Libre Space Foundation

- A non profit organization based in Athens, Greece
- Focus on space applications
- Commitment to open technologies
- Educational activities
Libre Space Foundation

- Established in 2014 after winning the Hackaday prize
- The winning project was the core of the **SatNOGS**
ESA SDR Makerspace
An ESA - LSF collaboration

14-month program with a budget of 500k euros

Investigate the use of SDR technology in space applications

Umbrella activity for 15+ subactivities around SDR and space communication

Several subactivities include contributions to GNU Radio

All results released as open source software and hardware
• Use Soapy API to interface with SDR hardware

• Extract device capabilities dynamically

• Deprecates the gr-osmosdr

• https://gitlab.com/librespacefoundation/gr-soapy.git
## gr-soapy

### Properties Source

<table>
<thead>
<tr>
<th>General</th>
<th>RF Options</th>
<th>Advanced</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID</strong></td>
<td>soapy_source_1_0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Device</strong></td>
<td>driver-airspy</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Args</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sampling Rate</strong></td>
<td>samp_rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Num Channels</strong></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Master Clock Rate</strong></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clock Source</strong></td>
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<td></td>
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</tr>
<tr>
<td><strong>Output Type</strong></td>
<td>Complex float32</td>
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</tbody>
</table>

**Source - out(0):**
Port is not connected.

### Properties Source

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<tbody>
<tr>
<td><strong>Ch0: Center Freq (Hz)</strong></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ch0: Gain Mode</strong></td>
<td>Manual</td>
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<td></td>
</tr>
<tr>
<td><strong>Ch0: LNA Gain Value</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Ch0: MIX Gain Value</strong></td>
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<tr>
<td><strong>Ch0: VGA Gain Value</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ch0: Automatic Gain</strong></td>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ch0: Antenna</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ch0: Bandwidth (Hz)</strong></td>
<td>0</td>
<td></td>
<td></td>
</tr>
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</table>

**Source - out(0):**
Port is not connected.
### gr-soapy Source Properties

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<td>ID</td>
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<tr>
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<tr>
<td>Output Type</td>
<td>Complex float32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### RF Options

- **Ch0 Center Freq (Hz)**: 0
- **Ch0 NCO Freq (Hz)**: 0
- **Ch0 Gain Mode**: Manual
- **Ch0 PSA Gain Value**: 0
- **Ch0 LNA Gain Value**: 0
- **Ch0 TIA Gain Value**: 0
- **Ch0 Antenna**:
- **Ch0 Bandwidth (Hz)**: 0
- **Ch0: Automatic DC Offset N**: False
<table>
<thead>
<tr>
<th>Devices</th>
<th>TX</th>
<th>RX</th>
<th>Multiple Channels</th>
<th>Gains</th>
<th>DC offset Correction</th>
<th>IQ Balance Correction</th>
<th>Auto Gain Control</th>
<th>Frequency Correction</th>
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<tbody>
<tr>
<td>Usrp b 210</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
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<td>✔</td>
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<td>✔</td>
<td>✔</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
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<td>✔</td>
<td>N/A</td>
<td>✔</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>✔</td>
</tr>
<tr>
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<td>✔</td>
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<td>✔</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</tr>
</tbody>
</table>
• A model emulating the LEO channel
• Path loss based on distance and/or atmospheric absorption
• Doppler effect
• **Great** tool for prototyping and experimentation
• [https://gitlab.com/librespacefoundation/gr-leo.git](https://gitlab.com/librespacefoundation/gr-leo.git)
IQzip

- Focus on **lossless** compression of IQ data

- Investigate the best compression algorithm in terms of:
  - Compression ratio
  - Compress/Decompress computational resources
  - Standardization

- Implement API and tools for compress/decompress IQ data

- [https://gitlab.com/librespacefoundation/sdrmakerspace/iqzip](https://gitlab.com/librespacefoundation/sdrmakerspace/iqzip)
And the winner is:

CCSDS 121.0-B-2
And the winner is: **CCSDS 121.0-B-2**!
gr-ccsds

- GNU Radio encoders and decoders implementing the CCSDS recommendation
  - Reed Solomon
  - Convolutional Coding $R = 1/2, 2/3, 3/4, 5/6, 7/8$
  - Turbo Coding
  - PCM
  - LDPC

- Testing with CCSDS modem from ESA!!!

- https://gitlab.com/librespacefoundation/gr-ccsds
• Characterize the performance of almost all available SDR devices
• Measurements for:
  • Noise floor
  • Receiver Dynamic Range
  • RX/TX spectral purity
  • TX Power
• https://gitlab.com/librespacefoundation/sdrmakerspace/sdreval/wikis/home
SDR & Machine Learning

- **Signnn**
  - Satellite signal classification through CNN
  - https://gitlab.com/librespacefoundation/sdrmakerspace/signnn

- **gr-orbitsense**
  - Signal presence or absence detection
  - Optimized for low SNR scenarios
  - https://gitlab.com/librespacefoundation/sdrmakerspace/gr-orbitsense

- **gr-dnn**
  - GNU Radio based framework for easy integration of Machine learning models
  - https://gitlab.com/librespacefoundation/sdrmakerspace/gr-dnn
More! (Under dev)

- SDR hardware radiation testing
- Direct sampling experimentation
- Improvements on UHD driver
- MIMO enabled ground station
- Framework for SDR testing CI/CD

More info at:
- https://sdrmaker.space
- https://gitlab.com/librespacefoundation/sdrmakerspace
Join the Conference!

Software Defined Radio for Satcom Applications
Conference
28-29 November 2019
Swiss Aeropole
(Payerne, Switzerland)

Enter is fee;
registration required.
For more informations:
https://sdrmaker.space/sdrcconference19