SatNOGS Client

Release 1.5.1+0.g3450ff2.dirty

SatNOGS

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CONTENTS

SatNOGS Client is the software responsible for automating satellite signal reception for SatNOGS. The main functions of SatNOGS Client is to pull observation jobs from SatNOGS Network and execute them on the a station host (usually a Raspberry Pi). These observation jobs create locally scheduled task which spawn SatNOGS Radio scripts for decoding and demodulating the signals. In addition to that, SatNOGS Client can optionally control a Hamlib compatible rotator to track the satellite. During the execution of an observation task, orbital calculations are performed to compensate for doppler shift and point the rotator to the correct direction. After the completion of an observation, the client gathers the observation artifacts and uploads them to SatNOGS Network.

CHAPTER

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1.1 User guide

1.1.1 Requirements

- Python 3.6+
- Hamlib 3.3+ Python bindings

1.1.2 Installation

1.1.2.1 Debian

To install the required dependencies in Debian run:

```
$ apt-get install python3-libhamlib2
```

1.1.2.2 SatNOGS Client

To install SatNOGS Client run:

```
$ pip install satnogs-client
```

This will install a console script called `satnogs-client`.

1.1.3 Configuration

Configuration of SatNOGS Client is done through environment variables. The environment variables can also be defined in a file called `.env`, place on the project root directory. The format of each line in `.env` file is `VARIABLE=VALUE`.

1.1.3.1 Environment variables

SATNOGS_API_TOKEN

Type *string*

Default *None*

Required *Yes*

Description SatNOGS Network API token associated with an account in SatNOGS Network. This token is secret. It can be found in SatNOGS Network user page.

SATNOGS_PRE_OBSERVATION_SCRIPT

Type *path*

Default *None*

Required *No*

Description A path to an executable to be executed before an observation job is started. Execution of this script blocks the observation job.

SATNOGS_POST_OBSERVATION_SCRIPT

Type *path*

Default *None*

Required *No*

Description A path to an executable to be executed after an observation job has finished. Execution of this script blocks the completion of an observation job.

SATNOGS_STATION_ID

Type *integer*

Default *None*

Required *Yes*

Description The ID of the SatNOGS Network station this client will act as. The station must be owned by the user with the defined API token.

SATNOGS_STATION_LAT

Type *float*

Default *None*

Required *Yes*

Description Latitude of the station location. Higher precision of this value increases accuracy of Doppler correction while lower precision increases station location privacy.

SATNOGS_STATION_LON

Type *float*

Default *None*

Required *Yes*

Description Longitude of the station location. Higher precision of this value increases accuracy of Doppler correction while lower precision increases station location privacy.

SATNOGS_STATION_ELEV

Type *integer*

Default *None*

Required *Yes*

Description Elevation of the station location. Higher precision of this value increases accuracy of Doppler correction while lower precision increases station location privacy.

SATNOGS_GPSD_CLIENT_ENABLED

Type *boolean*

Default *False*

Required *No*

Description Enable SatNOGS Client to connect to a GPSd daemon to pull positional information. The position is queried once, during SatNOGS Client startup.

SATNOGS_GPSD_HOST

Type *host*

Default `127.0.0.1`

Required *No*

Description Hostname or IP address of GPSd to connect to for pulling positional information.

SATNOGS_GPSD_PORT

Type *port*

Default `2947`

Required *No*

Description Port of GPSd to connect to for pulling positional information.

SATNOGS_GPSD_TIMEOUT

Type *integer*

Default `0`

Required *No*

Description Time to wait until GPSd returns positional information. A value of 0 means to wait indefinitely.

SATNOGS_APP_PATH

Type *path*

Default `/tmp/.satnogs`

Required *No*

Description Base path for storing output files.

SATNOGS_OUTPUT_PATH

Type *path*

Default `/tmp/.satnogs/data`

Required *No*

Description Path for storing output files.

SATNOGS_COMPLETE_OUTPUT_PATH

Type *path*

Default

Required *No*

Description Path to move output files once they are completed. Preserving output files is disabled if set to empty.

SATNOGS_INCOMPLETE_OUTPUT_PATH

Type *path*

Default `/tmp/.satnogs/data/incomplete`

Required *No*

Description Path for moving incomplete output files.

SATNOGS_REMOVE_RAW_FILES

Type *boolean*

Default *True*

Required *No*

Description Remove raw data files used for generating waterfalls.

SATNOGS_VERIFY_SSL

Type *boolean*

Default *True*

Required *No*

Description Verify SSL certificates for HTTPS requests.

SATNOGS_NETWORK_API_URL

Type *url*

Default `https://network.satnogs.org/api/`

Required *No*

Description URL pointing to API of SatNOGS Network.

SATNOGS_NETWORK_API_QUERY_INTERVAL

Type *integer*

Default `60`

Required *No*

Description Interval (in seconds) for pulling jobs form SatNOGS Network API.

SATNOGS_NETWORK_API_POST_INTERVAL

Type *integer*

Default `180`

Required *No*

Description Interval (in seconds) for posting observation data to SatNOGS Network API.

SATNOGS_ROT_MODEL

Type *string*

Default `ROT_MODEL_DUMMY`

Required *No*

Description Rotator model to control. This value must be the model string of a Hamlib rotator.

SATNOGS_ROT_BAUD

Type *integer*

Default `19200`

Required *No*

Description Hamlib rotator serial interface baud rate.

SATNOGS_ROT_PORT

Type *path*

Default `/dev/ttyUSB0`

Required *No*

Description Path to Hamlib rotator serial port device. The device must be accessible to the user which SatNOGS Client is running.

SATNOGS_RIG_IP

Type *host*

Default `127.0.0.1`

Required *No*

Description Hostname or IP address of Hamlib rotctld.

SATNOGS_RIG_PORT

Type *integer*

Default `4532`

Required *No*

Description Hamlib rigctld TCP port.

SATNOGS_ROT_THRESHOLD

Type *integer*

Default `4`

Required *No*

Description Azimuth/elevation threshold for moving the rotator. Position changes below this threshold will not cause the rotator to move.

SATNOGS_ROT_FLIP

Type *boolean*

Default *False*

Required *No*

Description Enable rotator flipping during high elevation passes.

SATNOGS_ROT_FLIP_ANGLE

Type *integer*

Default `75`

Required *No*

Description Elevation angle above which the rotator will flip.

SATNOGS_SOAPY_RX_DEVICE

Type *string*

Default *None*

Required *Yes*

Description SoapySDR device driver to use for RX. This setting must be defined in the form `driver=<name>` where `<name>` is the name of the SoapySDR device driver to use.

SATNOGS_RX_SAMP_RATE

Type *integer*

Default *None*

Required *Yes*

Description SoapySDR device sample rate. Valid sample rates for attached devices can be queried using `SoapySDRUtil --probe`.

SATNOGS_RX_BANDWIDTH

Type *integer*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device RF bandwidth. This setting configures the RF filter on devices that support it.

SATNOGS_DOPPLER_CORR_PER_SEC

Type *integer*

Default *Flowgraph-defined*

Required *No*

Description Number of Doppler corrections per second requested by SatNOGS Radio.

SATNOGS_LO_OFFSET

Type *integer*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device local oscillator offset to apply. This setting is used to shift the carrier away from the DC spike.

SATNOGS_PPM_ERROR

Type *float*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device oscillator frequency error correction to apply. This setting is defined in parts per million.

SATNOGS_GAIN_MODE

Type *string*

Default `Overall`

Required *No*

Description SoapySDR device gain mode. Valid values are: `Overall`, `Specific`, `Settings Field`.

SATNOGS_RF_GAIN

Type *float*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device overall gain, in dB. Device drivers set individual, device specific gains to approximate linearity on the overall gain.

SATNOGS_ANTENNA

Type *string*

Default *None*

Required *Yes*

Description SoapySDR device antenna to use for RX. Valid antennas for attached devices can be queried using `SoapySDRUtil --probe`.

SATNOGS_DEV_ARGS

Type *string*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device arguments. Valid device arguments for attached devices can be queried using `SoapySDRUtil --probe`.

SATNOGS_STREAM_ARGS

Type *string*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR stream arguments. Valid stream arguments for attached devices can be queried using `SoapySDRUtil --probe`.

SATNOGS_TUNE_ARGS

Type *string*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR channel tune arguments.

SATNOGS_OTHER_SETTINGS

Type *string*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR channel other settings.

SATNOGS_DC_REMOVAL

Type *boolean*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device automatic DC offset suppression.

SATNOGS_BB_FREQ

Type *string*

Default *Flowgraph-defined*

Required *No*

Description SoapySDR device baseband CORDIC frequency for devices that support it.

ENABLE_IQ_DUMP

Type *boolean*

Default *False*

Required *No*

Description Create I/Q data dumps for every observation. Use this feature with caution. Enabling this setting will store large amount of data on the filesystem.

IQ_DUMP_FILENAME

Type *path*

Default *None*

Required *No*

Description Path to file for storing I/Q data dumps.

DISABLE_DECODED_DATA

Type *boolean*

Default *False*

Required *No*

Description Disable output of decoded data.

UDP_DUMP_HOST

Type *host*

Default *Flowgraph-defined*

Required *No*

Description IP destination of UDP data with Doppler corrected I/Q.

UDP_DUMP_PORT

Type *port*

Default `57356`

Required *No*

Description Port for UDP data with Doppler corrected I/Q.

SATNOGS_WATERFALL_AUTORANGE

Type *boolean*

Default *True*

Required *No*

Description Automatically set power level range of waterfall images.

SATNOGS_WATERFALL_MIN_VALUE

Type *integer*

Default `-100`

Required *No*

Description Minimum power level of waterfall images.

SATNOGS_WATERFALL_MAX_VALUE

Type *integer*

Default `-50`

Required *No*

Description Maximum power level of waterfall images.

SATNOGS_ARTIFACTS_ENABLED

Type *boolean*

Default *False*

Required *No*

Description Enable generation and uploading of HDF5 artifacts files to SatNOGS DB.

SATNOGS_ARTIFACTS_API_URL

Type *url*

Default `https://db.satnogs.org/api/`

Required *No*

Description URL pointing to API of SatNOGS DB for uploading artifacts.

SATNOGS_ARTIFACTS_API_POST_INTERVAL

Type *integer*

Default `180`

Required *No*

Description Interval (in seconds) for posting artifacts to SatNOGS DB.

SATNOGS_ARTIFACTS_API_TOKEN

Type *string*

Default *None*

Required *No*

Description SatNOGS DB API token associated with an account in SatNOGS DB. This token is secret. It is used to upload artifacts to SatNOGS DB. It can be found in SatNOGS DB user page.

LOG_LEVEL

Type *string*

Default `WARNING`

Required *No*

Description SatNOGS Client logging level. Valid values are:

- `CRITICAL`
- `ERROR`
- `WARNING`
- `INFO`
- `DEBUG`

SCHEDULER_LOG_LEVEL

Type *string*

Default `WARNING`

Required *No*

Description SatNOGS Client scheduler logging level. Valid values are:

- `CRITICAL`
- `ERROR`
- `WARNING`
- `INFO`
- `DEBUG`

SENTRY_DSN

Type *string*

Default d50342fb75aa8f3945e2f846b77a0cdb7c7d2275

Required *No*

Description Sentry Data Source Name used for sending events to application monitoring and error tracking server.

SENTRY_ENABLED

Type *boolean*

Default *False*

Required *No*

Description Enable sending events to Sentry application monitoring and error tracking server.

1.1.4 Usage

To execute the script, run it on the command line:

```
$ satnogs-client
```

1.2 Developer guide

1.2.1 Installation

To install the required dependencies in Debian run:

```
$ apt-get install python3-libhamlib2
```

It is recommended to install the client in a virtualenv. The virtualenv needs to have access to system Python bindings. To create the virtualenv, you can use `virtualenvwrapper`. On the first time, create the virtualenv by running:

```
$ mkvirtualenv --system-site-packages -a . satnogs-client
```

To activate the virtualenv after it is created run:

```
$ workon satnogs-client
```

To install SatNOGS Client for development run in the project root directory:

```
$ pip install -e .
```

1.2.2 Configuration

This project uses `python-dotenv`. Configuration of `satnogsclient/settings.py` can be overridden by setting the respective environment variables or an `.env` file placed on the project root directory. Check *Configuration* for a list of all configuration variables.

1.2.3 Code Quality Assurance

The following code quality assurance tools are used in this project:

- `flake8`
- `isort`
- `yapf`
- `pylint`
- `robotframework`

1.2.4 Testing

1.2.4.1 System testing

Robot Framework is used for system testing. `robot/testsuites` contain Robot test cases and suites.

1.2.5 Automation

`tox` is used to automate development tasks. To install `tox` run:

```
$ pip install tox
```

To execute the default list of tasks run:

```
$ tox
```

1.2.5.1 Environments

The following `tox` environments are available:

- `flake8` - Check code for common errors, coding style and complexity
- `isort` - Check code for correct imports order
- `isort-apply` - Sort imports
- `yapf` - Check code for correct formatting
- `yapf-apply` - Reformat source code
- `pylint` - Execute static code analysis
- `build` - Build source and binary distributions
- `upload` - Upload source and binary distributions to PyPI
- `docs` - Build documentation
- `robot-lint` - Lint system test cases and suites
- `robot-tidy` - Reformat system test cases and suites
- `robot` - Execute system testing

To execute a single environment run:

```
$ tox -e <environment>
```

1.3 Modules reference

1.3.1 satnogsclient

SatNOGS Client module initialization

satnogsclient.**main**()
Main function

1.3.2 satnogsclient.locator.locator

class satnogsclient.locator.locator.**Locator**

static show_location(*gpsd*)

update_location()

1.3.3 satnogsclient.observer.commsocket

1.3.4 satnogsclient.observer.observer

class satnogsclient.observer.observer.**Observer**

observe()
Starts threads for rotcrl and rigctl.

plot_waterfall(*waterfall*)

poll_gnu_proc_status(*flowgraph*)

remove_waterfall_file()

rename_data_file()

rename_ogg_file()

run_rig()

run_rot()

setup(*observation_id*, *tle*, *observation_end*, *frequency*, *mode*, *baud*)
Sets up required internal variables. * returns True if setup is ok * returns False if issue is encountered

satnogsclient.observer.observer.**post_artifacts**(*artifacts_file*, *observation_id*)

1.3.5 satnogsclient.observer.orbital

satnogsclient.observer.orbital.**pinpoint**(*observer_dict*, *satellite_dict*, *timestamp=None*)
Provides azimuth and altitude of tracked object.

args: observer_dict: dictionary with details of observation point. satellite_dict: dictionary with details of satellite. time: timestamp we want to use for pinpointing the observed object.

returns: Dictionary containing azimuth, altitude and "ok" for error detection.

1.3.6 satnogsclient.artifacts

class satnogsclient.artifacts.**Artifacts**(*waterfall*, *observation_id*)

create()

1.3.7 satnogsclient.waterfall

exception satnogsclient.waterfall.**EmptyArrayError**
Empty data array exception

class satnogsclient.waterfall.**Waterfall**(*datafile_path*)
Parse waterfall data file

Parameters **datafile_path** (*str_array*) – Path to data file

plot(*figure_path*, *vmin=None*, *vmax=None*)
Plot waterfall into a figure

Parameters

- **figure_path** (*str*) – Path of figure file to save
- **value_range** (*tuple*) – Minimum and maximum value range

satnogsclient.waterfall.**_compress_waterfall**(*waterfall*)
Compress spectra of waterfall

Parameters **waterfall** (*dict*) – Watefall data

Returns Compressed spectra

Return type dict

satnogsclient.waterfall.**_get_waterfall**(*datafile_path*)
Get waterfall data

Parameters **datafile_path** (*str_array*) – Path to data file

Returns Waterfall data including compressed data

Return type dict

satnogsclient.waterfall.**_read_waterfall**(*datafile_path*)
Read waterfall data file

Parameters **datafile_path** (*str*) – Path to data file

Returns Waterfall data

Return type dict

1.3.8 satnogsclient.observer.worker

class satnogsclient.observer.worker.**Worker**(*ip*, *port*, *time_to_stop=None*, *frequency=None*, *sleep_time=None*)

Class to facilitate as a worker for rotctl/rigctl.

_altitude = None

_azimuth = None

_communicate_tracking_info()

_frequency = None

_observation_end = None

_sleep_time = 0.1

_stay_alive = False

property is_alive

Returns if tracking loop is alive or not.

observer_dict = {}

satellite_dict = {}

send_to_socket(*pin*, *sock*)

trackobject(*observer_dict*, *satellite_dict*)

Sets tracking object. Can also be called while tracking to manipulate observation.

trackstart()

Starts the thread that communicates tracking info to remote socket. Stops by calling trackstop()

trackstop()

Sets object flag to false and stops the tracking thread.

class satnogsclient.observer.worker.**WorkerFreq**(*ip*, *port*, *time_to_stop=None*, *frequency=None*, *sleep_time=None*)

_communicate_tracking_info()

Runs as a daemon thread, communicating tracking info to remote socket. Uses observer and satellite objects set by trackobject(). Will exit when observation_end timestamp is reached.

send_to_socket(*pin*, *sock*)

class satnogsclient.observer.worker.**WorkerTrack**(*ip*, *port*, *time_to_stop=None*, *frequency=None*, *sleep_time=None*)

_communicate_tracking_info()

Runs as a daemon thread, communicating tracking info to remote socket. Uses observer and satellite objects set by trackobject(). Will exit when observation_end timestamp is reached.

_flip = False

_midpoint = None

static find_midpoint(*observer_dict*, *satellite_dict*, *start*)

static flip_coordinates(*azi*, *alt*, *timestamp*, *midpoint*)

static normalize_angle(*num*, *lower=0*, *upper=360*)

send_to_socket(*pin*, *sock*)

trackobject(*observer_dict*, *satellite_dict*)
Sets tracking object. Can also be called while tracking to manipulate observation.

1.3.9 satnogsclient.rig

class satnogsclient.rig.**Rig**(*model=Hamlib.RIG_MODEL_DUMMY*, *path=''*, *debug=Hamlib.RIG_DEBUG_WARN*)
Communicate and interface with rigs

Parameters

- **model** – Model of Hamlib rig
- **path** (*str, optional*) – Path or address to Hamlib rig device
- **debug** (*int, optional*) – Hamlib rig debug level

close()
Close Hamlib rig device

property frequency
Get rig frequency

Returns Rig frequency

Return type float

open()
Open Hamlib rig device

property vfo
Get active VFO

Returns Active VFO

Return type int

1.3.10 satnogsclient.rotator

class satnogsclient.rotator.**Rotator**(*model*, *baud*, *port*)
Communicate and interface with rotators

Parameters

- **model** (*str*) – Model of rotator e.g. "ROT_MODEL_EASYCOMM3" or "ROT_MODEL_DUMMY"
- **baud** (*int*) – The baud rate of serial communication, e.g. 19200
- **port** (*str*) – The port of the rotator, e.g. "/dev/ttyUSB0"

close()
End the communication with rotator

get_conf(*cmd*)
Return the configuration of a register

Parameters **pos** (*int*) – Number of the register

Returns Value of register

Return type str

get_info()
Return information about the rotator

move(*direction*, *speed*)
Move the rotator with speed (mdeg/s) to specific direction

Parameters

- **direction** (*str*) – The direction of movent, e.g. ROT_MOVE_UP, ROT_MOVE_DOWN, ROT_MOVE_LEFT, ROT_MOVE_RIGHT
- **speed** (*int*) – The velocity set point in mdeg/s

open()
Start the communication with rotator

park()
Move the rotator to park position and return the current position

property position
Return the position in degrees of azimuth and elevation

Returns Position in degrees

Return type tuple(float, float)

reset()
Move the rotator to home position and return the current position

stop()
Stop the rotator and return the current position

1.3.11 satnogsclient.scheduler.tasks

satnogsclient.scheduler.tasks.**get_jobs**()
Query SatNOGS Network API to GET jobs.

satnogsclient.scheduler.tasks.**keep_or_remove_file**(*filename*)

satnogsclient.scheduler.tasks.**post_data**()
PUT observation data back to Network API.

satnogsclient.scheduler.tasks.**spawn_observer**(***kwargs*)

satnogsclient.scheduler.tasks.**status_listener**()

1.3.12 satnogsclient.settings

SatNOGS Client settings file

satnogsclient.settings.**_cast_or_none**(*func*, *value*)

satnogsclient.settings.**validate**(*logger*)
Validate the provided settings: - Check for the existance of all required variables - Validate format of the provided value for some required variables

Since this module has to be loaded before the logger has been initialized, this method requires a configured logger to be passed.

Arguments: logger – the output logger

1.3.13 satnogsclient.radio.flowgraphs

class satnogsclient.radio.flowgraphs.**Flowgraph**(*device*, *sampling_rate*, *frequency*, *mode*, *baud*, *output_data*)

Execute SatNOGS Flowgraphs

Parameters

- **device** (*str*) – SoapySDR device
- **sampling_rate** (*int*) – Sampling rate
- **frequency** (*int*) – RX frequency
- **mode** (*str*) – Mode of operation
- **baud** (*int*) – Baud rate or WPM
- **output_data** (*dict*) – Dictionary of output data

property enabled

Get flowgraph running status

Returns Flowgraph running status

Return type bool

property info

Get information and parameters of flowgraph and radio

Returns Information about flowgraph and radio

Return type dict

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