Libre Space Foundation
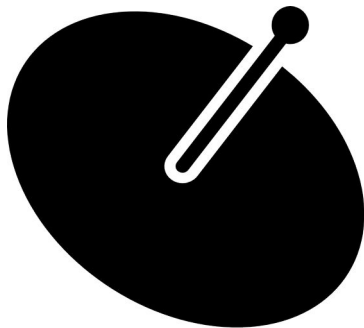
SLIDE 1

Libre Space Foundation

SLIDE A

Open Source Ground Station Network State of the Union

by Alfredos Damkalis

What is SatNOGS Project?

A global network of ground stations focused on automating satellite tracking and communication

What is SatNOGS Project?

A global network of ground stations focused on automating satellite tracking and communication

- Open Source Stack
  - Hardware
  - Software
  - Services
  - Data
- Keeping Modularity
- Automate everything

What is SatNOGS Project?

Ground Station	Web and other Services:
• Client • gr-satnogs and flowgraphs • Rotator • Antennas	• Network • DB • Decoders • Dashboards

What is an Artifact?

Artifact

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Artifact

> **Observation Data**
> (transmission frame, waterfall data etc)

What is an Artifact?

Artifact

Observation Data
(transmission frame,
waterfall data etc)

Metadata
to document the
observation parameters
and describe the
Observation Data

Ground Station - SatNOGS Client

Ground Station Software
- Communicates with Network
- Performs Observations

Ground Station - SatNOGS Client

The last year:

- Restructured and improved configuration process

- Codebase refactoring and bug fixes

- Artifacts support (experimental)

- Adjustments to gr-satnogs changes

Future:

- Continue changes for the new architecture

- Improve Artifacts support

- Implement interface to exchange data with the rest of the world

- Support transmission under SatNOGS COMMS project

Ground Station - gr-satnogs & flowgraphs

Radio Software
- Responsible for processing, demodulating and/or decoding received signals
- gr-satnogs: Out-Of-Tree GNU Radio Module
- flowgraphs: GNU Radio flowgraphs for processing different satellite transmissions

Ground Station - gr-satnogs & flowgraphs

Modes supported by satnogs-flowgraphs:

- FM
- CW
- APT
- DUV
- APRS
- IEEE 802.15.4

- BPSK
- FSK
- MSK
- AFSK
- SSTV
- ARGOS BPSK
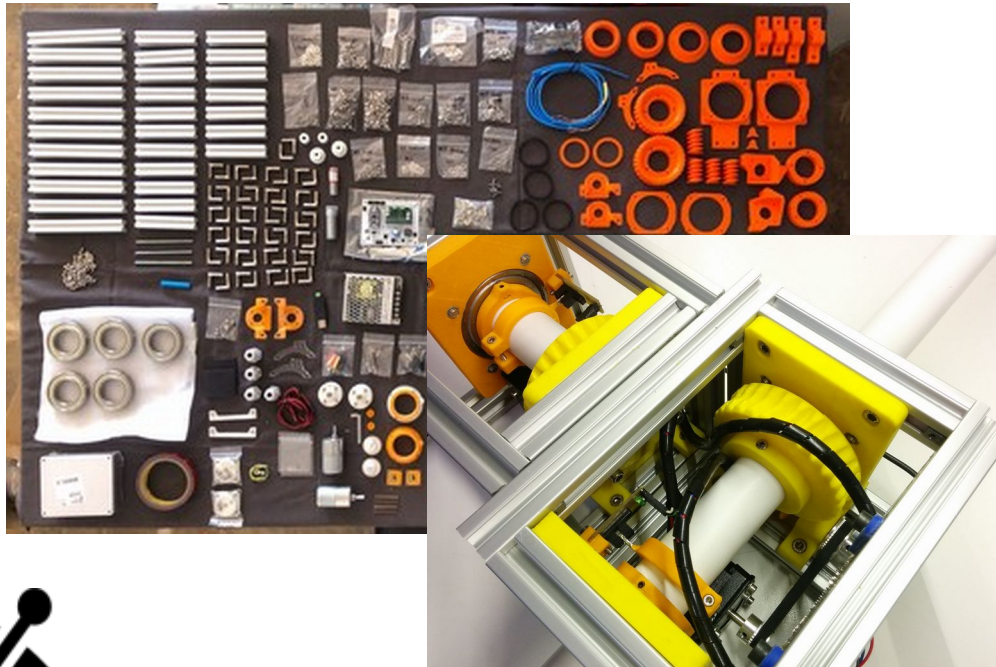
Ground Station - gr-satnogs & flowgraphs

The last year:

- Transition from gr-osmosdr to gr-soapy

- Split flowgraphs logic to a new repository

- Improved and added flowgraphs

- Artifacts support (experimental)

Future:

- Improve and add more flowgraphs

- Improve Artifact Support

- Support transmission under SatNOGS COMMS project

Ground Station - SatNOGS Rotator & Antennas

Ground Station - SatNOGS Rotator & Antennas

The last year:

- Maintenance and small fixes

- More people construct, use and test SatNOGS Rotator and antennas under different conditions

Future:

- Experiments with new concepts in rotator and antenna builds.

Ground Station - LSTN Kit

- A ground station kit to cover the needs of Library Space Technology Network (LSTN) pilot project

- LSTN pilot project aims to build SatNOGS ground stations at five public libraries around the world

- Funded by Alfred P. Sloan Foundation and created by John G. Wolbach Library at the Center for Astrophysics and the Libre Space Foundation

- More details in https://lstn.wolba.ch/

Web & Other Services - SatNOGS Network
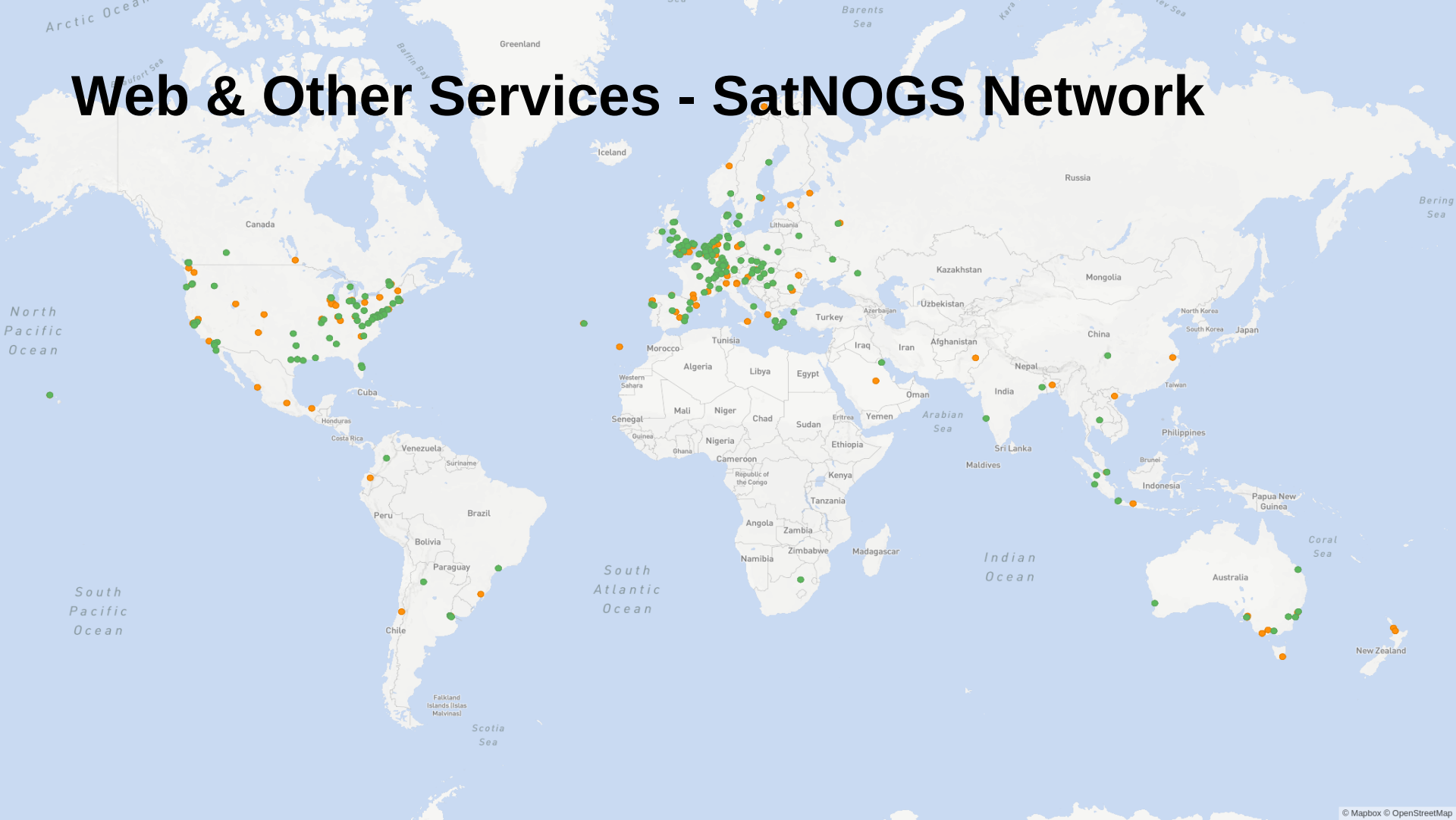
Web & Other Services - SatNOGS Network

Network Web Service

- Stations management

- Scheduling satellite observations

- Store, display and rate artifacts

Web & Other Services - SatNOGS Network

The last year:

- Improved performance on different levels

- Bug fixes and maintenance

- UI improvements

- Architecture changes to adapt in Artifact era

- Performed ~1.9 million observations!!!

Future:

- Improve API and API client

- Complete Artifacts support

- Improve scheduling automation

- Improve Artifact and observation rating system

- Support transmission under SatNOGS COMMs project

Web & Other Services - SatNOGS Network

Current Data	Last Year
~245 Online Stations	~220
~134 Testing Stations	~110
~5000 Observations/day	~3000
~25000 Demodulated Frames/Day	~9000

Web & Other Services - SatNOGS Network
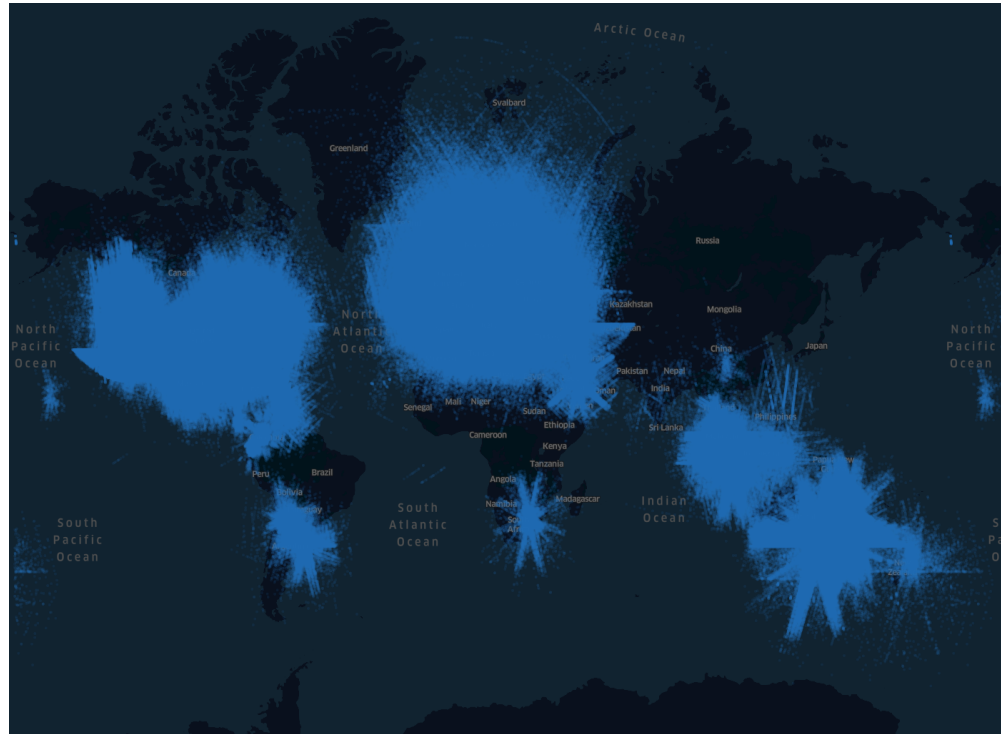
Web & Other Services - SatNOGS DB

DB Web Service

- Crowd-sourced satellite mission database

- Repository for Artifacts

Web & Other Services - SatNOGS DB
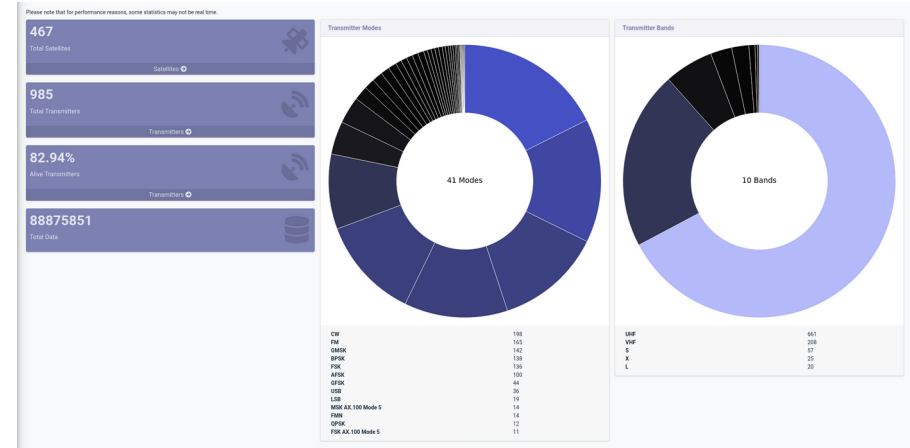
The last year:

- New and more user friendly UI

- Maintenance, performance improvements and bug fixes

- New API endpoint for TLE sets

- Artifact Support

- Integration of Metasat Schema by exposing the API in JSON-LD format

Future:

- Introduce (SatNOGS) Satellite ID

- Continue with Metasat Schema integration

- Complete Artifacts support

- Improve API and API client

- Standardize and improve DB service in coordination with other projects that use it

Web & Other Services - SatNOGS DB

Current Data	Last Year
467 Satellites	383
985 Transmitters	785
More than 88.5 million frames by 1276 contributors using SatNOGS Network or 3rd party software	48.5 million frames by 985 contributors

Web & Other Services - SatNOGS Decoders

Decoders Service

- Describe encoding of transmission frames with kaitai.io structures

- Generate scripts that decode these transmission frames

Web & Other Services - SatNOGS Decoders

The last year:

- New Decoders

- Improve decoding time

- More people and satellite teams involved, some before the satellite deployment

- Decoded ~70% of DB frames

Future:

- Create more decoders

- Continue involve people and satellite teams

- Improve the process design of decoders

Web & Other Services - SatNOGS Decoders

Supported Decoders
(last year entries with **BLUE**)

- AAUSAT4
- ACRUX-1
- ALSAT-1N
- **AMICALSAT**
- AMSAT FOX DUV
- ARMADILLO
- AX.25 frame decoder
- BISONSAT
- **BOBCAT-1**
- BUGSAT-1
- **CAPE-1**
- CAS-4A & CAS-4B
- CHOMPTT
- CUBEBEL-1
- **DUCHIFAT-3**

- ELFIN-A & ELFIN-B
- ENTRYSAT
- EQUISAT
- ES'HAIL-2 (QO-100)
- IRAZU
- IRVINE
- **ISS**
- LIGHTSAIL-2
- **MEZNSAT**
- MINXSS
- MYSAT-1
- **NEUTRON-1**
- **OPSSAT-1**
- ORIGAMISAT-1
- **PAINANI**

- **PHOENIX(ASU)**
- **POLYITAN-1**
- PWSAT-2
- **QARMAN**
- QBEE
- **QUBIK-1 & QUBIK-2**
- **QUETZAL-1**
- SIRIUSSAT-1 & SIRIUSSAT-2
- SKCUBE
- SPOC
- STRAND-1
- TBEX-A & TBEX-B
- UNISAT-6
- UWE-4
- **VZLUSAT-2**

Web & Other Services - SatNOGS Dashboards

Dashboard Web Service

- Display/Visualize decoded data from satellite transmissions in Grafana dashboards

Web & Other Services - SatNOGS Dashboards

The last year:

- New Dashboards created by the community and satellite teams, some before the satellite deployment

- Satellite teams used dashboards for mission analysis

Future:

- Create more dashboards

- Continue involve people and satellite teams

- Experiment with the Grafana alert system

SatNOGS Community Contribution Highlights

- TLE set generation prior and after deployment (76 TLE sets this year)

- Satellite identifications (NORAD ID assignment)

- Integration guide for Satellite teams

- Feedback and Support through issues, community forum and chat

- Updates on SatNOGS Wiki

- Scheduling and rating observations

- Being amazing Station Owners!

Join us

Wiki: https://wiki.satnogs.org

Repos: https://gitlab.com/librespacefoundation/satnogs

Community: https://community.libre.space

Thank you!