gr-dvbs2rx
An overview of the project state and path forward.

Igor Freire

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Project Overview
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- GNU Radio OOT module containing:
  - DVB-S2 signal processing blocks.
  - Example flowgraphs.
  - Production-ready Python apps: `dvbs2-rx` and `dvbs2-tx`. 
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• Fully-functional software-defined DVB-S2 receiver.
Outline

• Project state.
• Path forward for optimization and improvements.
• Examples based on the Blockstream Satellite Ku-band signal.
• CPU performance results.
DVB-S2 Rx Architecture

Block Diagram

IQ Samples

Symbols

Pad Source
Label: in

AGC
Rate: 10a
Reference: 1
Gain: 1
Max Gain: 65.36k

Rotator
Phase Increment: 0

Symbol Synchronizer
Oversampling Factor: 2
Loop Bandwidth: 4.5m
Damping Factor: 1
RRC Rolloff Factor: 200m
Interpolation Method: Polyphase

Frequency Correction Block

BBdeheader
Standard: DVB-S2
FECFRAME size: normal
Code rate: 1/4

BBdescrambler
Standard: DVB-S2
FECFRAME size: normal
Code rate: 1/4

BCH Decoder
Standard: DVB-S2
FECFRAME size: normal
Code rate: 1/4
Output mode: Message

DVB-S2 PL Sync
Gold code: 0
Freq. Estimation Period: 20
MF Oversampling: 2
Debug Level: 0
ACM/VCM mode: True
Multi stream (MIS): True
PLS filter (LSB): 0x....ffffff
PLS filter (MSB): 0x....ffffff

LDPC Decoder
Standard: DVB-S2
FECFRAME size: normal
Code rate: 1/4
Constellation: QPSK
Output mode: Message
Show Corrected SNR: Off
Max Iterations: 25

Pad Sink
Label: out

rotator_phase_inc
DVB-S2 Rx Architecture

Block Diagram

IQ Samples

Symbols

Pad Source
Label: in

Pad Sink
Label: out

AGC
Rate: 10u
Reference: 1
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XFECFRAME

rotator_phase_inc
Project State and Path Forward

Current Stage

- Minimal Functionality

- Constant coding and modulation (CCM).
- Single Input Stream (SIS).
- QPSK and 8PSK constellations.
- Pilot mode operation.
- Support for RTL-SDR and USRP.
- Tested on Ubuntu and Fedora.
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- Faster BCH and LDPC decoding.
- More efficient symbol timing sync.
- Support for lower signal-to-noise ratios (SNRs).
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### Comprehensive DVB-S2 Support
- Adaptive/variable coding and modulation (ACM/VCM).
- Multiple Input Stream (MIS).
- 16APSK and 32APSK constellations.
- Pilotless mode.
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  - Tested with more:
    - SDR boards.
    - DVB-S2 carriers.
    - Linux distributions/versions.
    - Host platforms.
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DVB-S2X
Current Limitations
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- Disturbed by the oversampling factor at low SNR.
- Not data-aided.
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- Faster than the GR in-tree symbol sync.
- Still too slow.
- Even integer oversampling only.
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• Pilotless mode not fully implemented.
• SNR limit around +2 dB in pilot mode.

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- Faster than the GR in-tree symbol sync.
- Still too slow.
- Even integer oversampling only.
- Pilotless mode not fully implemented.
- SNR limit around +2 dB in pilot mode.
- Could be faster.
- Refactoring and benchmarking.
Example
Blockstream Satellite Reception
Hardware Setup
Example
Blockstream Satellite Reception
Carrier Info and Frequencies

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Eutelsat 113</th>
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<tbody>
<tr>
<td>Longitude</td>
<td>113º W</td>
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<tr>
<td>DL Frequency</td>
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<tr>
<td>LNB LO</td>
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RTL-SDR Supported
Example
Blockstream Satellite Reception
Example Commands

dvbs2-rx --source rtl --freq 1316.9e6 --samp-rate 2e6 --sym-rate 1e6 --rolloff 0.2 --modcod qpsk3/5 --frame-size normal --pilots on
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Blockstream Satellite Reception
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RTL-SDR Source
L-band Freq.
sps=2

"Auto mode" available but a priori info recommended.
Example
Blockstream Satellite Reception
GUI Mode

dvbs2-rx --source rtl --freq 1316.9e6 --samp-rate 2e6 --sym-rate 1e6 --rolloff 0.2 --modcod qpsk3/5 --frame-size normal --pilots on --gui
CPU Utilization
High SNR Operation

gr-dvbs2rx symbol sync implementation
CPU Utilization

High SNR Operation

BCH Decoder > LDPC Decoder

gr-dvbs2rx symbol sync implementation
CPU Utilization
High SNR Operation

BCH Decoder > LDPC Decoder

gr-dvbs2rx symbol sync implementation

PL Sync with stable low CPU utilization (locked)
CPU Utilization
High SNR vs. Low SNR

18 dB SNR

4 dB SNR
CPU Utilization
High SNR vs. Low SNR

18 dB SNR

4 dB SNR

Higher LDPC Decoder utilization
CPU Utilization
High SNR vs. Low SNR

18 dB SNR

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Higher LDPC Decoder utilization

BCH Decoder still the 2nd highest
CPU Utilization
High SNR vs. Low SNR

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Higher LDPC Decoder utilization

4 dB SNR

BCH Decoder still the 2nd highest

Occasional peaks
Questions?

Repository: https://github.com/igorauad/gr-dvbs2rx

Docs: https://igorauad.github.io/gr-dvbs2rx/

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