The GNU Radio Companion Changelog
Overview

■ GNU Radio Companion Intro
  ■ Graphical Flow Graph Design
  ■ How to add your own blocks

■ Recently added features
  ■ Bypassed Blocks
  ■ Embedded Python Blocks / Modules
  ■ Custom Run Commands
  ■ Bootstrap depending hier_blocks

■ Current development and plans for future versions
The GNU Radio Companion

- Written by Josh Blum around 2007
  - Extended, patched and tinkered with by many since
  - 45 contributors (~90% of commits by 4 people)

- Maintained by me since 2013

- Written in (legacy) Python
  - PyGTK as GUI
  - Cheetah for templating Python code
  - Code base: ~12k lines, almost no tests =(
The GUI

Welcome to GNU Radio Companion v3.7.8.1-232-g532b31e7

Preferences file: /home/koslowski/.gnuradio/grc.conf
Block paths:
/home/koslowski/local/apps/gnuradio_master/share/gnuradio/grc/blocks
/home/koslowski/.gnuradio

Showing: "$"
Example Flow Graph

Generating: '/home/koslowski/grc/fosdem_intro.py'

Executing: '/home/koslowski/local/apps/gnuradio_master/bin/python -u /home/koslowski/grc/fosdem_intro.py'

Using Volk machine: sse4_a_64_orc

>>> Done
Example Flow Graph in Action

![Example Flow Graph in Action]

The GNU Radio Companion Changelog
FOSDEM 2016, Sebastian Koslowski
Behind the Scenes Example

Using Volk machine: sse4_a_64_orc

>>> Done

Generating: '/home/koslowski/grc fosdem_intro.py'

Generating: '/home/koslowski/grc fosdem_intro.py'
Generated Python

```python
#!/usr/bin/env python2
# -*- coding: utf-8 -*-
# GNU Radio Python Flow Graph
# Title: FOSDEM Intro
# Generated: Thu Jan 28 16:35:35 2016

from gnuradio import analog
from gnuradio import blocks
from gnuradio import eng_notation
from gnuradio import filter
from gnuradio import gr
from gnuradio.eng_option import eng_option
from gnuradio.filter import firdes
from optparse import OptionParser

class fosdem_intro(gr.top_block):
    def __init__(self, cutoff=8e3):
        gr.top_block.__init__(self, "FOSDEM Intro")
```

class fosdem_intro(gr.top_block):

    def __init__(self, cutoff=8e3):
        gr.top_block.__init__(self, "FOSDEM Intro")

    # Parameters
    self.cutoff = cutoff

    # Variables
    self.samp_rate = samp_rate = 32000

    # Blocks
    self.low_pass_filter_0 = filter.fir_filter_ccf(1, firdes.low_pass(1, samp_rate, cutoff, 4e3, firdes.WIN_HAMMING, 6.76))
    self.blocks_throttle_0 = blocks.throttle(gr.sizeof_gr_complex*1, samp_rate, True)
    self.blocks_null_sink_0 = blocks.null_sink(gr.sizeof_gr_complex*1)
    self.analog_noise_source_x_0 = analog.noise_source_c(analog.GR_GAUSSIAN, 0, 0, 0)

fosdem_intro(top_block):
Generated Python

def __init__(self, cutoff=8e3):
    ...
    # Connections
    # Set Samp Rate
    self.connect(((self.analog_noise_source_x_0, 0), (self.blocks_throttle_0, 0)))
    self.connect(((self.blocks_throttle_0, 0), (self.low_pass_filter_0, 0)))
    self.connect(((self.low_pass_filter_0, 0), (self.blocks_null_sink_0, 0)))

    def get_cutoff(self):
        return self.cutoff

    def set_cutoff(self, cutoff):
        self.cutoff = cutoff
        self.low_pass_filter_0.set_taps(firdes.low_pass(1, self.samp_rate, self.cutoff, 1))

    def get_samp_rate(self):
        return self.samp_rate

    def set_samp_rate(self, samp_rate):
        self.samp_rate = samp_rate
        self.blocks_throttle_0.set_sample_rate(self.samp_rate)
        self.low_pass_filter_0.set_taps(firdes.low_pass(1, self.samp_rate, self.cutoff, 1))
def argument_parser():
    parser = OptionParser(option_class=eng_option, usage="%prog: [options]")
    parser.add_option("", "--cutoff", dest="cutoff", type="eng_float", default=eng_notation.num_to_str("FOSDEM Intro")
    help="Set Cutoff Freq [default=%default]"
    return parser

def main(top_block_cls=fosdem_intro, options=None):
    if options is None:
        options, _ = argument_parser().parse_args()

    tb = top_block_cls(cutoff=options.cutoff)
    tb.start()
    try:
        raw_input('Press Enter to quit: ')
    except EOFError:
        pass
    tb.stop()
    tb.wait()

if __name__ == '__main__':
    main()
How to add your own block

- **Block Wrapper/ XML**
  ![Block Wrapper/ XML](image)

- **Metadata:**
  - name, category, docs, flags

- **Parameters:**
  - key, name, type, default value, GUI

- **Ports:**
  - key, name, type (vlen), domain, GUI

- **Templates:**
  - imports, make, callbacks, (variable value)
How to add your own block

```xml
<block>
  <name>Add Const</name>
  <key>blocks_add_const_vxx</key>
  <import>from gnuradio import blocks</import>
  <make>blocks.add_const_v$(type.fcn)($const)</make>
  <callback>set_k($const)</callback>
  <param>
    <name>IO Type</name>
    <key>type</key>
    <type>enum</type>
    <option>
      <name>Complex</name>
      <key>complex</key>
      <opt>const_type:complex_vector</opt>
      <opt>fcn:cc</opt>
    </option>
    <option>
      <name>Float</name>
      <key>float</key>
      <opt>const_type:real_vector</opt>
      <opt>fcn:ff</opt>
    </option>
  </param>
  <param>
    <name>Constant</name>
    <key>const</key>
    <value>0</value>
    <type>$type.const_type</type>
  </param>
  <param>
    <name>Vec Length</name>
    <key>vlen</key>
    <value>1</value>
    <type>int</type>
  </param>
  <check>len($const) == $vlen</check>
  <check>$vlen > 0</check>
  <sink>
    <name>in</name>
    <type>$type</type>
    <vlen>$vlen</vlen>
  </sink>
  <source>
    <name>out</name>
    <type>$type</type>
    <vlen>$vlen</vlen>
  </source>
</block>```
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- Current development and plans for future versions
Bypassed Blocks

- Say you're streaming data through some blocks...

... and want to bypass one

- Works for
  - Single I/O of the same type
  - Can be explicitly disabled in XML

- Thanks to Seth Hitefield
Embedded Python Blocks

- Say you want ...
  - to quickly try something
  - a self-contained (tutorial) Flowgraph with custom DSP

- Python Blocks
  - Stored in the Flowgraph
  - Edited directly from GRC
  - Live, on-the-fly Block Wrappers
Embedded Python Blocks

```python
import numpy as np
from gnuradio import gr
import pmt

class blk(gr.sync_block):
    def __init__(self, factor=1.0, some_param=True,
                 some_other_param=[1, 2, 3]):
        gr.sync_block.__init__(
            self,
            name='Python Block Example',
            in_sig=[np.complex64],
            out_sig=[np.complex64]
        )
        self.factor = factor
        port_key = pmt.intern('control')
        self.message_port_register_in(port_key)
        self.set_msg_handler(port_key, self.handle_msg)

    def handle_msg(self, self, msg):
        pass

    def work(self, self, input_items, output_items):
        output_items[0][:] = input_items[0] * self.factor
        return len(output_items[0])
```

Properties: Python Block Example

- **Factor**: 1.0
- **Some Param**: True
- **Some Other Param**: [1, 2, 3]

OK  Cancel  Apply
Embedded Python Modules

- Say you quickly want ...
- to include longer python code
- keep it in the GRC file

```python
# this module will be imported into your flowgraph

MY_CONSTANT = 1

def my_function(a):
    pass

class MyClass(object):
    pass
```

![Diagram showing properties of a variable and Python module ID and objects.](image-url)
Custom Run Commands

- Say you want ...
  - to modify/extend/embedded your Flowgraph and still run in from GRC
  - deploy and execute it remotely

- You can have GRC run any command
  - Oh oh…
  - import the generated code in new model and reuse/extend the
    - top_block, main, arg_parser
  - Have some script run SCP and SSH for remote execution
Bootstrap depending hier_blocks

- Say you distribute a OOT module including a Flowgraph which depends on other GRC generated hier_blocks

- GRC will auto-generate these now if
  - it knows where to look
  - “.” is default, multiple allowed
  - the Flowgraph ID and filename match

- Of course, embedded hierarchical blocks would be nicer…
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Current development and future versions

- Long term goals
  - Switch to a QT-based GUI
  - Rewrite/clean/modularize the core
    - get rid of quick fixes, endless special cases and side-effects
    - ease entry for new contributors
  - Switch to Python3
  - Replace XML-based Block Wrappers

- Want to help? Join the GRC Working Group!
The end