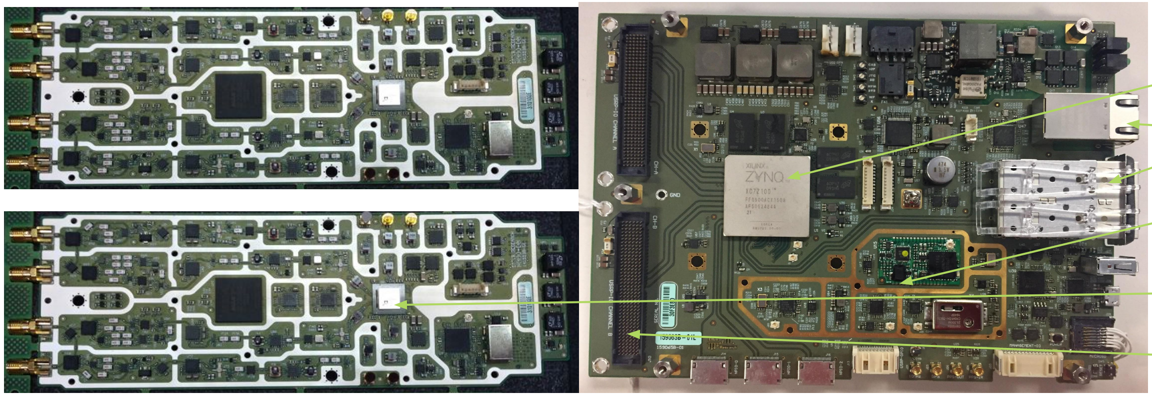
“You have turned on the future!” Updates from Ettus Research R&D

Martin Braun

Senior Git Wrangler, Ettus Research

GRCon ‘17

N310: Not just a respin



Zynq + Embedded Linux

Heterogenous Transports

Host-configured peripherals

RFIC comes with API

FPGA depends on RF HW

- A bit of E310, a bit of X310, and many other things
- It’s 2017, and we have many more requirements
  - Feedback from E310, X310, and RFNoC users went into the software + hardware design
- If you enjoy boredom, you’d hate working for Ettus

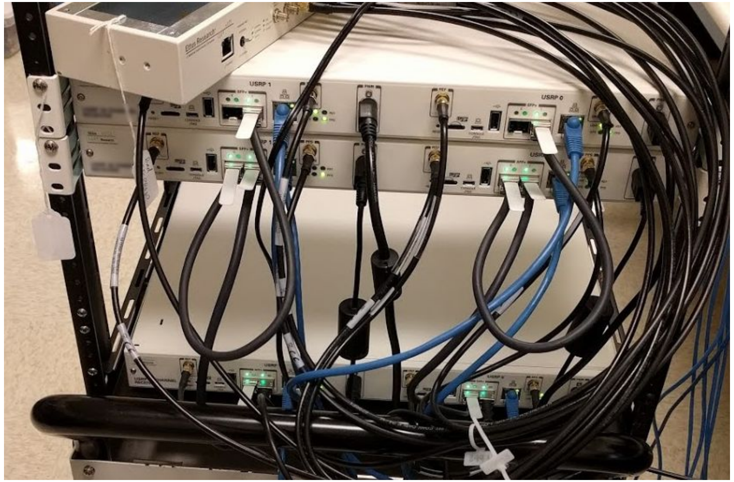
Moving to more systems: RASM

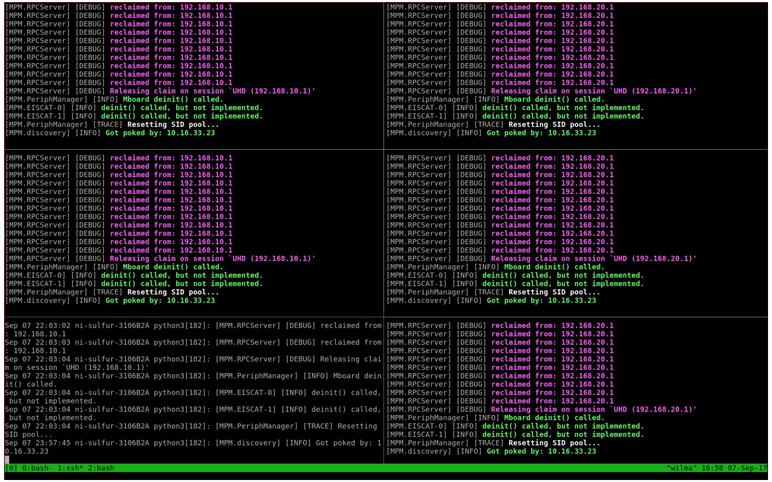
- Enter the marketing terminology
- Systems of many devices are worthless if there’s no good way to manage them
- Field upgrades, fan controls, remote diagnostics, remote self-tests, close-to-hardware APIs, monitoring, ...

Reliability
Availability
Serviceability
Manageability

Multi-Device Management

- RASM is not just a selling feature
- Debugging multi-usrp setups makes us creative…
- In the early stages, ghetto-RASM may be sufficient…
  - `$ cat iplist | xargs -L 1 -t -n 1 -Iusrpip -P 1 ssh root@usrpip ls`
  - `$ tmux setw synchronize-panes on`





```
[MPM.RPCServer] [DEBUG] reclaimed from: 192.168.10.1
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[MPM.PeriphManager] [TRACE] Resetting SID pool...
[MPM.discovery] [INFO] Got poked by: 10.16.33.23
```

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```
Sep 07 22:03:02 ni-sulfur-3106B2A python3[182]: [MPM.RPCServer] [DEBUG] reclaimed from
: 192.168.10.1
Sep 07 22:03:03 ni-sulfur-3106B2A python3[182]: [MPM.RPCServer] [DEBUG] reclaimed from
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Sep 07 22:03:04 ni-sulfur-3106B2A python3[182]: [MPM.EISCAT-1] [INFO] deinit() called,
 but not implemented.
Sep 07 22:03:04 ni-sulfur-3106B2A python3[182]: [MPM.PeriphManager] [TRACE] Resetting
SID pool...
Sep 07 23:57:45 ni-sulfur-3106B2A python3[182]: [MPM.discovery] [INFO] Got poked by: 1
0.16.33.23
```

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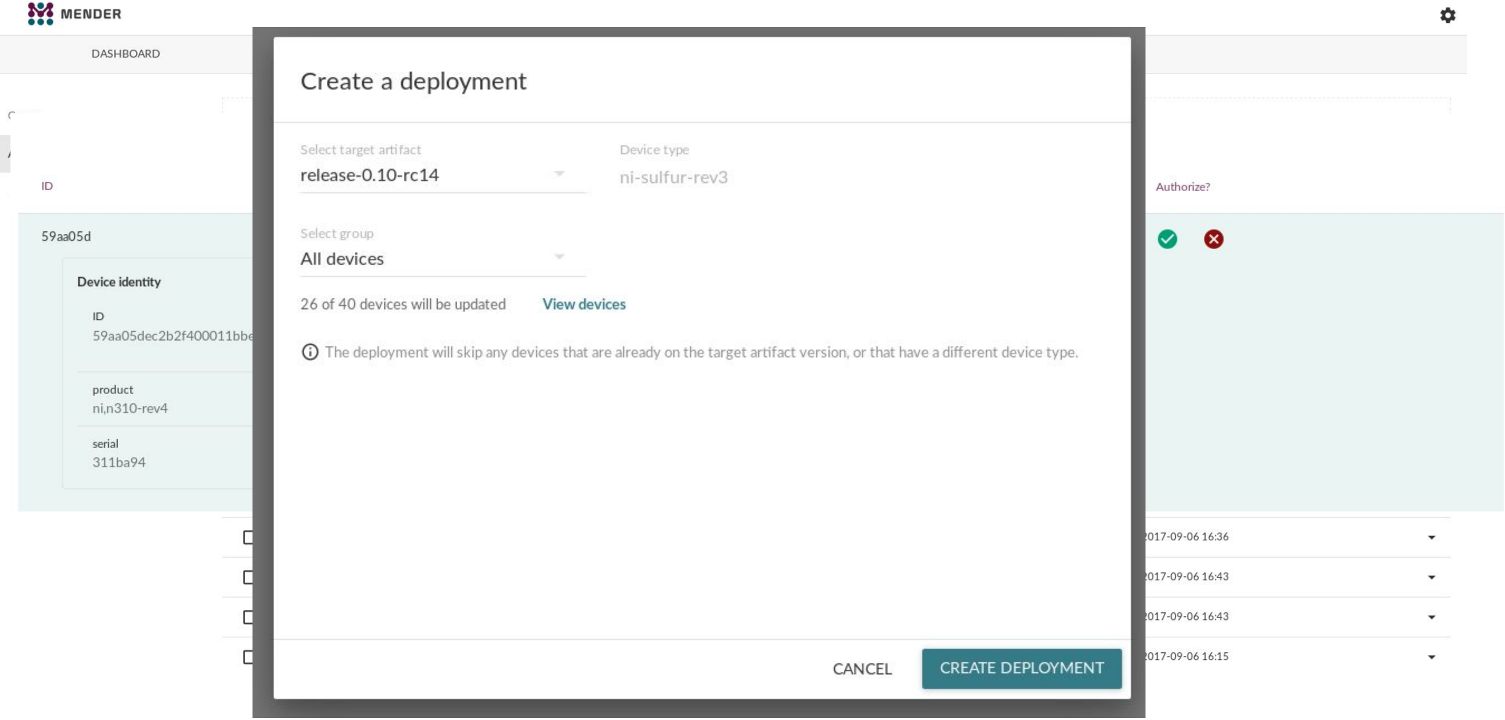
```

```
[0] 0:bash- 1:ssh* 2:bash                                        "wilma" 16:58 07-Sep-17
```

Remote Deployment: Mender.IO

- Solution to remote updates of many devices
  - Disclaimer: We will (try) not (to) force tools onto



59aa05d

Device identity

ID
59aa05dec2b2f400011bbe

product
ni,n310-rev4

serial
311ba94

□ 2017-09-06 16:36
□ 2017-09-06 16:43
□ 2017-09-06 16:43
□ 2017-09-06 16:15

Create a deployment

Select target artifact: release-0.10-rc14

Device type: ni-sulfur-rev3

Select group: All devices

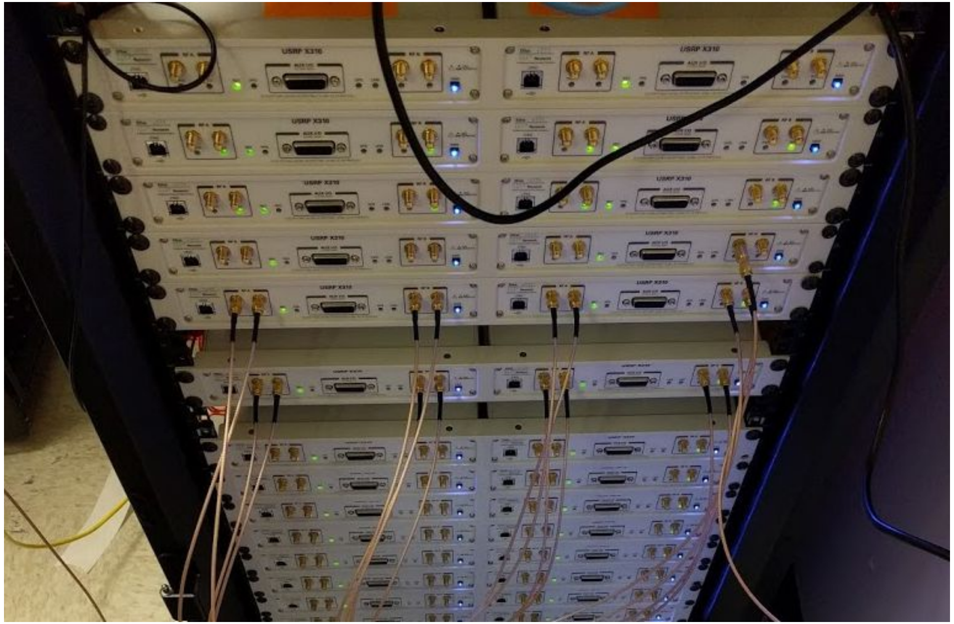
26 of 40 devices will be updated   View devices

ⓘ The deployment will skip any devices that are already on the target artifact version, or that have a different device type.

More devices? Smarter devices!

"The IQ of a mob is the IQ of its most stupid member divided by the number of mobsters." -- Sir Terry Pratchett

- More and more, clusters of many USRPs are becoming prevalent
- Classic separation of UHD + FPGA is no longer sufficient
- Let the embedded OS do some of the heavy lifting

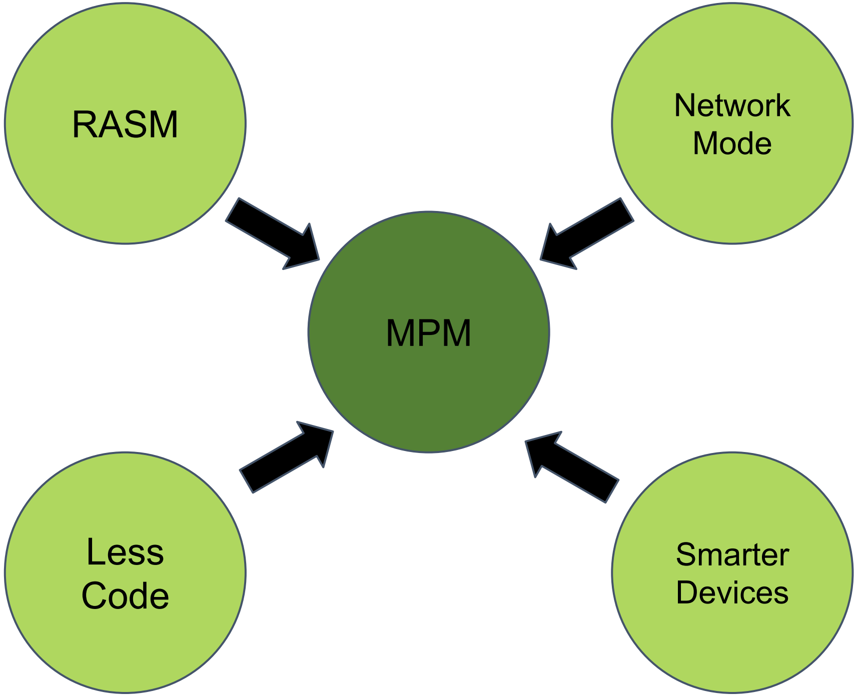


Network Mode

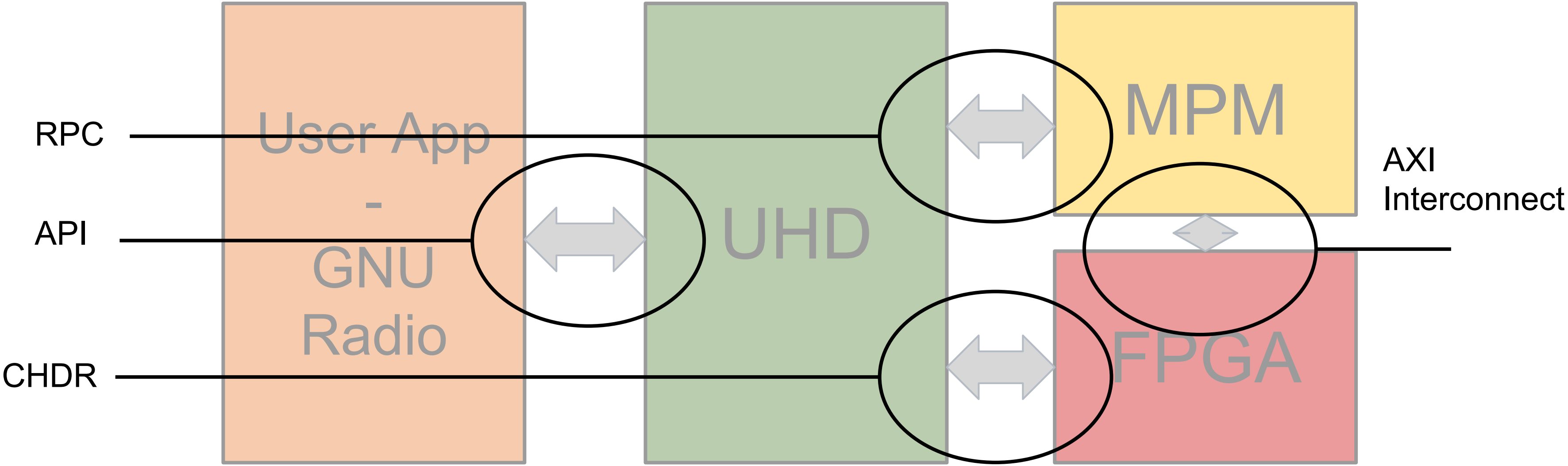
- Number two feedback for E310 was the lack of N200-like mode (“network mode”)
- But of course, running UHD embedded is also appealing
- ARM Cortex-A9 is not super fast, but SFP+ ports must not be slowed down
- ...and also, we don’t want two versions of UHD per device

MPM

- Boil it all down, and out comes…
- Module Peripheral Manager
- Software local to device
- Written in Python, C, and C++ (whichever version we prefer)



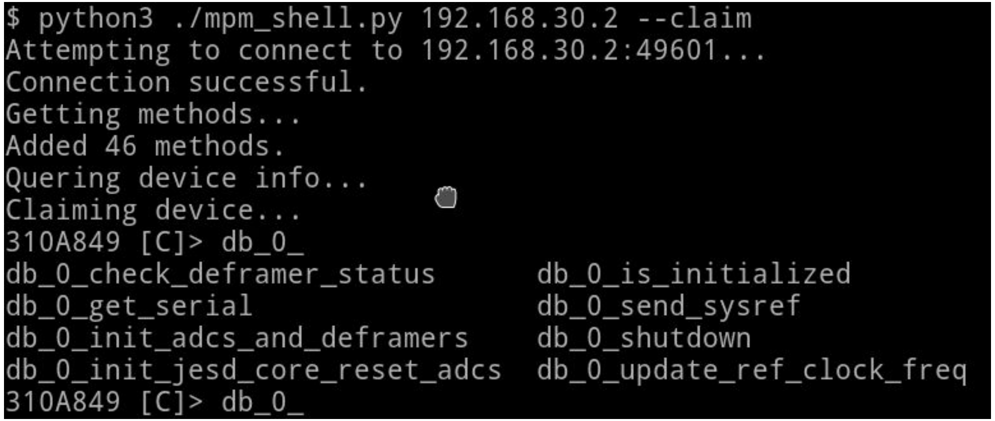
MPM


RPC
API
CHDR
User App
-
GNU
Radio
UHD
MPM
FPGA
AXI
Interconnect

USRP 2971

MPM

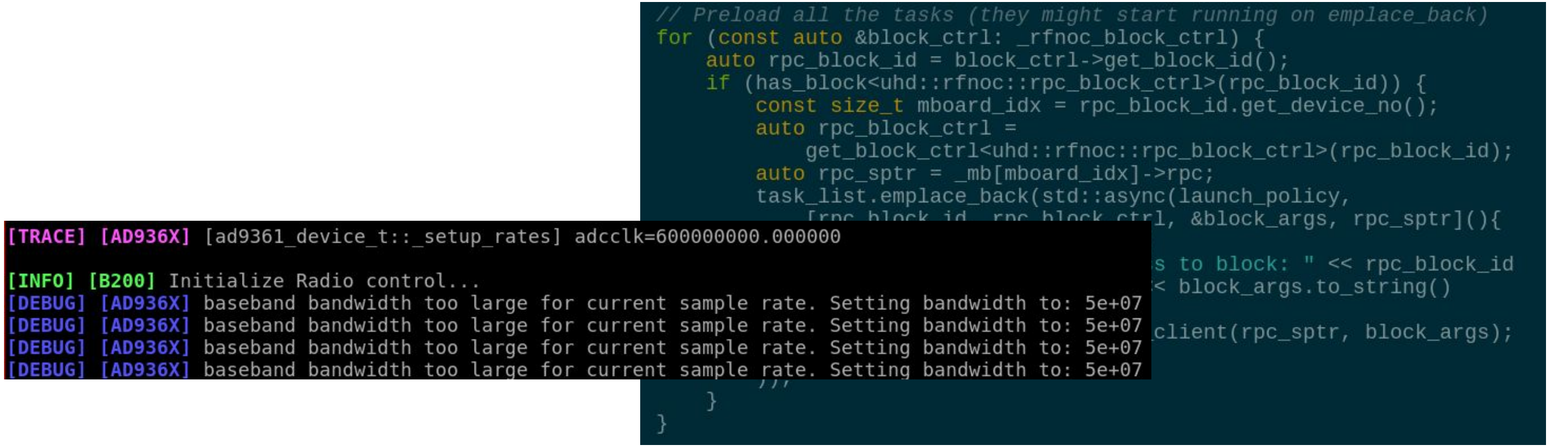
- Good for device, good for developers
- Move many problems outside of UHD (and confines thereof)
- We can use Python
- Command-line interface
- Better separation, less dependencies during development



```
$ python3 ./mpm_shell.py 192.168.30.2 --claim
Attempting to connect to 192.168.30.2:49601...
Connection successful.
Getting methods...
Added 46 methods.
Quering device info...
Claiming device...
310A849 [C]> db_0_
db_0_check_deframer_status      db_0_is_initialized
db_0_get_serial                 db_0_send_sysref
db_0_init_adcs_and_deframers    db_0_shutdown
db_0_init_jesd_core_reset_adcs  db_0_update_ref_clock_freq
310A849 [C]> db_0_
```

UHD Updates

- C++11 coming to UHD with next major release
- Logging API
- 3.11 release, to replace 3.10 release cycle, 1-2 months out
- 3.9 LTS branch will live on for a while



```
// Preload all the tasks (they might start running on emplace_back)
for (const auto &block_ctrl: _rfnoc_block_ctrl) {
    auto rpc_block_id = block_ctrl->get_block_id();
    if (has_block<uhd::rfnoc::rpc_block_ctrl>(rpc_block_id)) {
        const size_t mboard_idx = rpc_block_id.get_device_no();
        auto rpc_block_ctrl =
            get_block_ctrl<uhd::rfnoc::rpc_block_ctrl>(rpc_block_id);
        auto rpc_sptr = _mb[mboard_idx]->rpc;
        task_list.emplace_back(std::async(launch_policy,
            [rpc_block_id, rpc_block_ctrl, &block_args, rpc_sptr](){

                                        s to block: " << rpc_block_id
                                        < block_args.to_string()

                                        client(rpc_sptr, block_args);
        }));
    }
}
```

```
[TRACE] [AD936X] [ad9361_device_t::_setup_rates] adcclk=600000000.000000

[INFO] [B200] Initialize Radio control...
[DEBUG] [AD936X] baseband bandwidth too large for current sample rate. Setting bandwidth to: 5e+07
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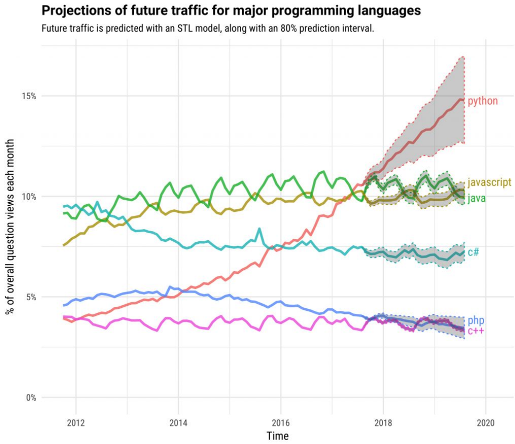
[DEBUG] [AD936X] baseband bandwidth too large for current sample rate. Setting bandwidth to: 5e+07
```

Ettus Research Python API

- No, there’s not just a Python API. There’s two Python APIs!
  - Ettus Research: Boost.Python based (Mirrors C++ API)
    - Hosted on Ettus github
  - NRL: ctypes-based, uses ffi (Mirrors C API)
    - https://github.com/pysdr/pysdruhd
- No SWIG was involved in either Python API



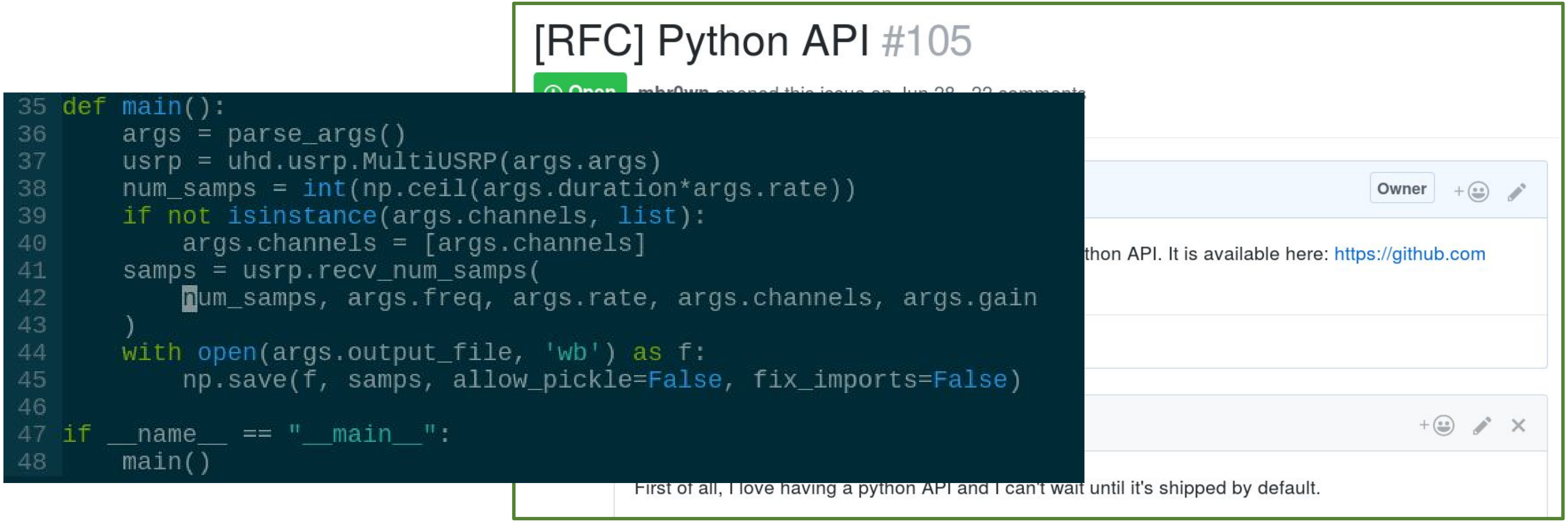
Projections of future traffic for major programming languages

Future traffic is predicted with an STL model, along with an 80% prediction interval.

Source: [Stack Overflow]

Ettus Python API

- Current state: Public feature branch github
  - `$ git checkout python-api`
  - We’re collecting feedback on our issue tracker



```python
def main():
    args = parse_args()
    usrp = uhd.usrp.MultiUSRP(args.args)
    num_samps = int(np.ceil(args.duration*args.rate))
    if not isinstance(args.channels, list):
        args.channels = [args.channels]
    samps = usrp.recv_num_samps(
        num_samps, args.freq, args.rate, args.channels, args.gain
    )
    with open(args.output_file, 'wb') as f:
        np.save(f, samps, allow_pickle=False, fix_imports=False)

if __name__ == "__main__":
    main()
```

[RFC] Python API #105

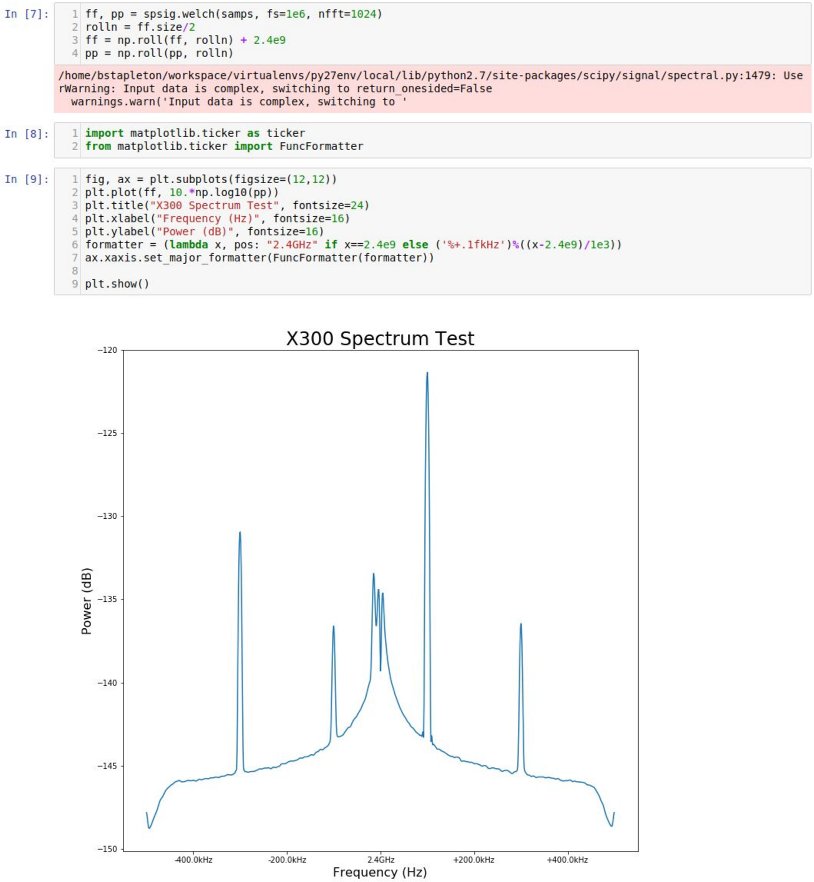
Open mbr0wn opened this issue on Jun 28 · 22 comments

thon API. It is available here: https://github.com

First of all, I love having a python API and I can't wait until it's shipped by default.

Python API + Jupyter

- Run your signal analysis directly inside your notebook!
- Convenience methods make it easy to pull samples in and out of USRPs from Jupyter
- Complements on-line, real-time processing in GNU Radio
- Will make you look so awesome in the classroom!



In [7]:

```
ff, pp = spsig.welch(samps, fs=1e6, nfft=1024)
rolln = ff.size/2
ff = np.roll(ff, rolln) + 2.4e9
pp = np.roll(pp, rolln)
```

```
/home/bstapleton/workspace/virtualenvs/py27env/local/lib/python2.7/site-packages/scipy/signal/spectral.py:1479: Use
rWarning: Input data is complex, switching to return_onesided=False
  warnings.warn('Input data is complex, switching to '
```

In [8]:

```
import matplotlib.ticker as ticker
from matplotlib.ticker import FuncFormatter
```

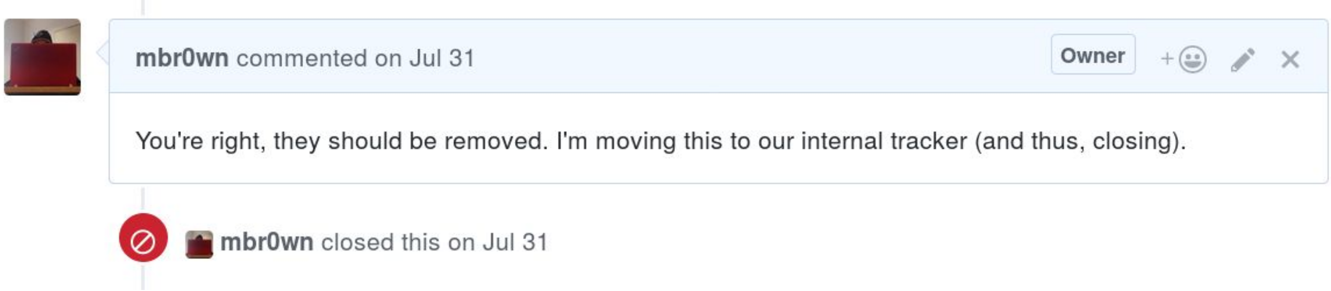
In [9]:

```
fig, ax = plt.subplots(figsize=(12,12))
plt.plot(ff, 10.*np.log10(pp))
plt.title("X300 Spectrum Test", fontsize=24)
plt.xlabel("Frequency (Hz)", fontsize=16)
plt.ylabel("Power (dB)", fontsize=16)
formatter = (lambda x, pos: "2.4GHz" if x==2.4e9 else ('%+.1fkHz')%((x-2.4e9)/1e3))
ax.xaxis.set_major_formatter(FuncFormatter(formatter))

plt.show()
```

What happened to my issue?

- Ever posted a bug on our public github issue tracker?
- You might get something like this:



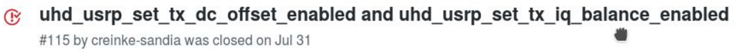
mbr0wn commented on Jul 31

You're right, they should be removed. I'm moving this to our internal tracker (and thus, closing).

mbr0wn closed this on Jul 31

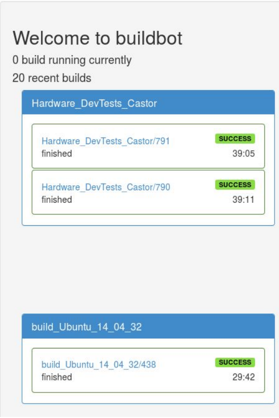
- So… what happens now?

A bug's life



uhd_usrp_set_tx_dc_offset_enabled and uhd_usrp_set_tx_iq_balance_enabled

#115 by creinke-sandia was closed on Jul 31



Welcome to buildbot

0 build running currently

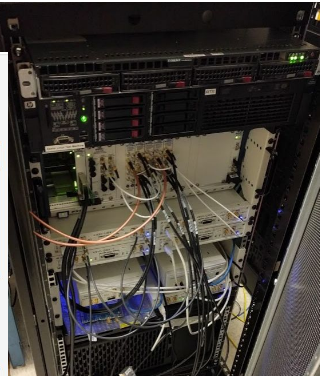
20 recent builds

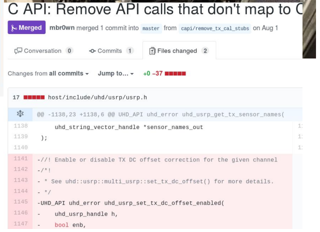
Hardware_DevTests_Castor

Hardware_DevTests_Castor/791 finished	SUCCESS 39:05
Hardware_DevTests_Castor/790 finished	SUCCESS 39:11

build_Ubuntu_14_04_32

build_Ubuntu_14_04_32/438 finished	SUCCESS 29:42





C API: Remove API calls that don't map to C

Merged mbr0wn merged 1 commit into master from capi/remove_tx_cal_stubs on Aug 1

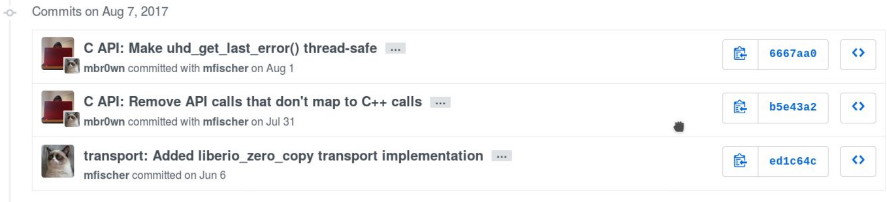
+0 −37

17 host/include/uhd/usrp/usrp.h

```
@@ -1138,23 +1138,6 @@ UHD_API uhd_error uhd_usrp_get_tx_sensor_names(
     uhd_string_vector_handle *sensor_names_out
 );

-//! Enable or disable TX DC offset correction for the given channel
-/*!
- * See uhd::usrp::multi_usrp::set_tx_dc_offset() for more details.
- */
-UHD_API uhd_error uhd_usrp_set_tx_dc_offset_enabled(
-    uhd_usrp_handle h,
-    bool enb,
```

Intermediate public feature branch



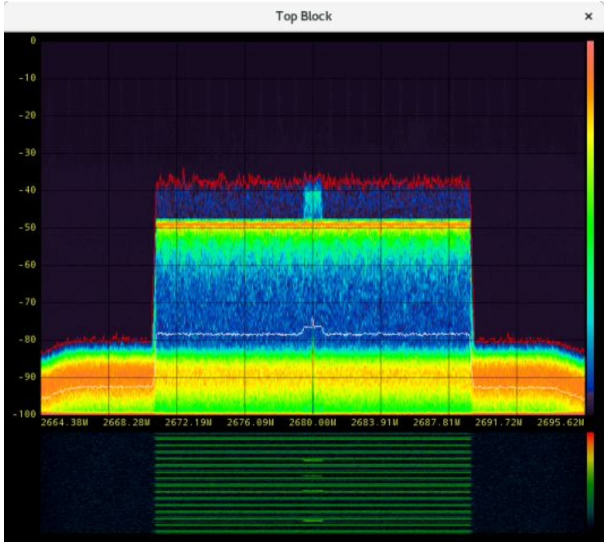
Commits on Aug 7, 2017

C API: Make uhd_get_last_error() thread-safe ... mbr0wn committed with mfischer on Aug 1	6667aa0
C API: Remove API calls that don't map to C++ calls ... mbr0wn committed with mfischer on Jul 31	b5e43a2
transport: Added liberio_zero_copy transport implementation ... mfischer committed on Jun 6	ed1c64c

- Continuous Integration
- Code Reviews
- Internal Tests

Final Word of Advice

- If you want to develop radio hardware…
- ...use GNU Radio. You won’t regret it.
- Great visuals
- Plenty of DSP blocks
- Easy to modify



Phased Aligned for 15 years

Thank you all!

- ...for being here this week
- ...for contributing to GNU Radio
- ...for asking great questions!