



GDAŃSK UNIVERSITY
OF TECHNOLOGY



Satellite Ground Station in Gdańsk

Sławomir Figiel
software developer

Tomasz Mrugalski
project manager,
hardware engineer

Ewelina Omernik
analyst / designer

Supervisor: prof. **Marek Moszyński**, PhD DSc
Technical supervisor: **Wojciech Siwicki**, PhD

Agenda

- Motivation
- Project schedule
- Project Design & Architecture
- Hardware selection (antennas)
- Software for receiving process
- Tough problems we faced
- Summary, next steps



The background of the slide is a photograph showing several large satellite dish antennas (parabolic reflectors) mounted on complex metal support structures. They are silhouetted against a bright, orange, and cloudy sky, suggesting a sunset or sunrise. The dishes are arranged in a row, receding into the distance.

Long term objective: **Help building Polish space ecosystem by providing data downlink service**

Project goals:

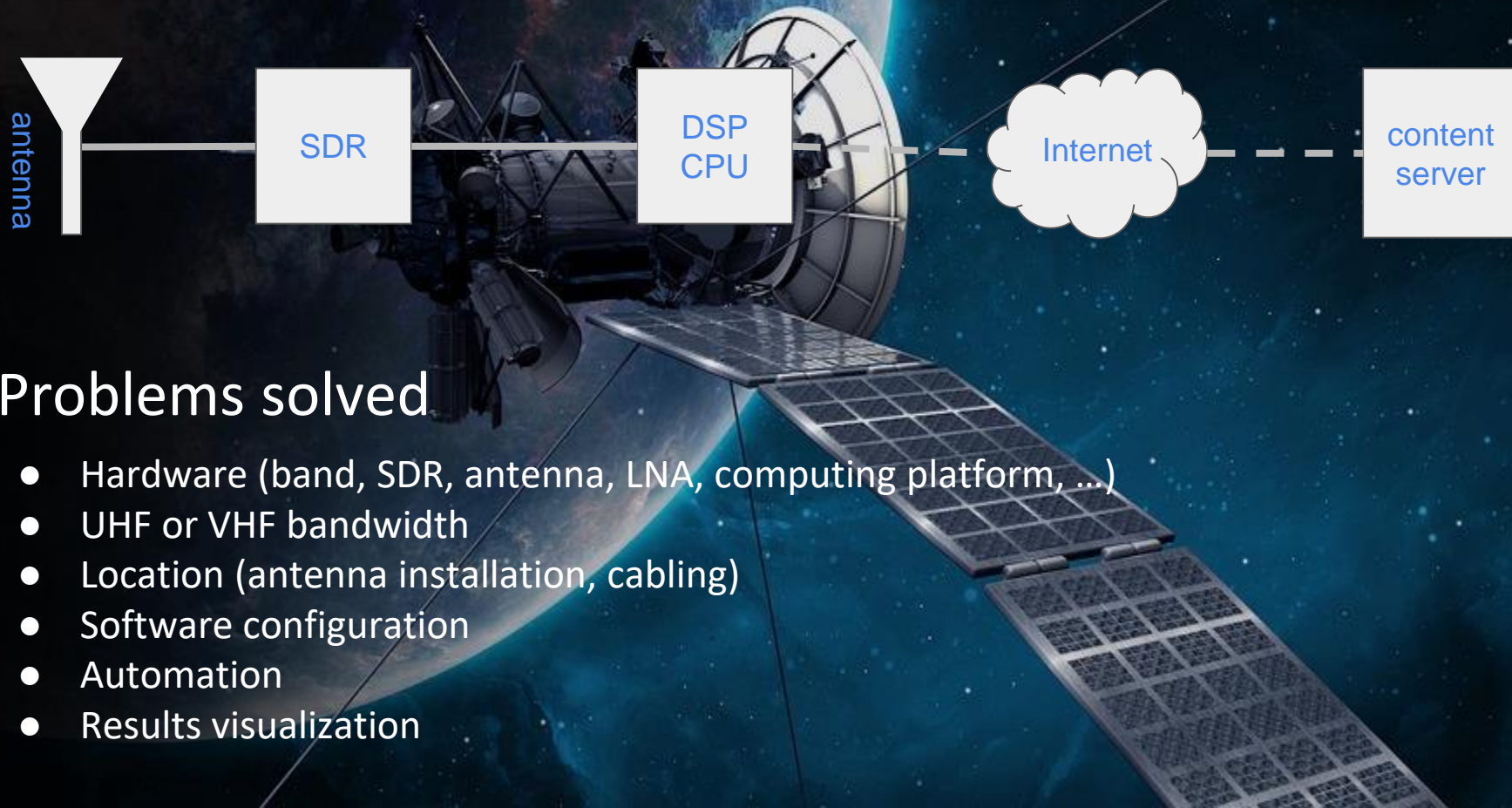
Design, implementation and operation of a ground station

- Omnidirectional antenna (fixed)
- UHF or VHF bandwidth
- SDR (Software Defined Radio)
- Embedded platform (Raspberry Pi)

Project Schedule

| No. | Task | Deadline |
|-----|-----------------------------------|------------|
| 1 | Feasibility study | 2019-10-17 |
| 2 | Hardware acquisition | 2019-11-07 |
| 3 | System integration | 2019-11-14 |
| 4 | Software automation design | 2019-11-21 |
| 5 | Software implementation | 2019-12-19 |
| 6 | Test campaign | 2020-01-09 |

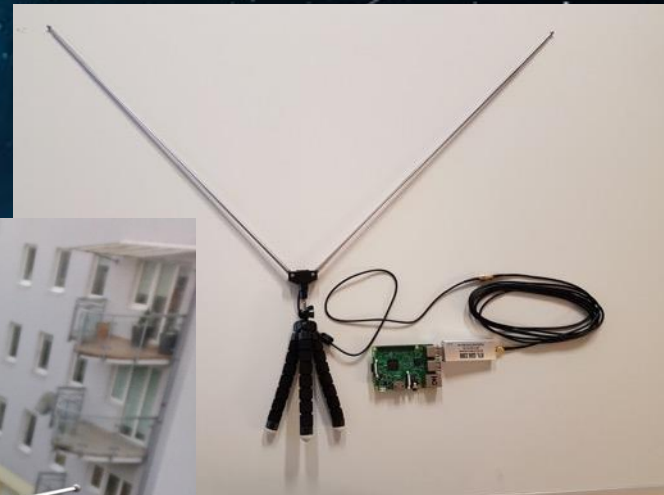
Architecture



Problems solved

- Hardware (band, SDR, antenna, LNA, computing platform, ...)
- UHF or VHF bandwidth
- Location (antenna installation, cabling)
- Software configuration
- Automation
- Results visualization

Antenna v1



Antenna v2 - TA-1 Turnstile



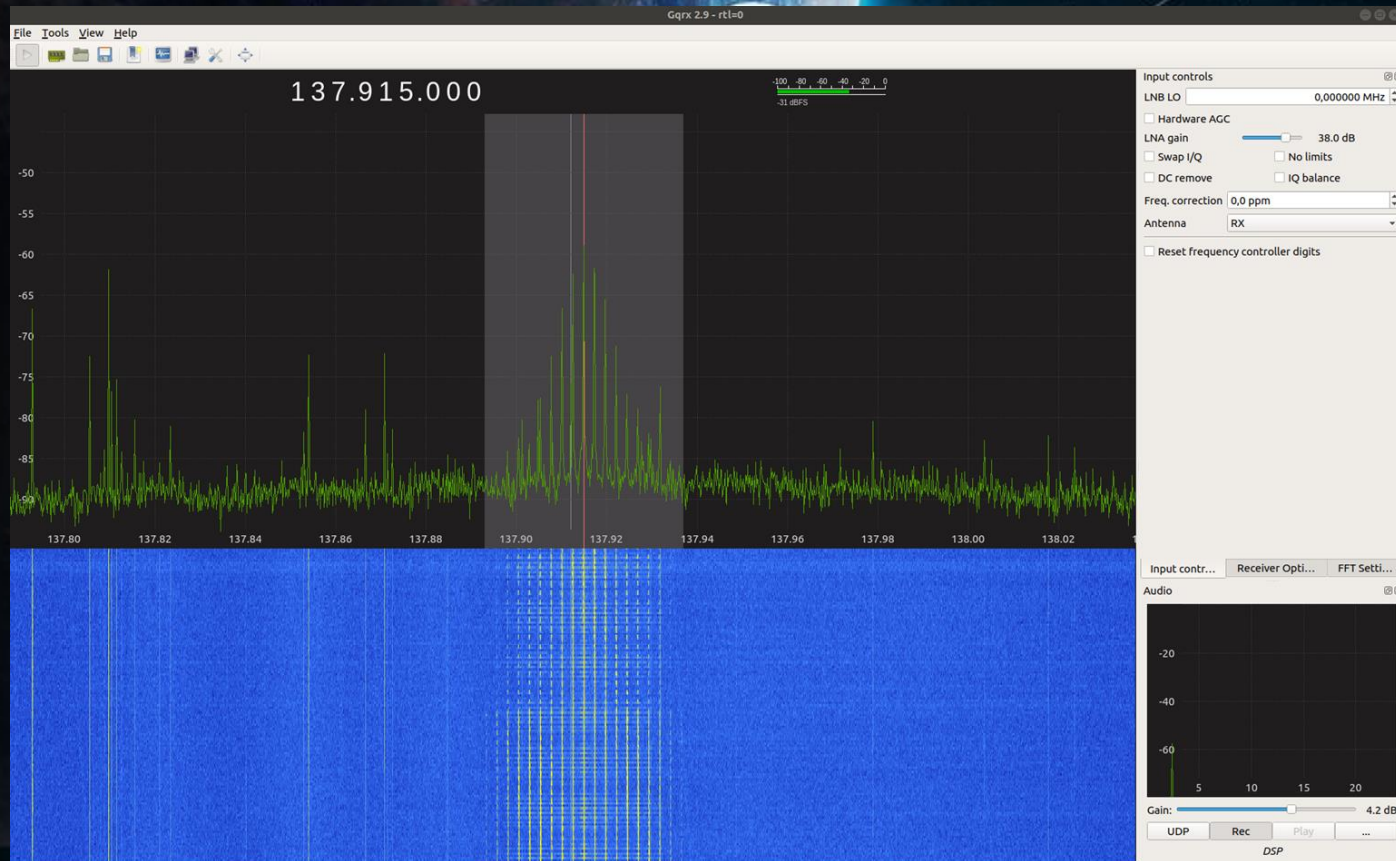
SDR + Raspberry Pi



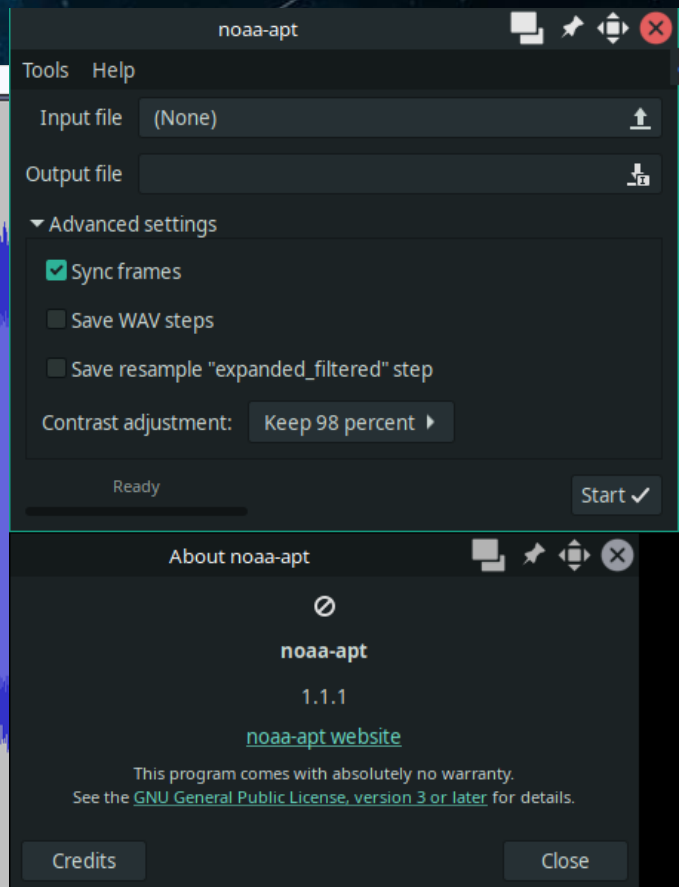
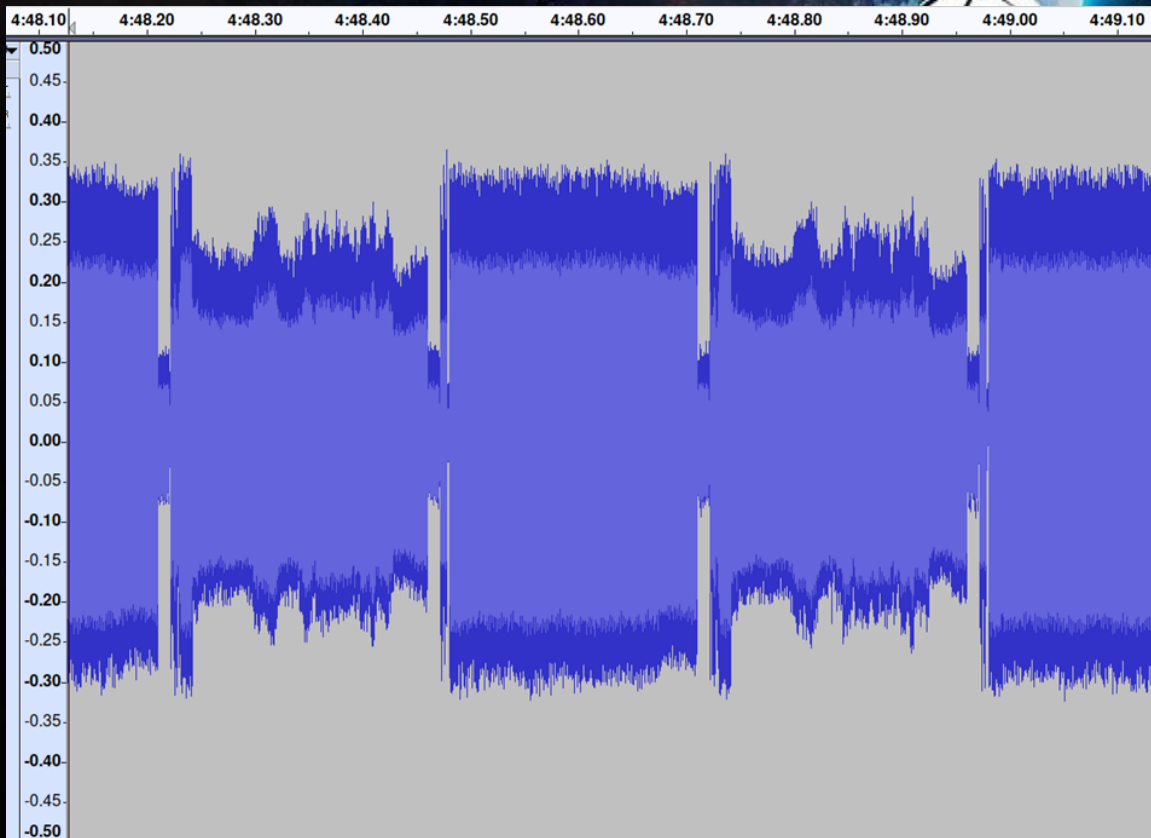
A detailed illustration of a satellite in orbit. The satellite features a central body with various instruments and a large, prominent parabolic dish antenna. Two long, rectangular solar panel arrays extend from the sides, each composed of many smaller solar cells. The background shows the curved horizon of the Earth with blue oceans and white clouds, set against the deep black of space filled with distant stars.

How to receive a sat transmission in 5 easy steps

Step 2: Tune SDR to transmission frequency

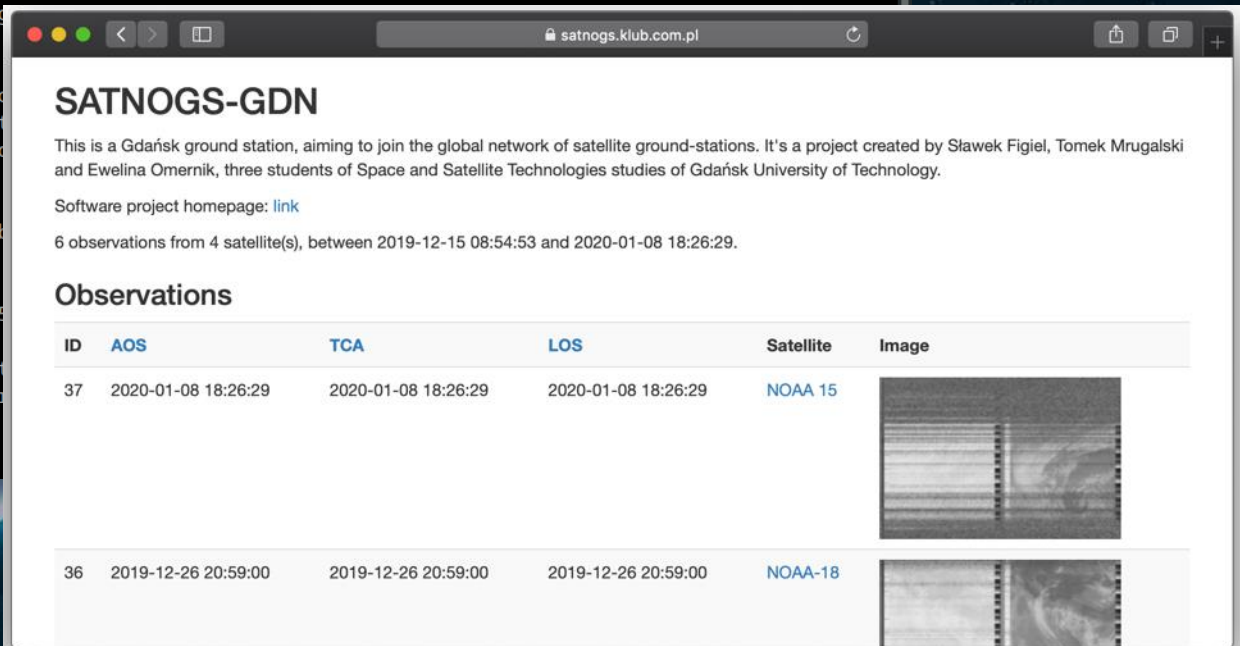


Step 3: Decode transmission



Step 4: Upload to content server <https://satnogs.klub.com.pl/>

```
pi@raspberrypi:~$ noaa-apt -o gqrx_20200108_172745_137912500.png gqrx_20200108_172745_137912500.wav
noaa-apt image decoder version 1.1.1
2020-01-08 18:50:17,068 INFO [noaa_apt] Reading WAV file
2020-01-08 18:50:17,069 WARN [noaa_apt::wav] WAV file has 2 channels (probably stereo), processing only the first one
2020-01-08 18:50:28,332 INFO [noaa_apt] Resampling to 12480
2020-01-08 18:50:39,819 INFO [noaa_apt] Demodulating
2020-01-08 18:50:39,966 INFO [noaa_apt] Filtering
2020-01-08 18:50:41,497 INFO [noaa_apt] Syncing
2020-01-08 18:50:45,877 INFO [noaa_apt::noaa_apt] Fe
2020-01-08 18:50:45,973 INFO [noaa_apt] Resampling t
2020-01-08 18:50:46,154 INFO [noaa_apt::noaa_apt] Ac
2020-01-08 18:50:46,360 INFO [noaa_apt] Writing PNG
2020-01-08 18:50:46,707 INFO [noaa_apt] Finished
pi@raspberrypi:~$ python3 devel/satnog-gdn/tools/sub
29" "2020-01-08 18:33:00" "2020-01-08 18:41:20"
Detected python: 3.7.3
Uploading file: cmd=[scp gqrx_20200108_172745_137912500.png
gqrx_20200108_172745_137912500.png
Adding record in the db: sqlcmd=[INSERT INTO observat
-08 18:26:29', '2020-01-08 18:26:29', 'NOAA 15', 'gq
INSERT 0 1
pi@raspberrypi:~$
```



The screenshot shows a web browser window with the URL satnogs.klub.com.pl. The page title is "SATNOGS-GDN". The main content area contains a paragraph about the Gdańsk ground station, a link to the software project homepage, and a section titled "Observations" which displays a table of satellite observations.

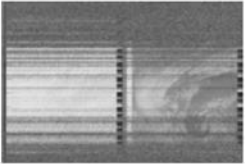

SATNOGS-GDN

This is a Gdańsk ground station, aiming to join the global network of satellite ground-stations. It's a project created by Sławek Figiel, Tomek Mrugalski and Ewelina Omernik, three students of Space and Satellite Technologies studies of Gdańsk University of Technology.

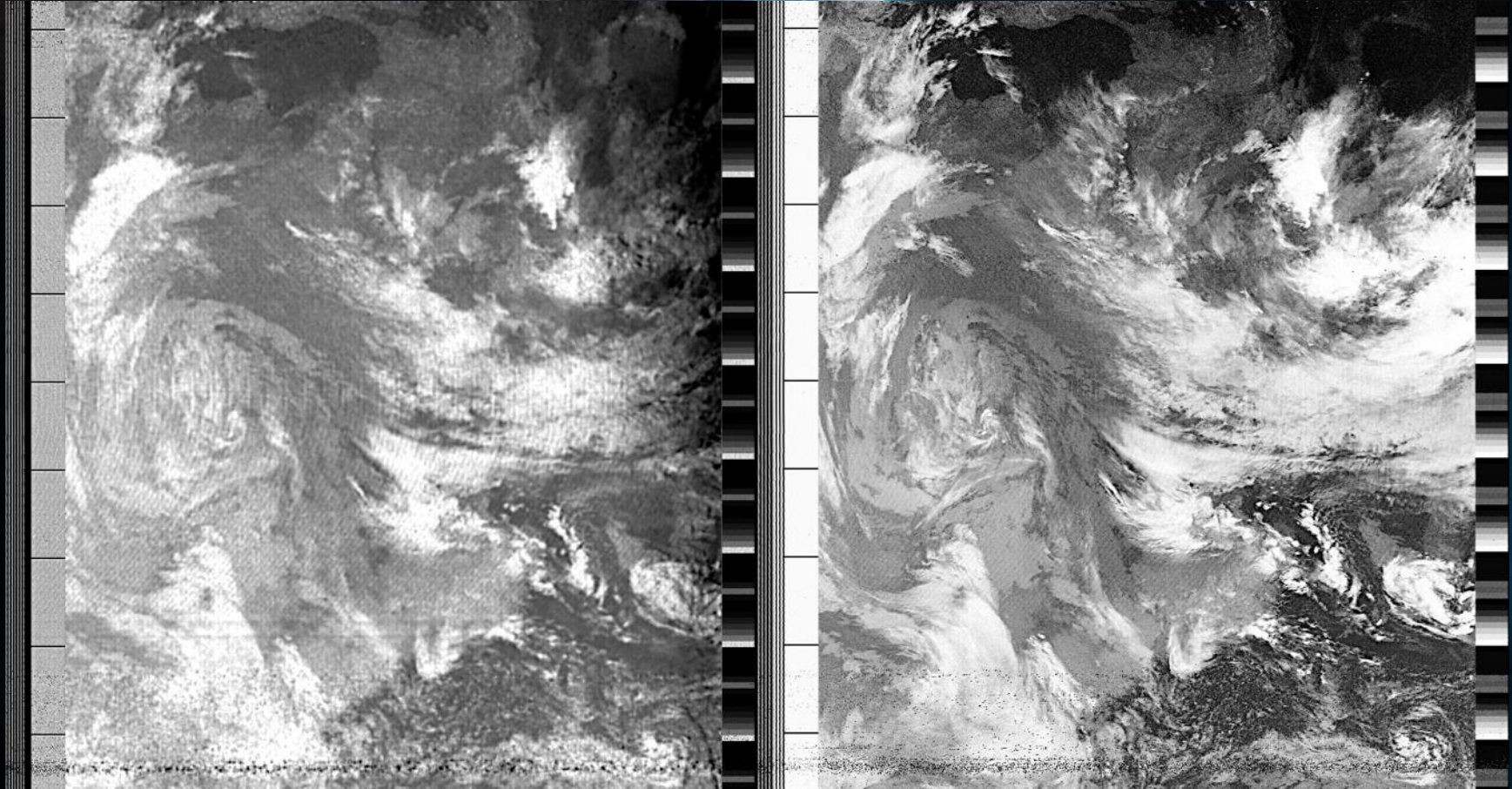
Software project homepage: [link](#)

6 observations from 4 satellite(s), between 2019-12-15 08:54:53 and 2020-01-08 18:26:29.

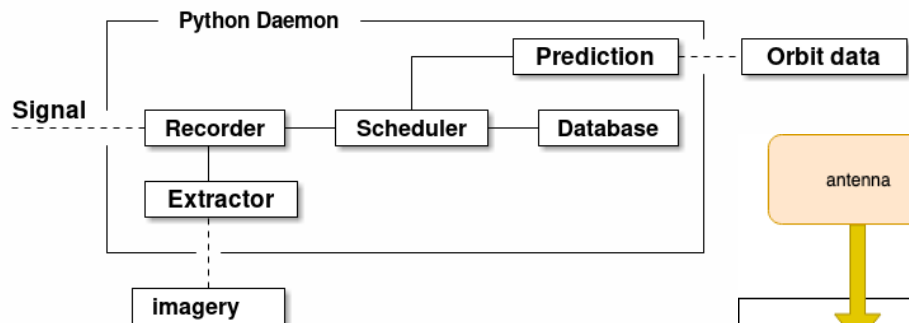
Observations

| ID | AOS | TCA | LOS | Satellite | Image |
|----|---------------------|---------------------|---------------------|-------------------------|--|
| 37 | 2020-01-08 18:26:29 | 2020-01-08 18:26:29 | 2020-01-08 18:26:29 | NOAA 15 |  |
| 36 | 2019-12-26 20:59:00 | 2019-12-26 20:59:00 | 2019-12-26 20:59:00 | NOAA-18 |  |

Step 5: Profit!

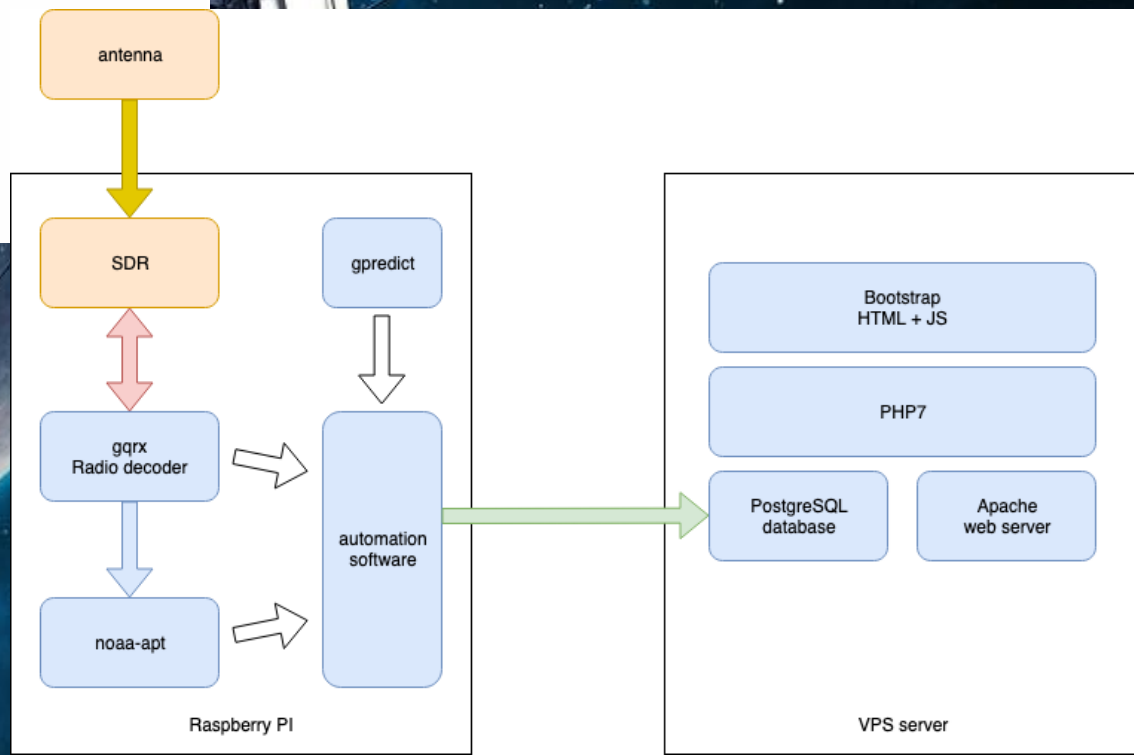


Automation

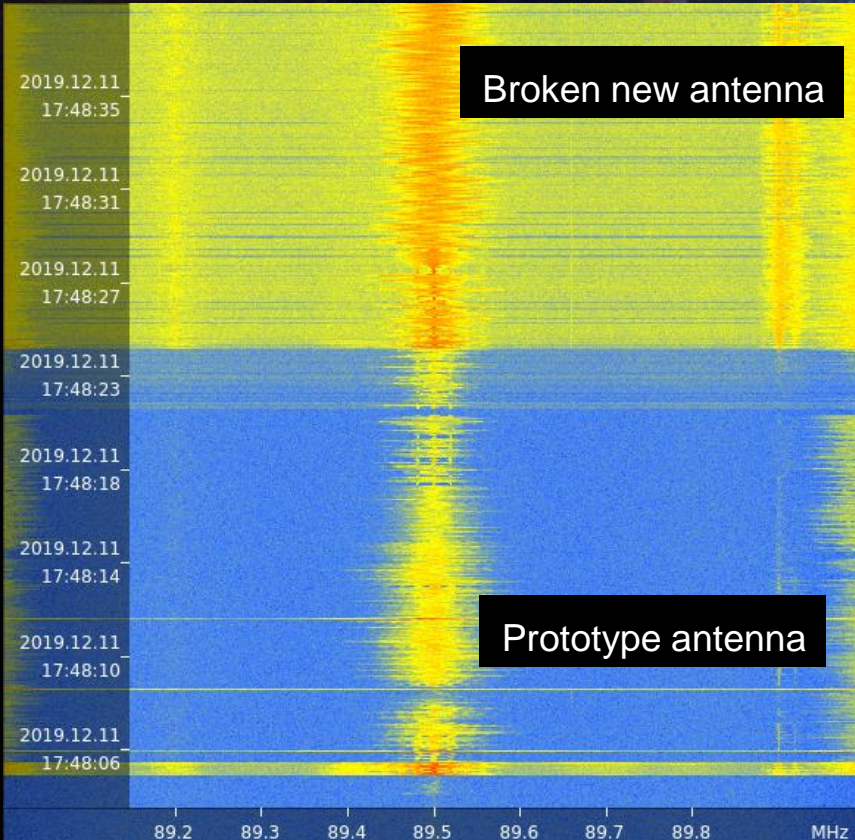


Realization

Concept



Troubleshooting



SWR measurements

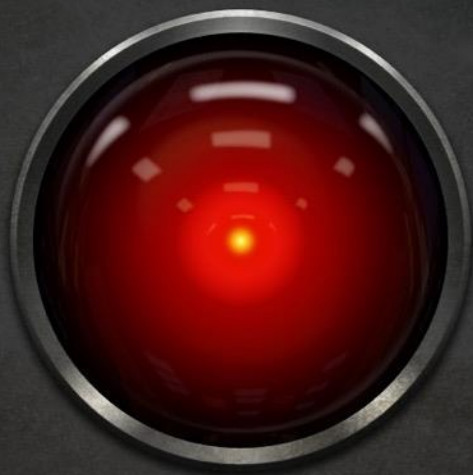


Results

- First SatNOG satellite ground station in northern Poland
- Research data gathering started
- 100% open source

Next steps

- Publish on Github
- Better code and improve web interface
- Connect to SATNOG network
- Switch to directional antenna
- Switch to UHF, S and X band
- Cooperation with amateur Cubesat projects



<https://satnogs.klub.com.pl/>