

# SatNOGS: Satellite Networked Open Ground Stations

•••

Dan White, AD0CQ

**SatNOGS**  
NETWORK

**SatNOGS**  
DB

**SatNOGS**  
CLIENT

**SatNOGS**  
GROUND  
STATION

# LibreSpaceFoundation.org

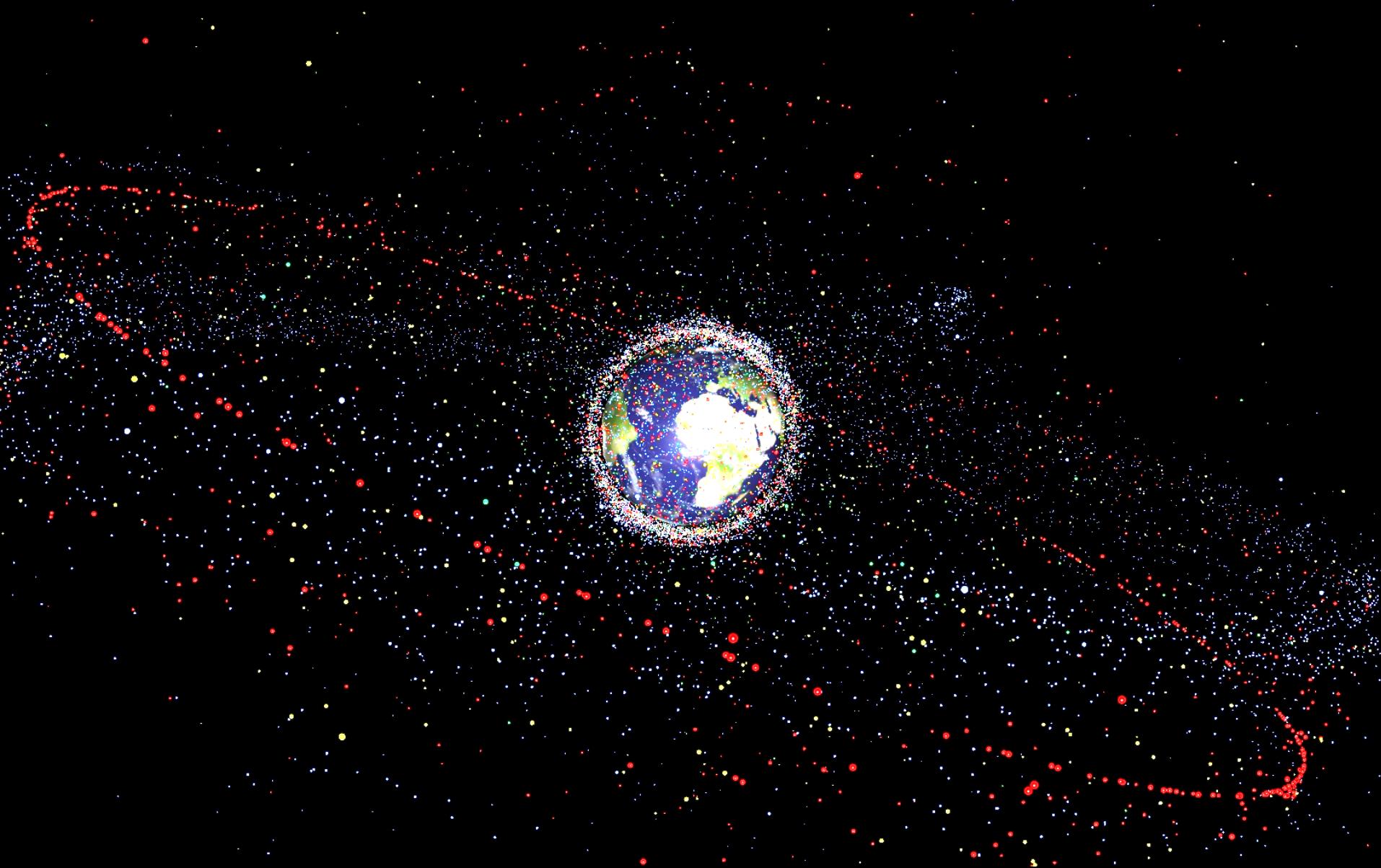
## Athens, Greece

Ioannis Giannelos, Agisilaos Zissimatos,  
Eleytherios Kosmas, Dimitrios Papadeas,  
**Pierros Papadeas, Matthaios Papamathaiou,**  
Nikolaos Roussos, **Vasileios Tsiligiannis,**  
Ioannis Charitopoulos

**community.satnogs.org**

**Corey Shields KB9JHU, Bloomington IN**

Some of you are here!

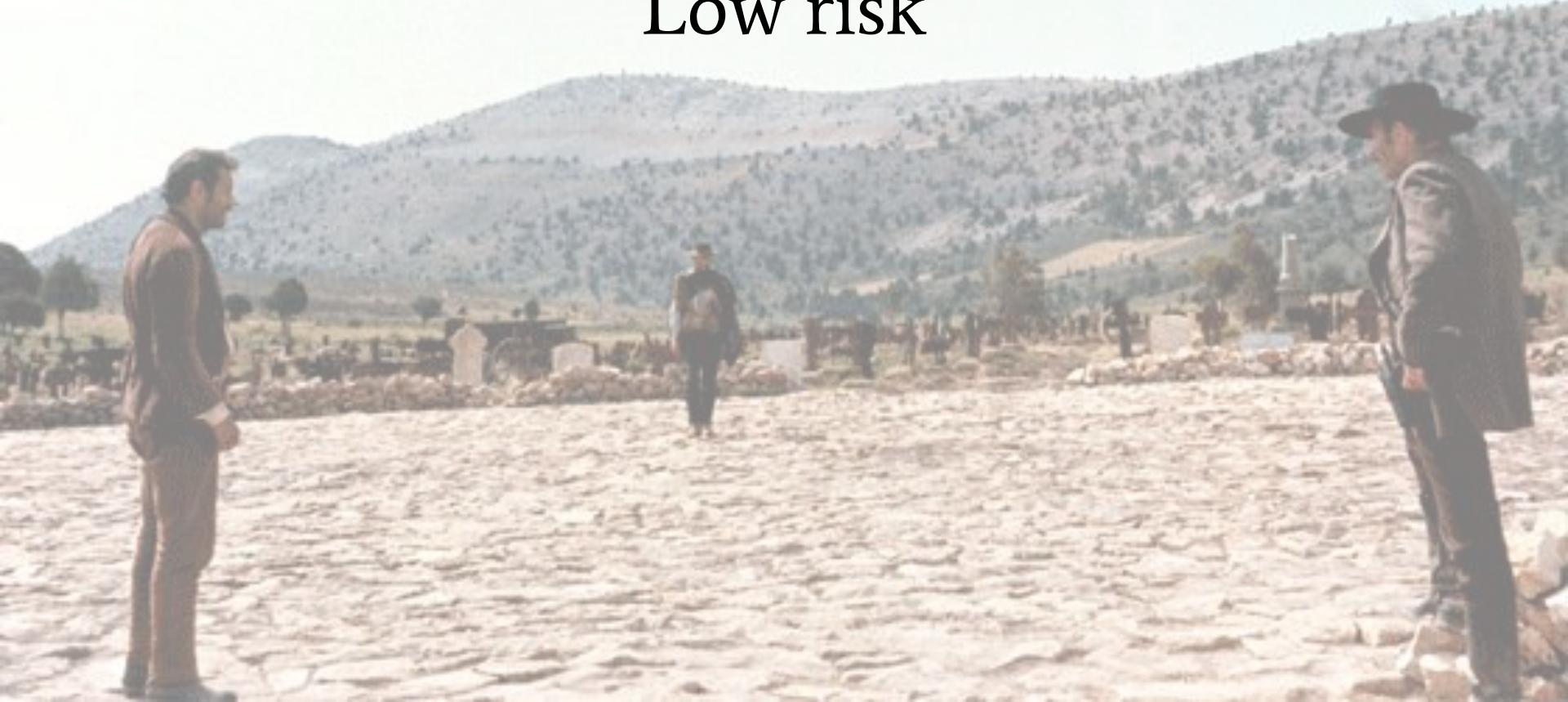


# CubeSats in Low Earth Orbit

“Cheap” to launch -> rapidly decreasing

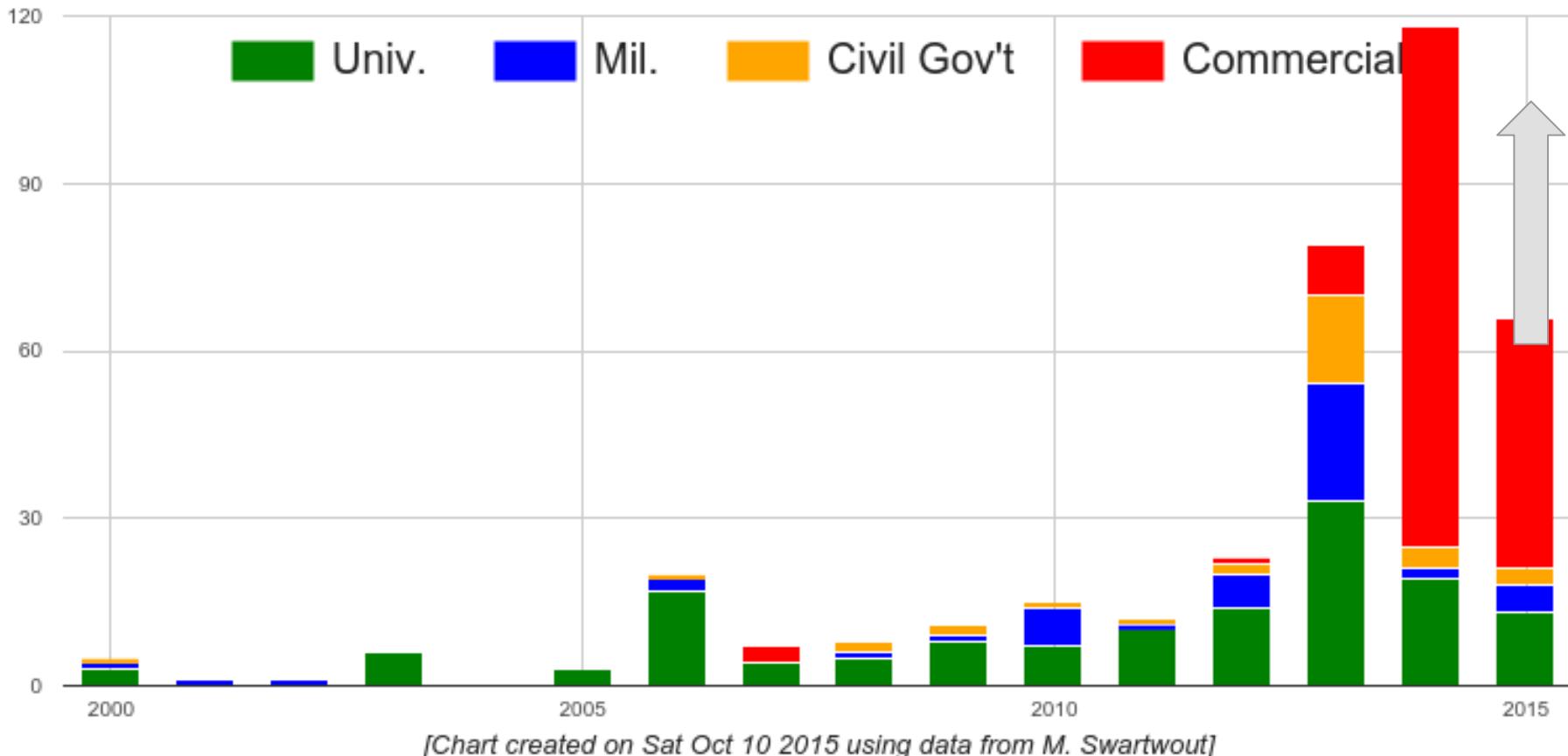
Quick to build

Low risk



# CubeSat launches to mid-2015

CubeSats by Mission Type (2000-present)



[Chart created on Sat Oct 10 2015 using data from M. Swartwout]

# CubeSats in Low Earth Orbit

10 minutes over horizon

3x / day

low power / bandwidth



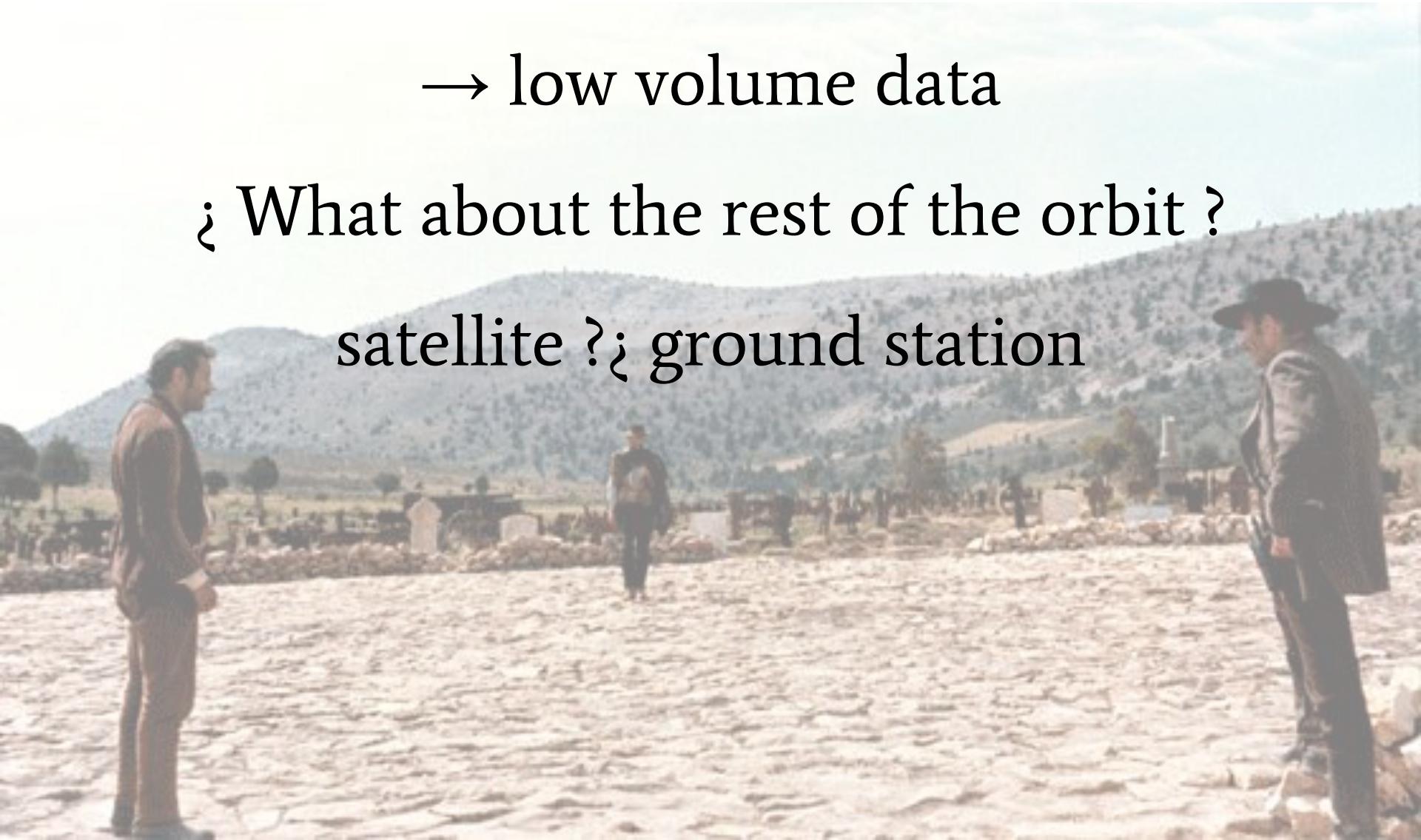
# CubeSats in Low Earth Orbit

this is 2% downlink duty cycle

→ low volume data

{ What about the rest of the orbit ?

satellite ? { ground station

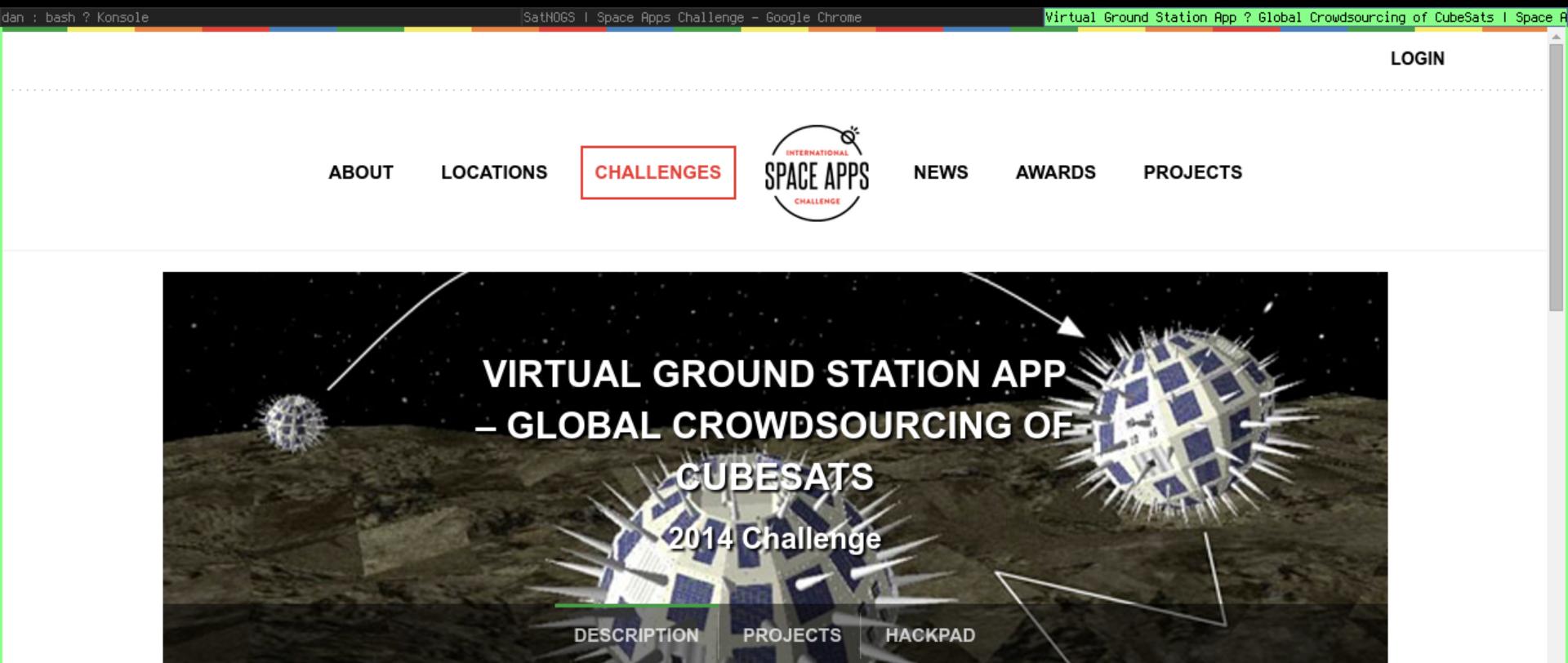


# By our powers combined, ...



# Group from: [hackerspace.gr](http://hackerspace.gr)

2014 Space Apps Challenge - People's Choice Finalist



Hashtags:

#spacetech, #virtualgroundstationapp

Contact:

[virtualgroundstationapp@spaceappschallenge.org](mailto:virtualgroundstationapp@spaceappschallenge.org)

Tags:

# 2014 Hackaday Prize



# SatNOGS

THE HACKADAY PRIZE

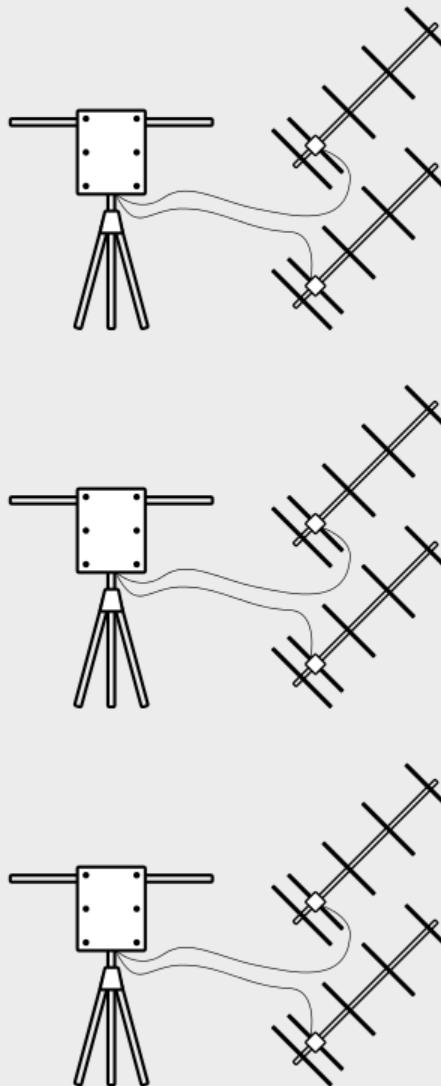


Users

Global  
Management  
Network

Ground Stations

Satellites



**SatNOGS**  
NETWORK

**SatNOGS**  
DB

**SatNOGS**  
CLIENT

**SatNOGS**  
GROUND  
STATION

fig - Google Drive   2015 DCC Presentation   2015 ARRL / TAPR DCC   SatNOGS Network API   SatNOGS

[GitHub, Inc. \[US\]](https://github.com/satnogs) https://github.com/satnogs

Search GitHub   Pull requests   Issues   Gist   Notifications   +   Profile

 **SatNOGS** 0  
Satellite Networked Open Ground Station  
Space http://satnogs.org info@satnogs.org

**Repositories** 10 **People** 10

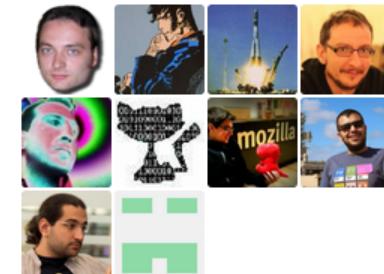
**Filters**

**satnogs-ansible** Ansible scripts for SatNOGS infra Shell ★ 3 ⚡ 1  
Updated 3 hours ago

**satnogs-org** Organizational Repo for management ★ 3 ⚡ 0  
Updated a day ago

**satnogs-rotator** SatNOGS Rotator project ★ 36 ⚡ 23  
Updated 10 days ago

**People** 10 >



# SatNOGS Network

fig - Google Drive x 2015 DCC Presentation x 2015 ARRL / TAPR DCI x SatNOGS Network - F x dan@valpo

<https://network.satnogs.org>

The website features a top navigation bar with links for Home, About, Observations, Ground Stations, Community, Sign Up, and Log In. A large world map in the background displays the locations of various ground stations, with a prominent cluster in Europe and North America. A central callout box contains the text "Ground stations swarm control, at your fingertips." and a "Join us!" button. Below the map, there's a "Featured Ground Station" section showing a photo of a setup under a blue tent with a "SatNOGS" sign. To the right, there are two tabs for "Latest Observations" and "Scheduled Observations". The "Scheduled Observations" table lists the following data:

ID	Satellite	Frequency	Encoding	Timeframe	Observer
21	JAS-2 (FO-29)	435.795 MHz	-	2015-09-27 20:15:00 2015-09-27 20:52:00	Pierros Papadeas
20	ITUPSAT 1	437.325 MHz	CW	2015-09-27 19:00:00 2015-09-27 19:30:00	Pierros Papadeas
19	JAS-2 (FO-29)	435.800 MHz	SSB	2015-09-27 18:30:00	Corey Shields

# SatNOGS Network

Web server - Python: Django, requests, +more

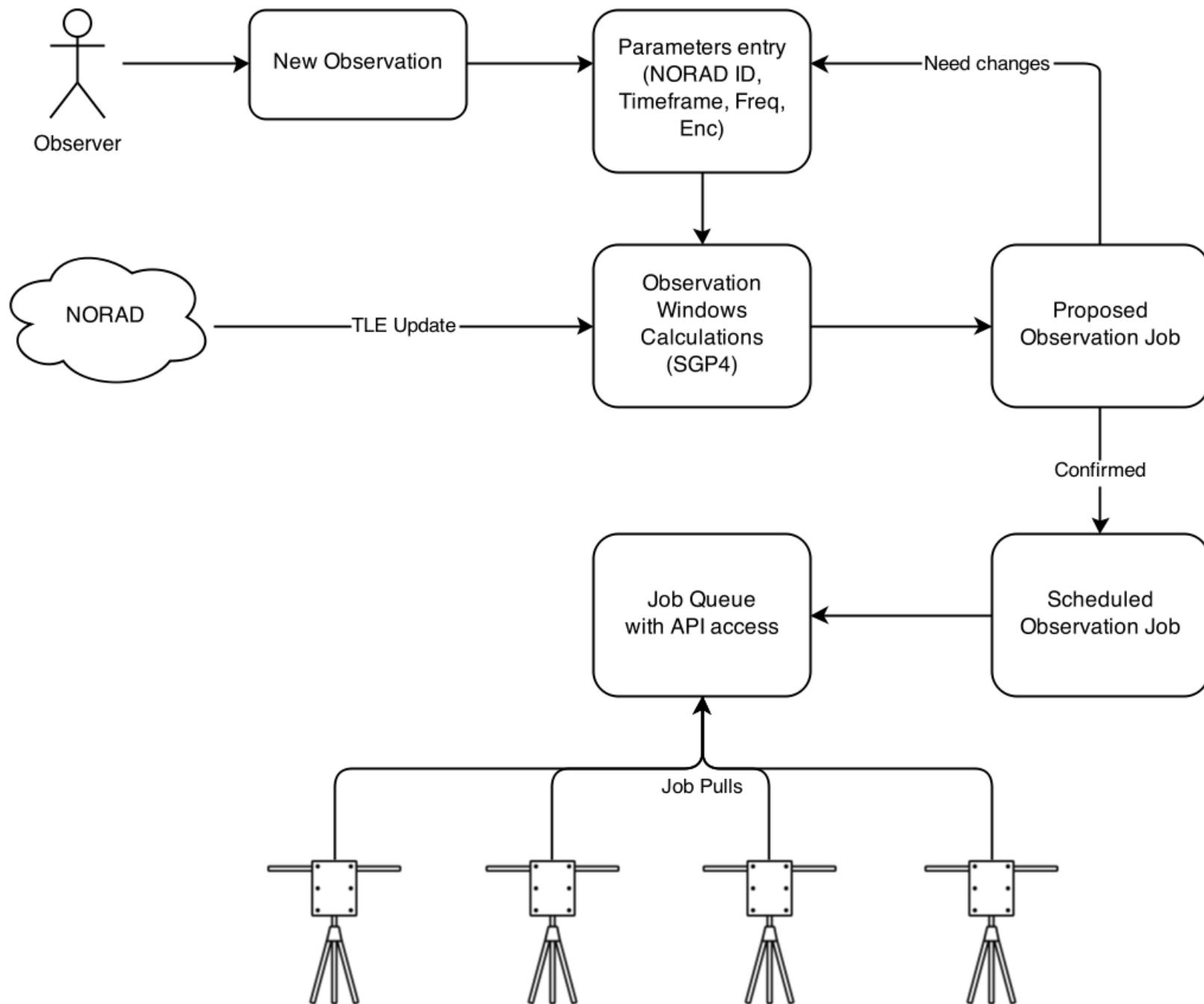
[github.com/satnogs-network](https://github.com/satnogs-network)

- **Observers** schedule **Observations**
  - Satellite + transmitter
  - Time window of interest

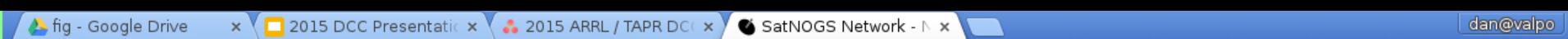
# SatNOGS Network

Web server - Python: Django, requests, +more

- **Network** (the server) finds available and visible ground stations
  - Creates a **Job** for each station



# SatNOGS Network



This is the stage environment. Feel free to test it and [report bugs](#). Production deployment is at [network.satnogs.org](http://network.satnogs.org).



Home    About    Observations    Ground Stations    Community



## New Observation

Satellite

39444 - FUNCUBE-1 (AO-73)

Start Time

2015-10-10 16:06



Transmitter

BPSK Telemetry - 145.935 MHz - BFSK

End Time

2015-10-10 23:06



**IMPORTANT:** Timeframe is considered to be in UTC timezone.

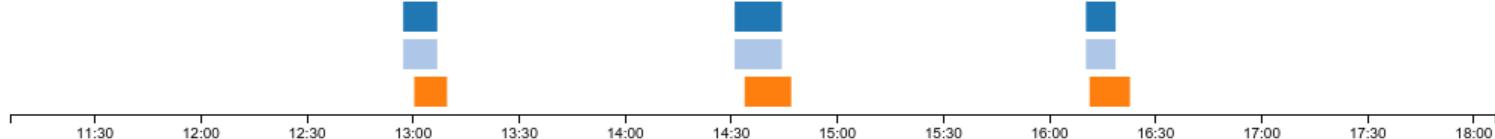
**Calculate Observation**

## Calculated Timeline

20 - SV1IYO

16 - Hackerspace.gr 1

18 - oe6xug



**Schedule Observation**

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Observation data are freely distributed under the [CC BY-SA](#) license.

SatNOGS | [Back to top](#)

# SatNOGS Network Web server

Python: Django, requests, +more

```
HTTP 200 OK
Content-Type: application/json
Vary: Accept
Allow: GET, HEAD, OPTIONS
```

```
[
```

```
{
    "id": 788,
    "start": "2015-10-12T02:10:01Z",
    "end": "2015-10-12T02:18:11Z",
    "ground_station": 18,
    "tle0": "BEESAT",
    "tle1": "1 35933U 09051C 15282.12865753 .00000385 00000-0 98729-4 0 9998",
    "tle2": "2 35933 98.4227 42.6629 0005953 14.2858 345.8506 14.55715956320639",
    "frequency": 436000000
},
{
    "id": 787,
    "start": "2015-10-12T00:28:03Z",
    "end": "2015-10-12T00:42:12Z",
    "ground_station": 18,
```

**Ground Stations** execute jobs

- Upload received signal to **Network**
- **Observation** available for all via  
web / API

# SatNOGS Network

fig - Google Drive x 2015 DCC Presel x 2015 ARRL / TAPI x SatNOGS Netwo x SatNOGS Netwo x SatNOGS Netwo x SatNOGS Netwo x dan@valpo

← → C H https://network-dev.satnogs.org/observations/223/

This is the stage environment. Feel free to test it and report bugs. Production deployment is at [network.satnogs.org](https://network.satnogs.org).

## Timeline

The timeline chart displays four horizontal bars representing observations. The x-axis shows time from 04:00 to 04:30. The observations are: 17 - Rocket (dark blue bar), 16 - Hackerspace.gr 1 (light blue bar), 18 - oe6xug (orange bar), and 26 - Tartu Test 1 (yellow-orange bar). All observations appear to start around 04:05.

Observation ID	Name	Color
17	Rocket	Dark Blue
16	Hackerspace.gr 1	Light Blue
18	oe6xug	Orange
26	Tartu Test 1	Yellow-Orange

## Data

Data payload #735 from 17 - Rocket

Waiting for data

Timeframe 2015-09-22 09:10:30 ~ 2015-09-22 09:22:38

Data payload #733 from 16 - Hackerspace.gr 1

A spectral plot showing signal activity. The x-axis represents frequency and the y-axis represents amplitude. The plot shows a dense, noisy signal with no clear structured peaks.

Timeframe 2015-09-22 09:09:05 ~ 2015-09-22 09:20:59

# SatNOGS DB Central place for sat TLEs, TX, mode.

## JSON API

fig - Google Drive 2015 DCC Presentation 2015 ARRL / TAPR DC SatNOGS Network - C SatNOGS DB dan@valpo

<https://db.satnogs.org>

DB Filter by Name or NORAD Cat ID 65 82 32

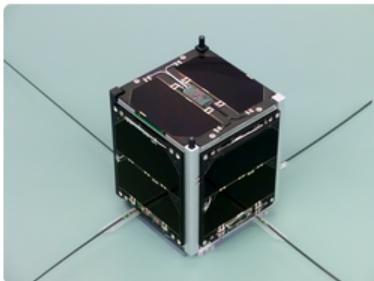
 <b>39087 - AAUSAT3</b> CW Beacon	 <b>40054 - AISAT</b> CW Beacon	 <b>35933 - BEE-SAT</b> GMSK 4k8 9k6 CW Beacon
 <b>39136 - BEE-SAT-2</b> CW Beacon	 <b>40014 - BUGSAT-1 (TITA)</b> AX.25 beacon	 <b>39153 - CUBEBUG-1 (CAPITAN BETO)</b> AFSK 1200
 <b>39440 - CUBEBUG-2 (LO-74)</b>	 <b>27848 - CUBESAT XI-IV (CO-57)</b> Mode U CW Be... Mode U AFSK TLM	 <b>28895 - CUBESAT XI-V (CO-58)</b> Mode U BEACON Mode U TLM
 <b>27844 - CUTE-1 (CO-55)</b> Mode U Beacon Mode U TLM	 <b>32785 - CUTE-1.7+APD II (CO-65)</b> Mode U TLM 1 Mode U TLM 2 Mode L/U Digip...	 <b>32789 - DELFI-C3 (DO-64)</b> Mode V BPSK T... Mode V BPSK T...

# SatNOGS DB

SatNOGS DB - Sugge x Dan

https://db.satnogs.org/satellite/39444/ etihwnad ▾

**39444 - FUNCUBE-1 (AO-73)**



Suggest New Transmitter

**Mode U/V Linear**

Alive	True
Invert	True
Uplink Low	435.130 Mhz
Uplink High	435.150 Mhz
Downlink Low	145.950 Mhz
Downlink High	145.970 Mhz

**CW Beacon**

Alive	True
Mode	CW
Downlink Low	145.815 Mhz

**BPSK Telemetry**

Alive	True
Mode	BFSK
Invert	True
Downlink Low	145.935 Mhz

# SatNOGS Client

The software which runs at the ground station.

- Pulls **Jobs** from the **Network**
- Waits for **Job** start time
- Controls receiver - RTL2832U - based, *any*
  - Band, doppler
- Sends commands to rotator
  - Easycomm → use your own !

# SatNOGS Ground Station

## The Hardware

**SatNOGS  
NETWORK**

No Network  
Connectivity

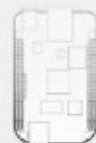
**SatNOGS  
CLIENT**

Gpredict  
& Gqrx

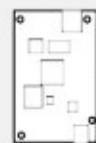
Commercial  
Software



Raspberry Pi



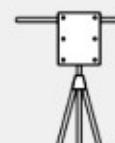
Beaglebone Black



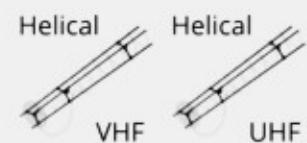
Odroid U3



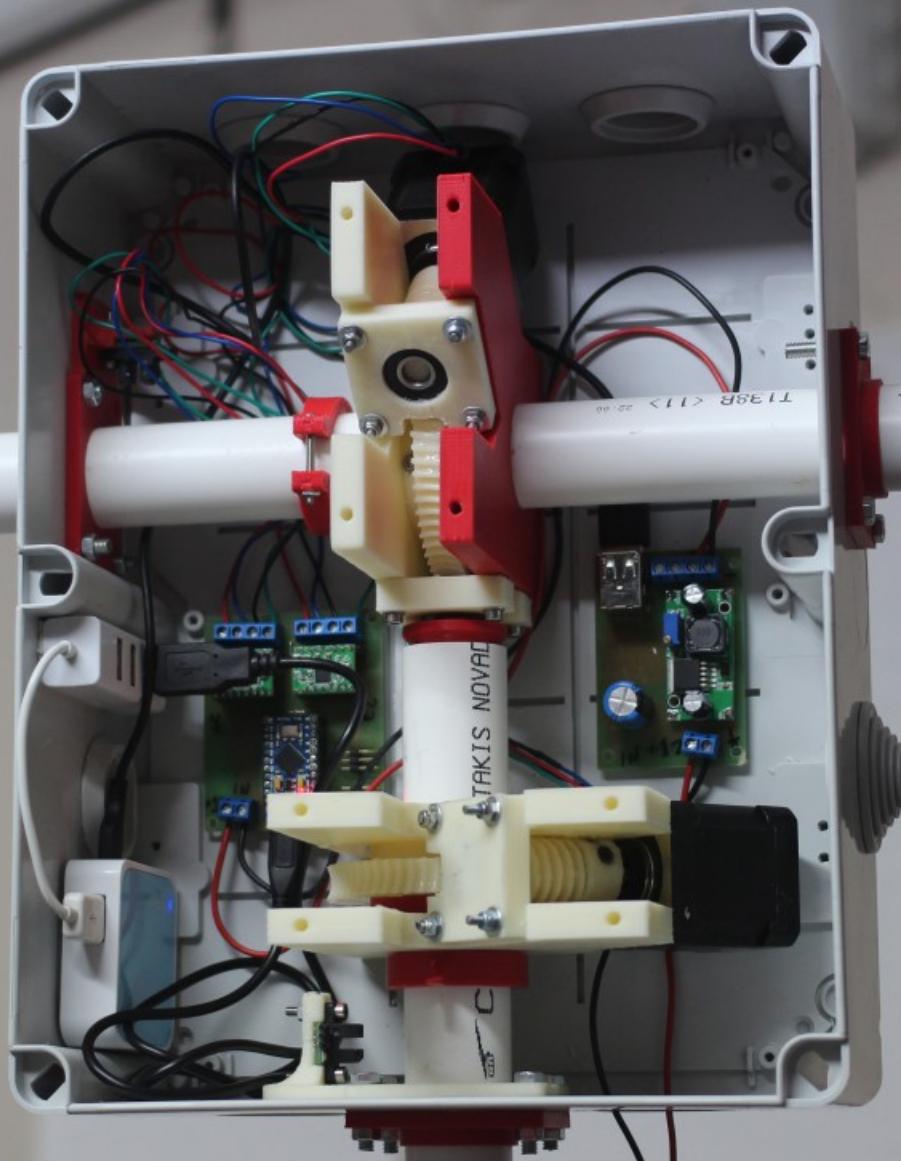
Commercial  
Rotator



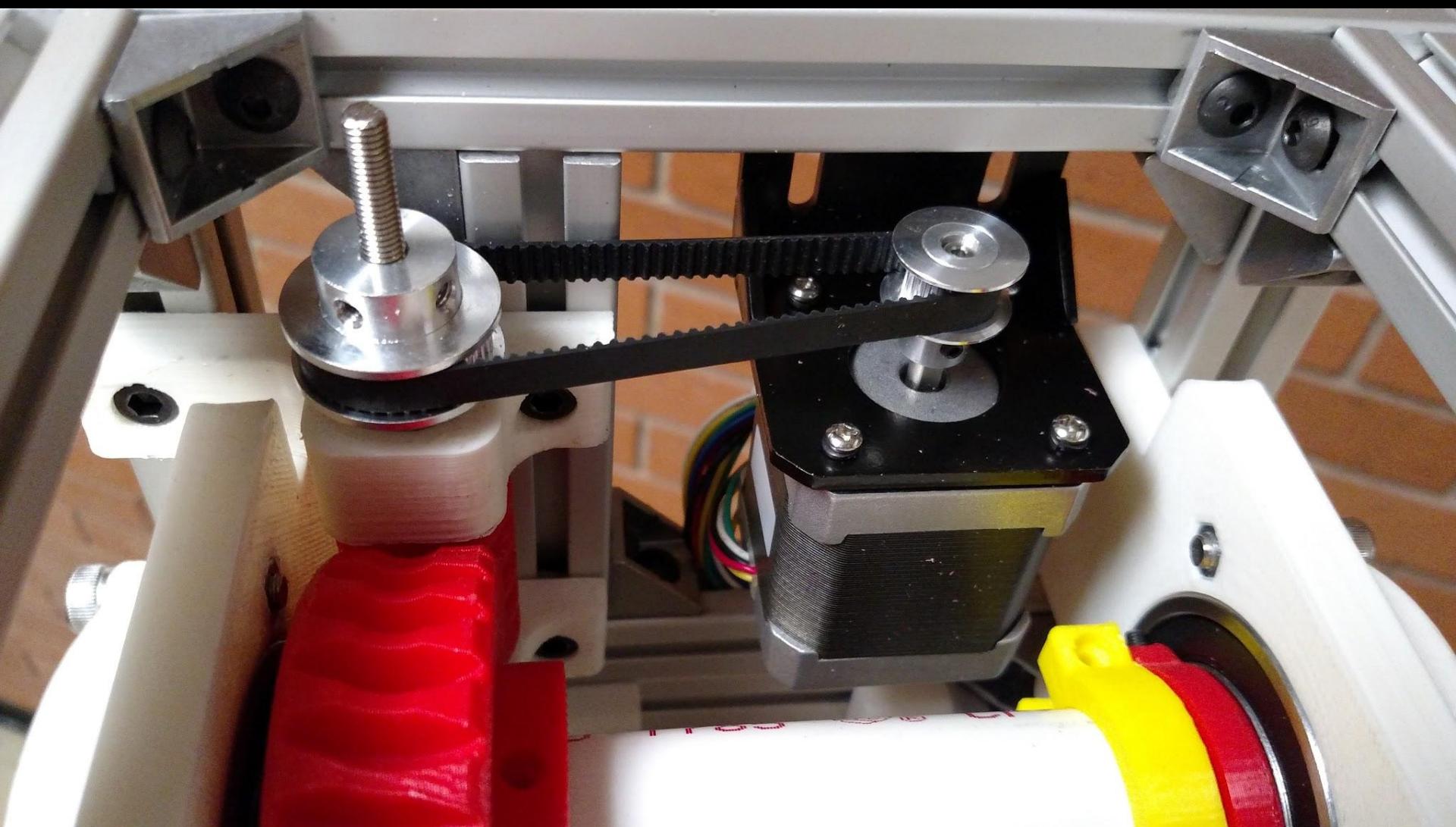
**SatNOGS**  
v2 Ground  
Station



# SatNOGS Ground Station - v2



# SatNOGS Ground Station - v3



# Receivers

RTL2832u dongle - software ready

Yours via CAT

HackRF

Ettus

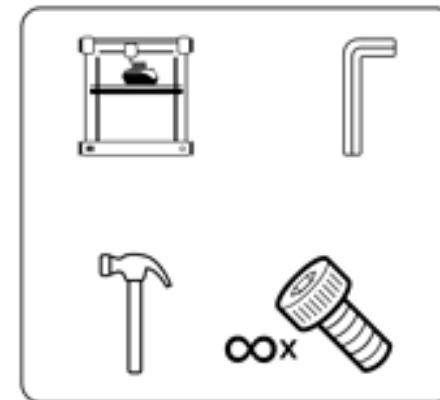
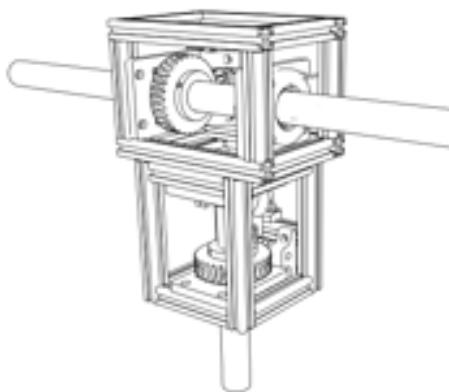




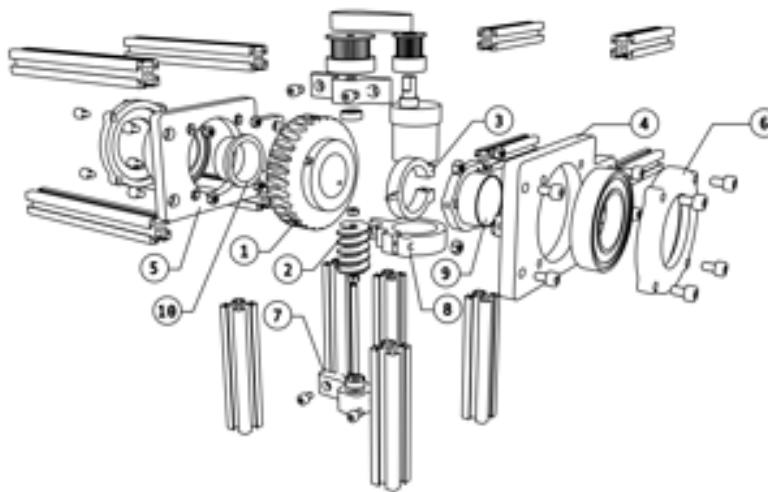
manthos 🇸

If SatNOGS was designed from a carpenter somewhere in the Scandinavian peninsula... 😊

# SJATNÖGS



1.





# HACKADAY

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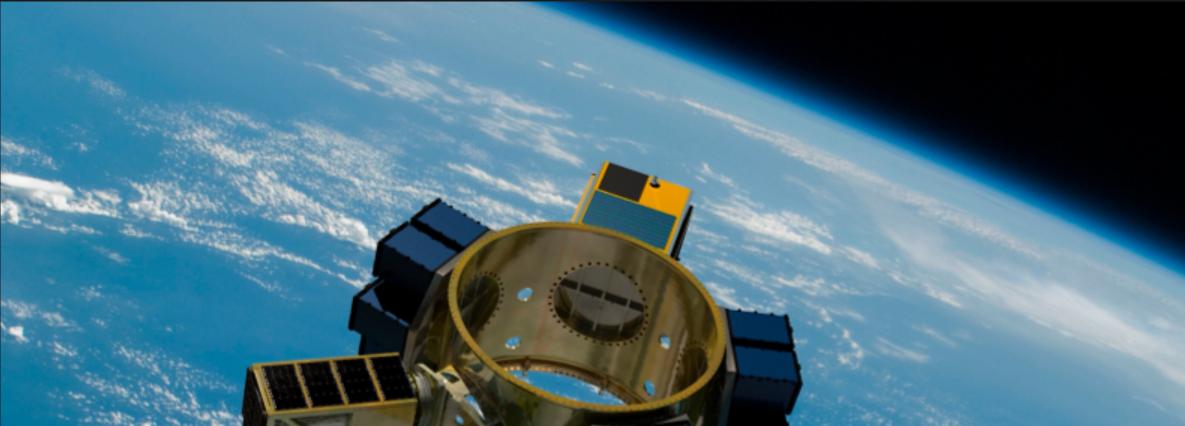
October 10, 2015

## ORIGINAL HACKERS' NEW SATELLITE IN ORBIT

by: Rud Merriam

No comments

October 10, 2015

[f](#) [t](#) [g+](#)

Limited Time  
SALES EVENT

THE  
MSO2000B SERIES OSCILLOSCOPE  
SAVE UP TO 33%

[LEARN MORE](#) **Tektronix**

**LIGHTBLUE BEAN**

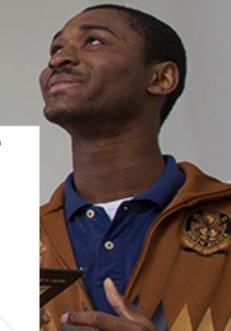
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Daniel Blood '10 expands Valpo's mission through Engineers Without Borders

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INTRODUCTION TO  
MICROCONTROLLERS &

# First time hearing SO-50



Fox-1A

LilacSat-2

# Hands-on engagement

The next generation →  
(it's not me)

FM capture theory + reality

Doppler shift



# Future ground station ??

Valpo' dual-pol radar

Az:  $360^\circ$  / 10 s



[satnogs.org](http://satnogs.org)

[community.satnogs.org](http://community.satnogs.org)

[github.com/satnogs](https://github.com/satnogs)

#satnogs on freenode IRC

valpo.edu • [dan.white@valpo.edu](mailto:dan.white@valpo.edu)