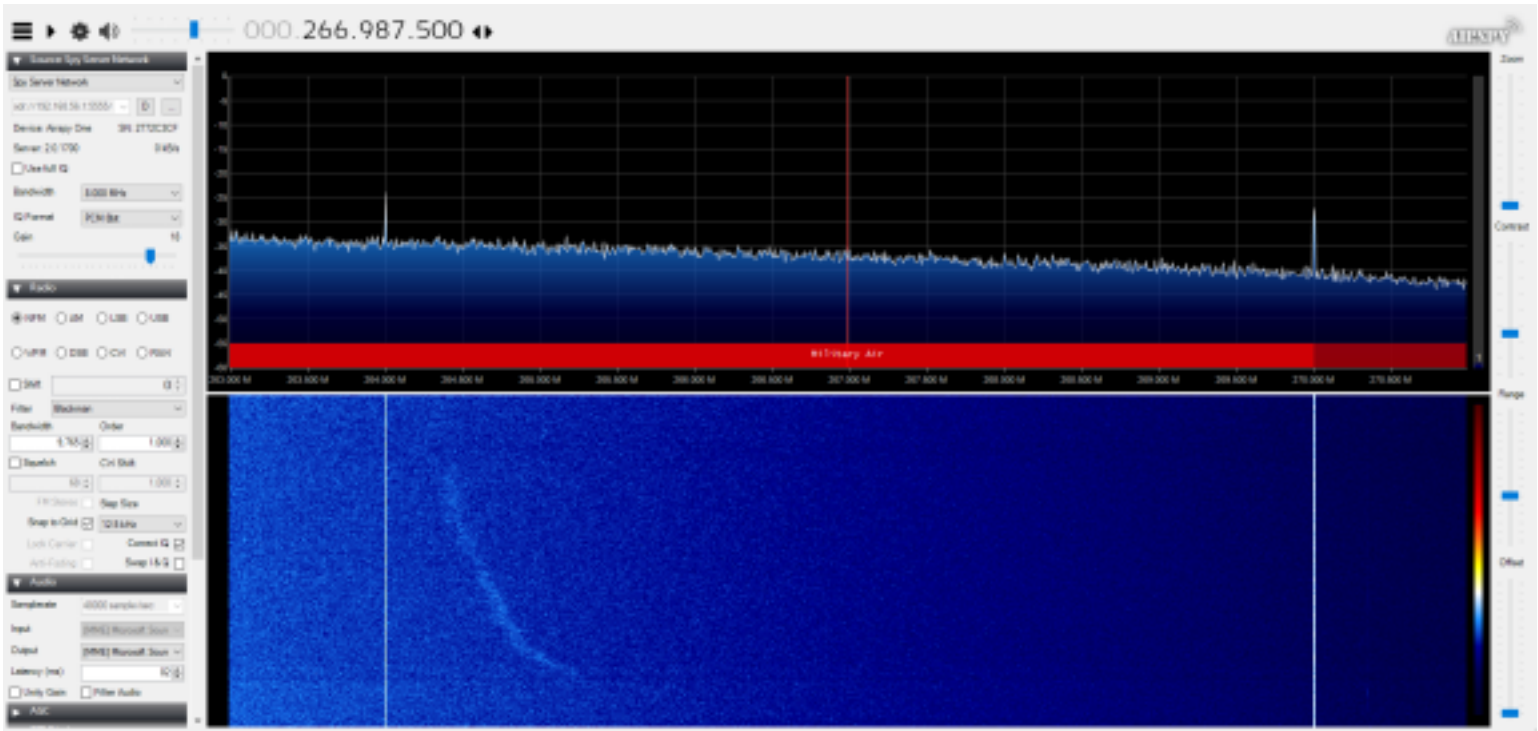
up to 150MHz - Airband, Ham, Marine. Quite busy, esp 150-156MHz Anyway connection/disconnection does not seem to have any effect.

up to 200MHz - Busy. Unaffected by connection/disconnection. Probably TV stations

Activity at 264MHz

264.15 - becomes active when plugged in. Frequency seem to drift from higher to lower, and it keeps drifting until it settles at around 264MHz. But it's not a very strong signal. The drift is in the screen capture shown below.

The strong peak at 264MHz has nothing to do with the keyboard.



2019-01-01

A search for interesting emission in the range 24-300MHz was carried out.

Keyboard-02 retest (emissions are a bit cleaner)

This time, another standalone laptop, not connected to any power source, was used to run Keyboard-02, which runs on USB v1.10

Conditions

No USB charger in room.

Fan turned off

Air conditioning turned off

All LAN cables unplugged.

3m wire antenna was used with AirSpy SDR

Target Keyboard was connected to a standalone laptop

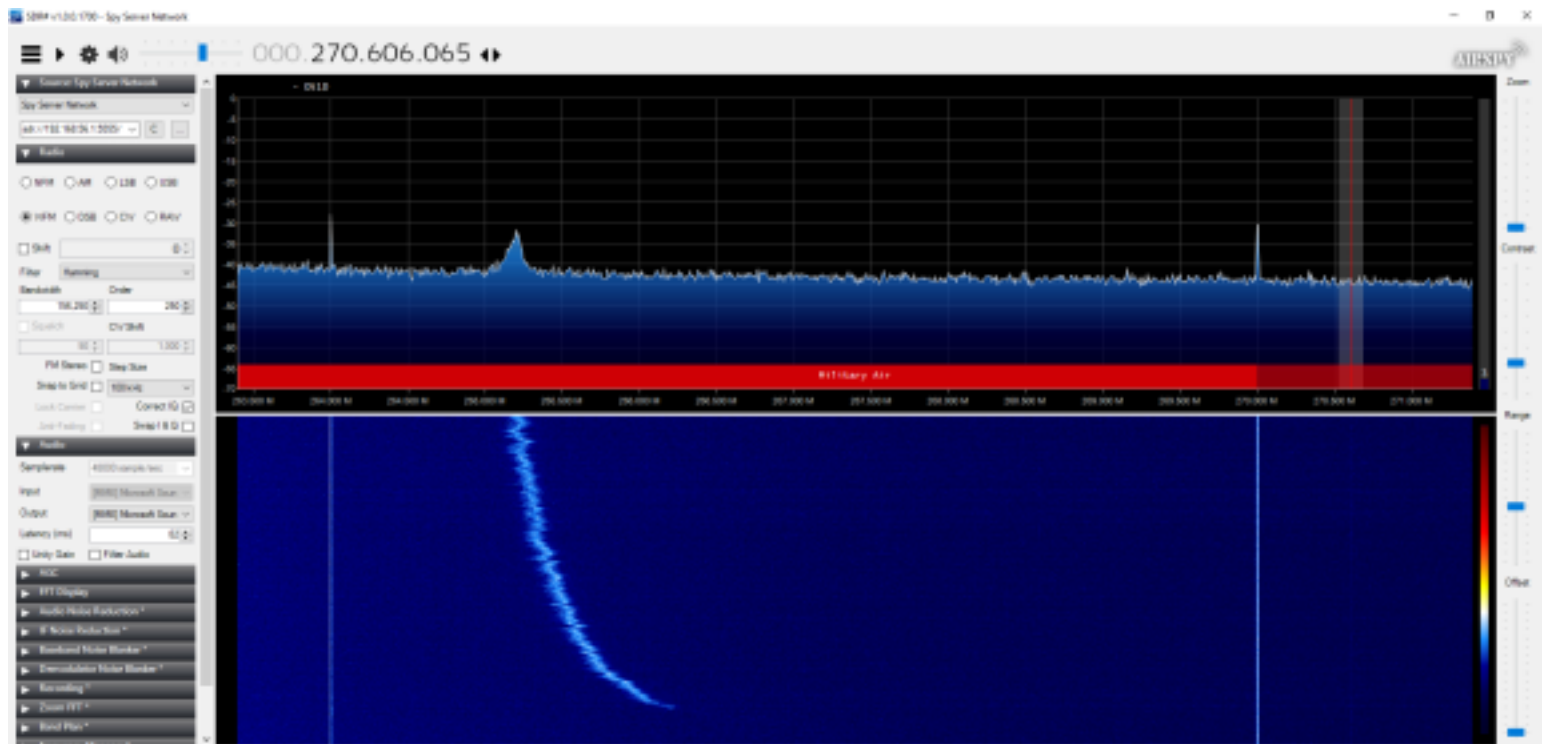
Electrical appliances are unplugged as much as possible. Only a lamp was switched on

Distance between keyboard and antenna ~ 1m

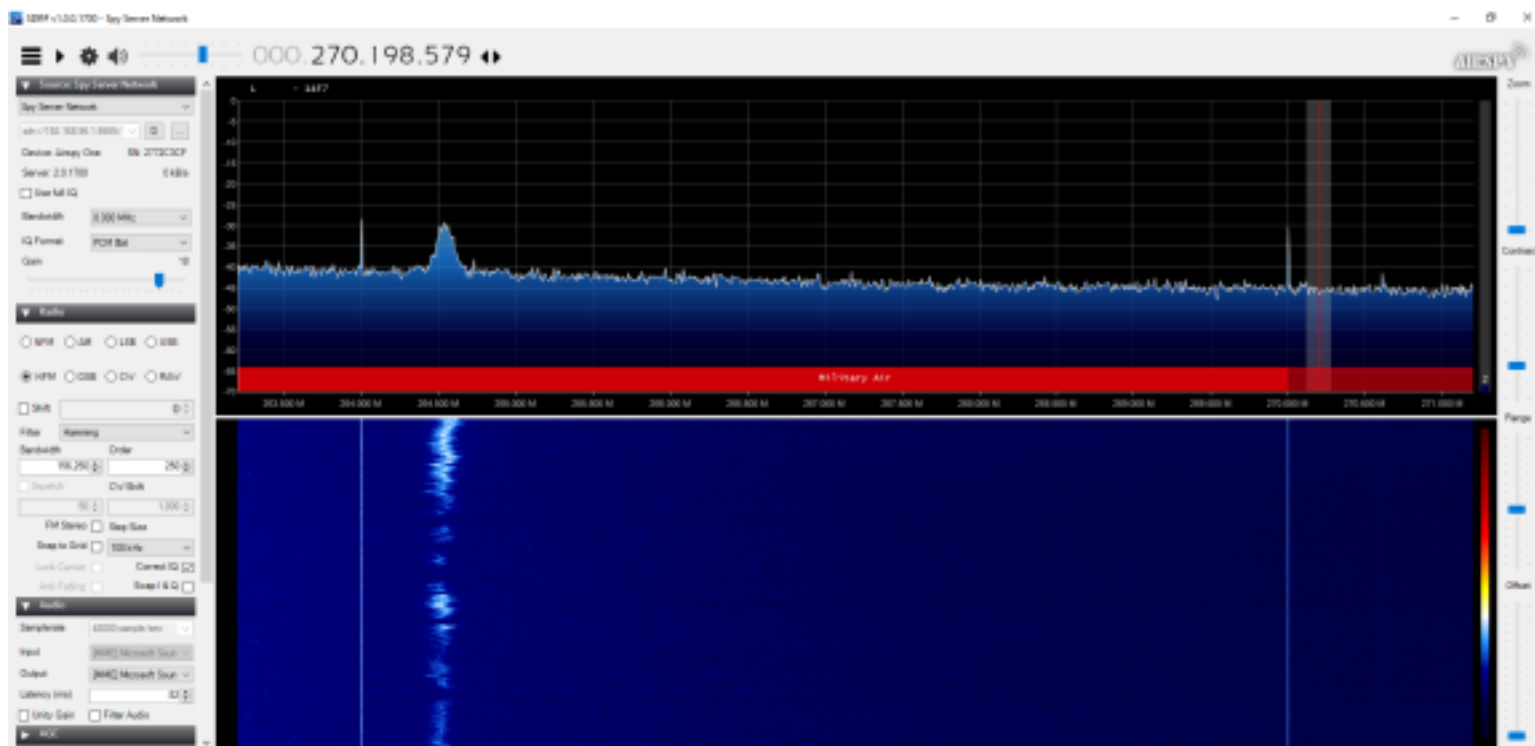
This was done in the early morning, before dawn

264.5MHz emission

The 264MHz signal we previously saw looks more prominent now, probably because of the lower noise floor

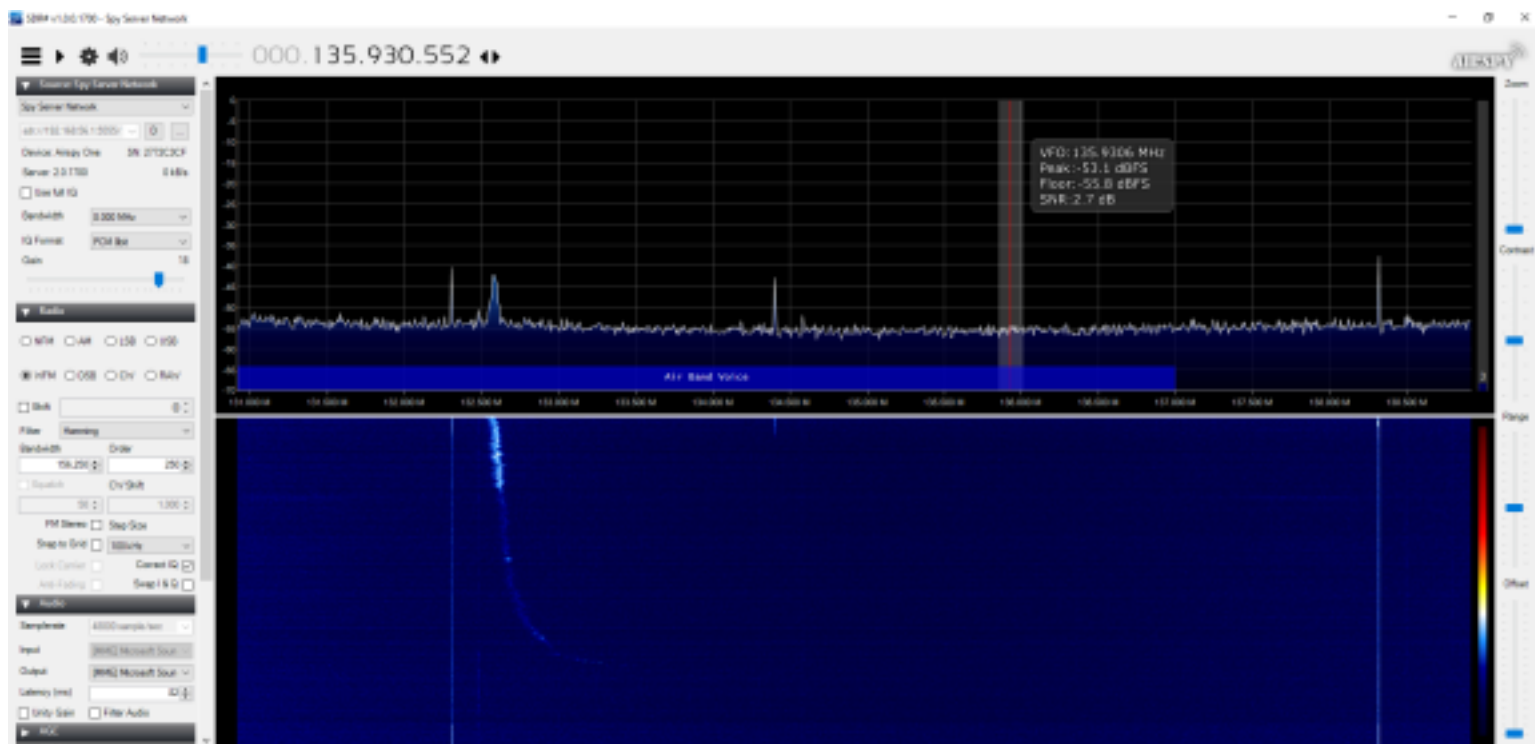


This signal strengthened and weakened depending on how much I exposed the keyboard's USB cable



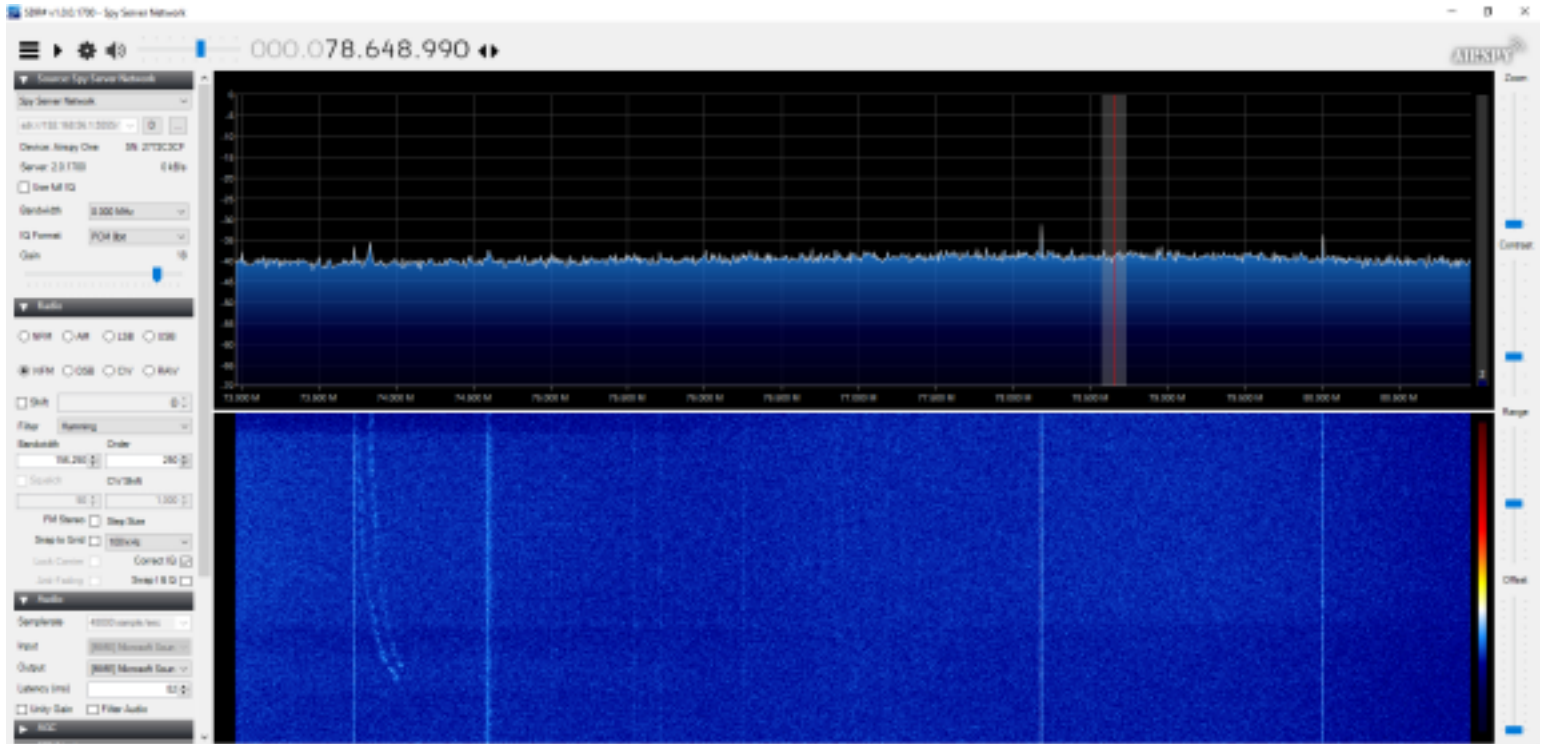
132.42MHz emission

This newly discovered emission looked rather strong once it has settled down. 20dB SNR can even be obtained when the USB cable is positioned correctly.



73.72MHz emission

Another pair of weaker emission at 73.72MHz was noted - they are weak thanks to the high noise floor here. The pair of drifting emissions are due to the keyboard, which was just connected.



Even weaker emissions seem to be observed at 81.2, 84.2, 85.6, and 85.8, but they seem too weak to be of any interest, due to the high noise floor.

Keyboard-01

Keyboard-01 has emissions all over the place. This is a USB 1.10 keyboard

Conditions

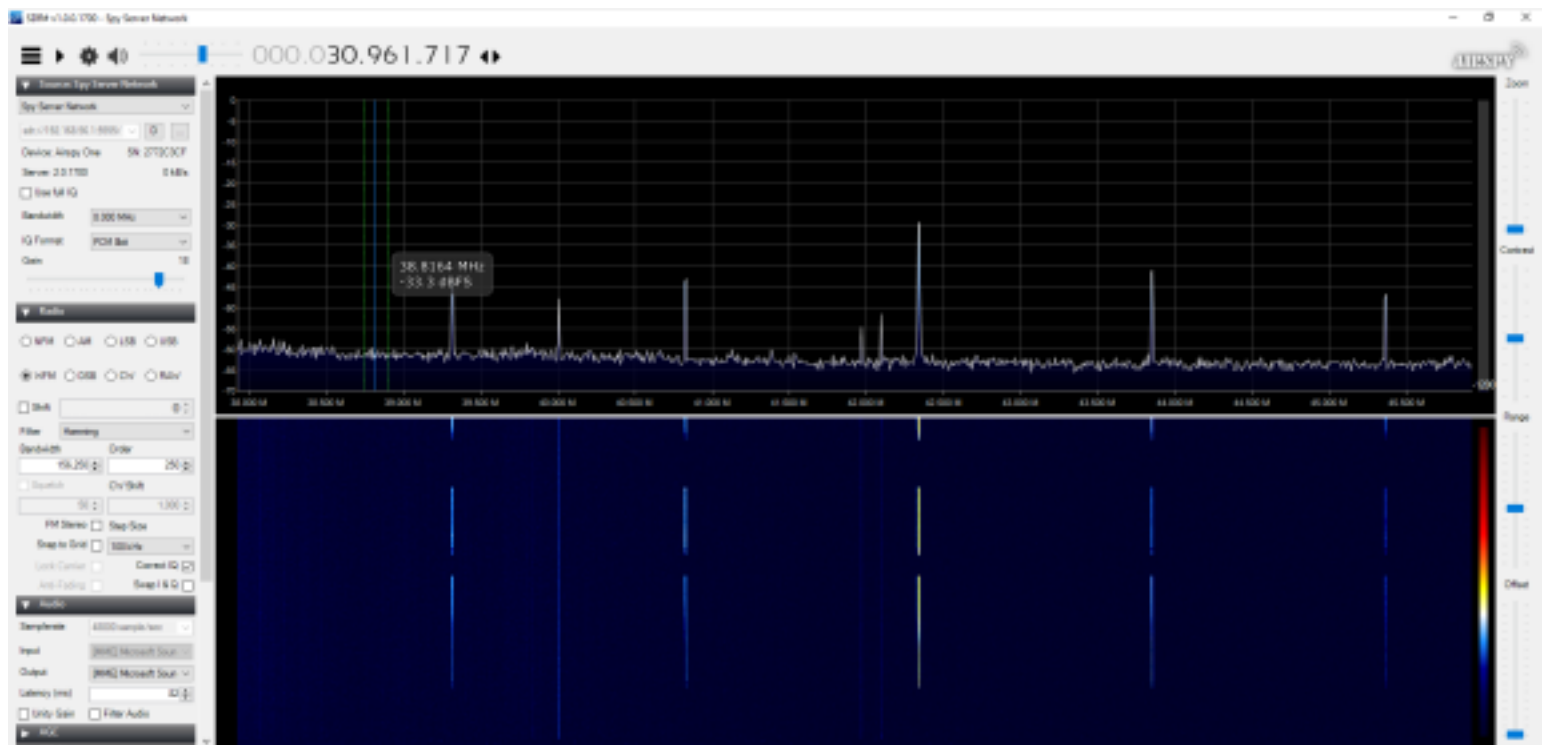
No USB charger in room.
Fan turned off
Air conditioning turned off
All LAN cables unplugged.
3m wire antenna was used with AirSpy SDR
Target Keyboard was connected to a standalone laptop
Distance between keyboard and antenna ~ 1m
This was done in the afternoon

Many peaks were observed at the following frequencies. This list is non exhaustive.

24.19, 25.7, 27.22, 28.72, ..., 30.24, 31.75, 34, 79, 36.29 (S), ..., 42.34, 43.85, ..., 72.57 (S), 74.09 (S), ..., 87.7, ..., 102.8 (30 SNR), to beyond 300MHz

These **peaks occur at intervals of about 1.5MHz** and they were observed up till and beyond 300MHz, where I stopped tracking. There are just too many of these peaks around. Some of these peaks achieved SNR of 30dB.

This waterfall diagram shows an example of plugging and unplugging the keyboard. The peaks at 39.3, 40.83, 42.34, 43.85 are due to the Keyboard-01.



Keyboard-03

Keyboard-03 uses USB v1.10

Conditions

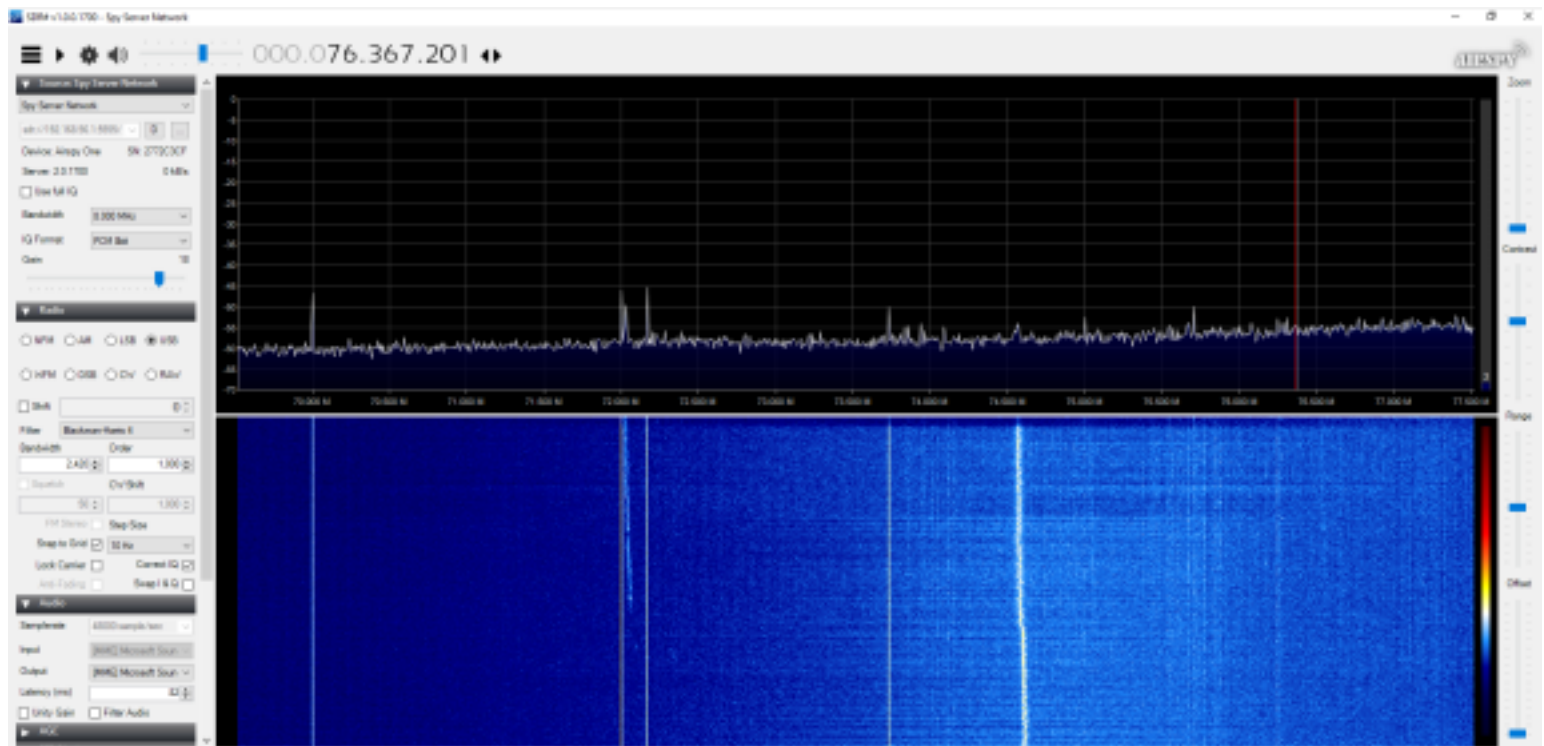
No USB charger in room.
Fan turned off
Air conditioning turned off
All LAN cables unplugged.
3m wire antenna was used with AirSpy SDR
Target Keyboard was connected to a standalone laptop
Distance between keyboard and antenna ~ 1m
This was done in the afternoon

72.02MHz emission

This appeared whenever I connected the USB cable. The emission was initially very weak. It only strengthened when the USB cable was extended and adjusted. In the screen capture below, it starts to appear in the centre of the waterfall diagram, and that was when I plugged in Keyboard-03's USB cable into the standalone laptop.

There is also another emission at 77.7 whose appearance and disappearance seem to be correlated with that of the 72MHz emission.

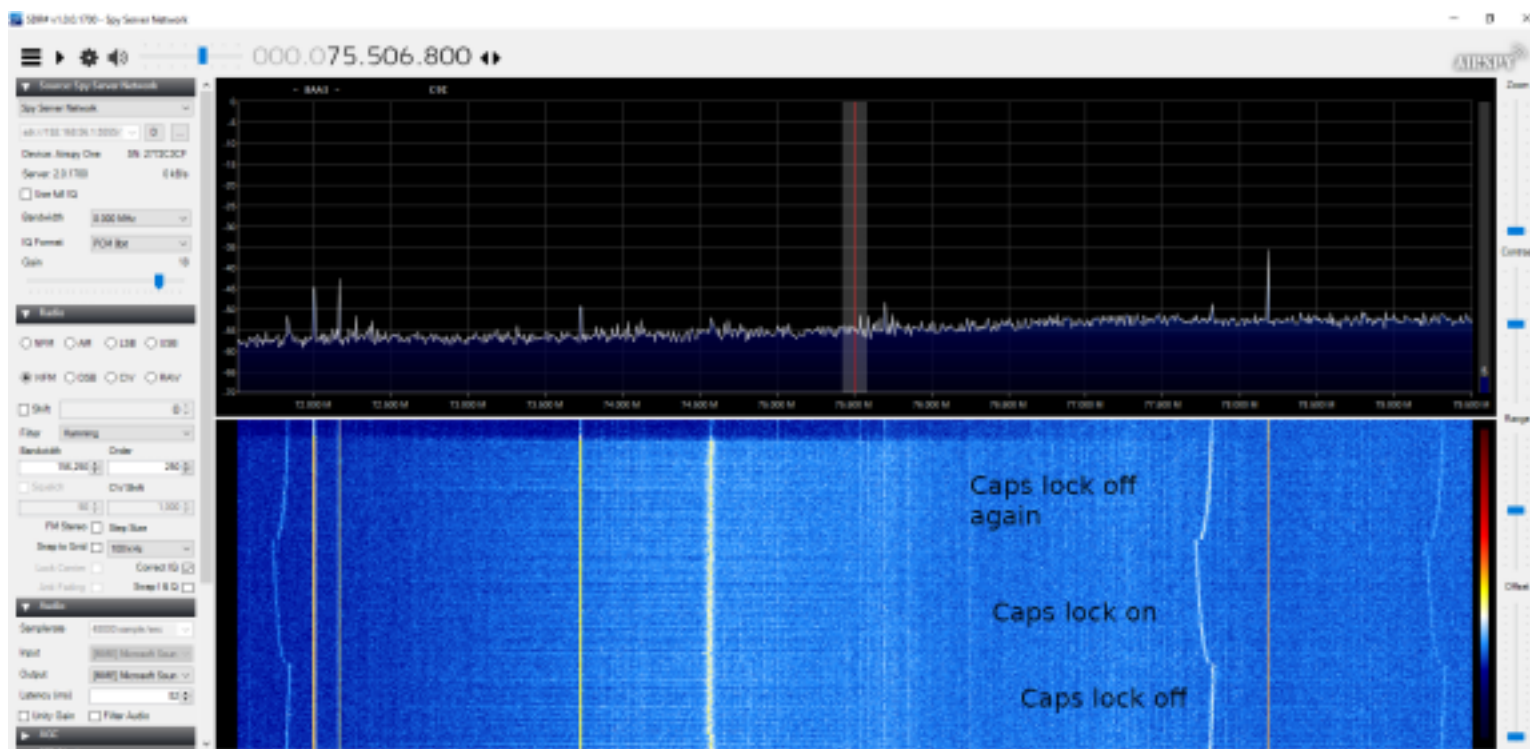
There may also be another very weak emission at 73.54, but I cannot confirm I saw this.



Effect of Caps/Num Lock

By accident, it was discovered that the frequency of this pair of emissions seem to depend on

the the status of the Caps lock key (and maybe the Num lock key as well)



The emission on the left keeps drifting. After some time, the Caps lock ON/OFF frequency pair had drifted to 71.25/71.36 MHz. The strength varies erratically. Some times it is imperceptible, but some times the SNR can reach 15dB.

There are at least 4 sets of such emissions from 70-80MHz. The strength varies. Not all are strong at all times.

Keyboard-04

Keyboard-04 uses USB 1.11

Conditions

No USB charger in room.

Fan turned off

Air conditioning turned off

All LAN cables unplugged.

3m wire antenna was used with AirSpy SDR

Target Keyboard was connected to a standalone laptop

Distance between keyboard and antenna ~ 1m

This was done in the afternoon

No obvious emission from 24-300 MHz was found arising from connection and disconnection of Keyboard-04 with the standalone laptop.

Documentation

This node summarises more formal results. There is nothing here yet.