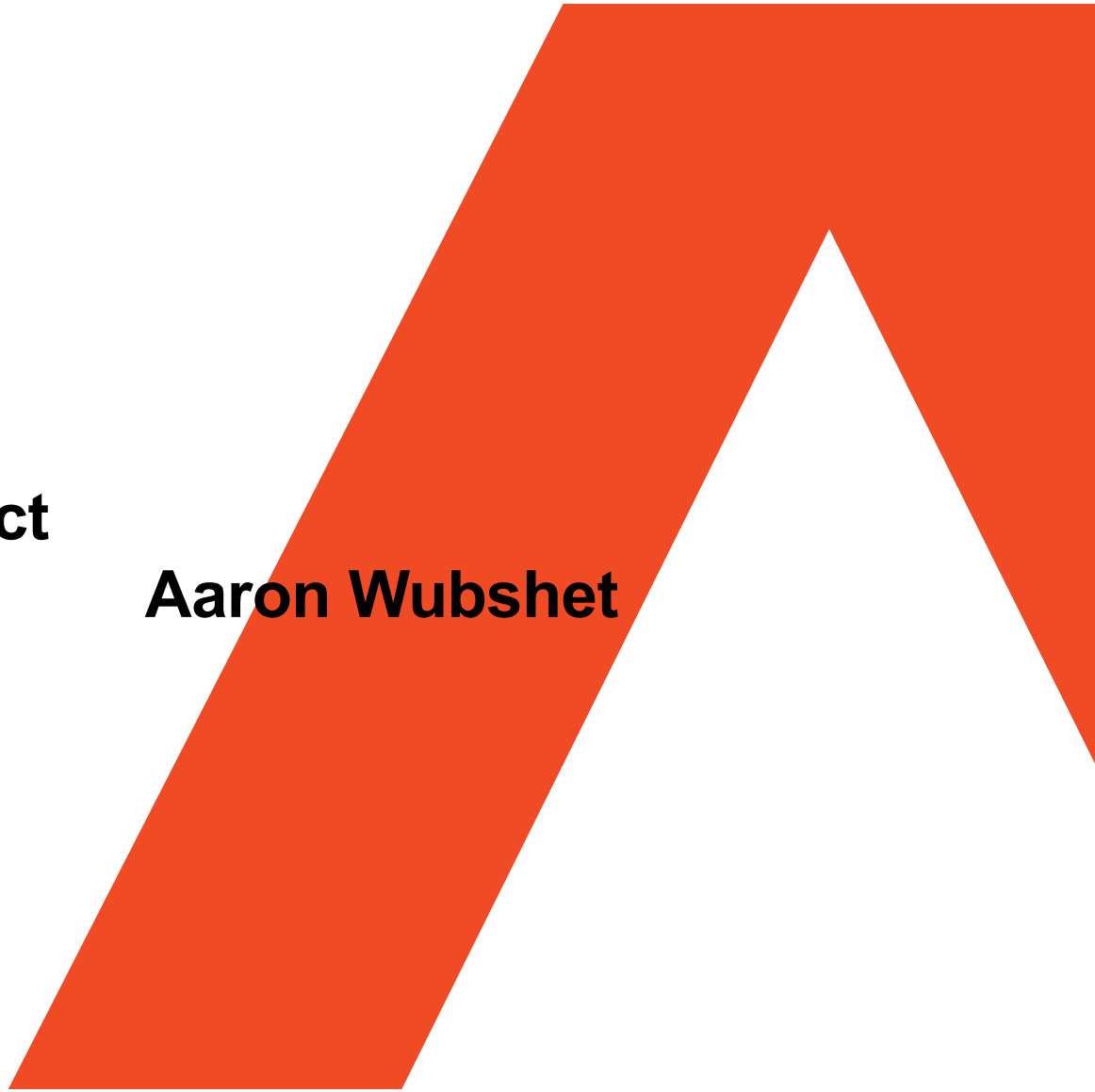


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**USRP Testbed  
Plant A SEED Project**

**Aaron Wubshet**



# Agenda

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- ▶ Project Overview
- ▶ Materials
- ▶ Results & Demo
- ▶ Lessons Learned
- ▶ Summary

# Project Overview

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- ▶ Software Defined Radio (SDR)
  - ▶ Minimize dedicated hardware to make upgrading a matter of pushing a firmware update to the system
  - ▶ USRP (an example of SDR)
- ▶ Exploration and Synthesis
  - ▶ Explored applications of such systems (cellular networks, GNSS, WiFi, etc)
- ▶ Series of miniprojects to get accustomed with GNU radio and working with USRP(explore DSP properties)
- ▶ Week 1: Downloading software/familiarizing myself with Linux
- ▶ Week 2: Downloading drivers and networking hardware correctly
- ▶ Week 3: implementing GNU radio flow graphs/downloading GSM base station software
- ▶ Week 4: implementing GSM base station using OpenBTS

# Materials

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## Hardware

- ▶ Ettus Research USRP2
- ▶ Dell Inspiron i7
- ▶ USB-to-Ethernet dongle
- ▶ Cellphones

## Software

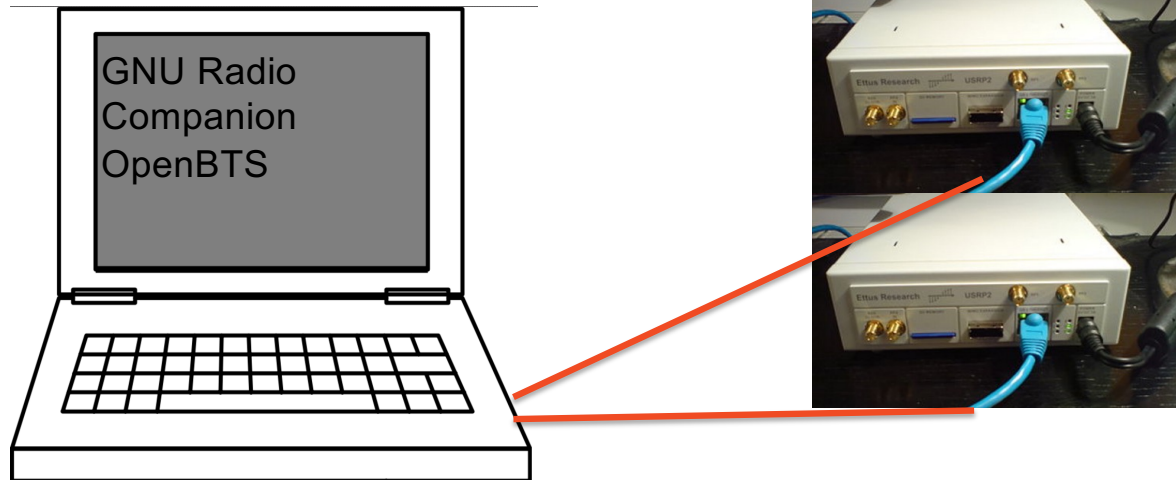
- ▶ GNU Radio
- ▶ ImageMagick
- ▶ UHD
- ▶ OpenBTS
- ▶ Ubuntu 14.04

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# Dual USRP Setup

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# Results and Demos

# Simple GRC Implementations

## GRC GUI

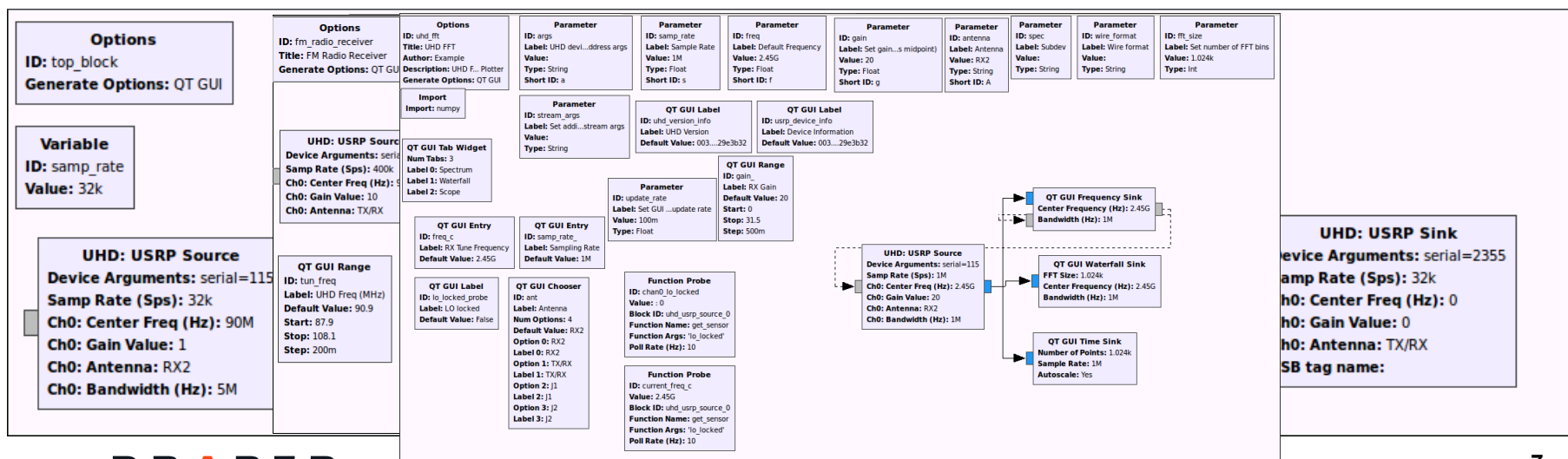
- Spectrum analyzer
- Dynamic control after flow graph is executed

## FM Radio Receiver

- Tunable wideband FM receiver
- Filtering and gain functionality

## Proof of Concept Transceiver Set up

- USRPS on different networks
- One transmitting, one receiving



# Advanced GRC Implementation

- ▶ National Oceanic and Atmospheric Administration automatic picture transmission (NOAA APT)
- ▶ Operation frequency: 137Mhz
- ▶ Circular polarized antenna needed
- ▶ Pixel intensity modulates a 2.4KHz tone
- ▶ Amplitude detector: 2.4 kHz audio tone to pixel intensity on an 8 bit gray scale

Satellite pixel intensity

AM modulate, 2.4 kHz tone, subcarrier

FM modulate the 137 MHz carrier

FM receiver

Amplitude  
detector

Processing to make there be 4 samples per period



# OpenBTS: Cellular Base Station Implementation

- ▶ OpenBTS
  - ▶ Software-based GSM base station
- ▶ Required services
  - ▶ Smqueue
    - ▶ Queueing calls and texts
  - ▶ SIPAuthServe
    - ▶ Database registration of phone numbers
  - ▶ Asterisk
    - ▶ Call and text routing

```
Starting the system...
ALERT 10753:10760 2017-01-30T16:39:01.3 OpenBTS.cpp:174:startTransceiver: startt
ng transceiver ./transceiver with 1 ARFCNs
linux; GNU C++ version 4.8.4; Boost_105400; UHD_003.010.001.HEAD-0-g929e3b32

Using internal frequency reference
-- Opening a USRP2/N-Series device...
-- Current rcv frame size: 1472 bytes
-- Current send frame size: 1472 bytes
Processing signal vector for sig 28
Done processing signal vector for sig 28
Rethrowing signal 28
1485812343.900646 3072349952:
system ready

1485812343.900662 3072349952:
use the OpenBTSCLI utility to access CLI

1485812343.919888 3072349952: OpenBTSCLI network socket support for tcp:49300

OpenBTS>

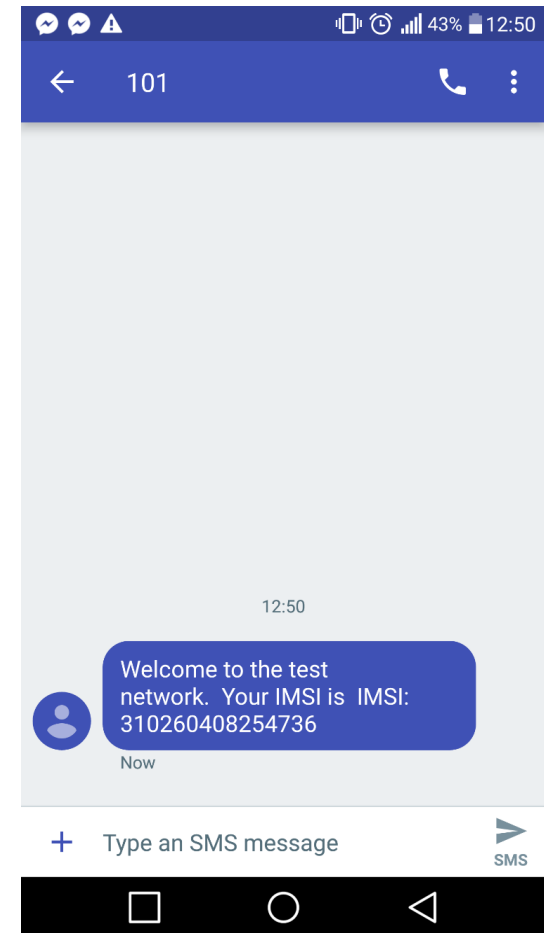
aarondraper@aarondraper-Inspiron-5759: ~/Desktop
lipchange.sh~      startusrpandopenbts.sh  ubuntu-14.04.1-desktop-i386.iso
MyScreenshot.png~  startusrpandopenbts.sh~  uhd_fft115.grc
ssoa.sh            test.grc                      uhd_fft.py
aarondraper@aarondraper-Inspiron-5759:~/Desktop$ sh ssoa.sh
[sudo] password for aarondraper:
ALERT 10943:10943 2017-01-30T16:40:23.9 sipauthserve.cpp:328:main: ./sipauthserv
e (re)starting
ALERT 10943:10943 2017-01-30T16:40:23.9 sipauthserve.cpp:353:main: can't bind so
cket on port 5064
ALERT 10952:10952 2017-01-30T16:40:24.1 smqueue.cpp:2798:main: smqueue (re)start
ing
smqueue logs to syslogd facility LOCAL7, so there's not much to see here
smqueue: poll.c:282: poll: Assertion 'pArray != (struct pollfd *) ((void *)0)' f
ailed.
asterisk start/running, process 10967
aarondraper@aarondraper-Inspiron-5759:~/Desktop$ sh ssoa.sh
ALERT 11001:11001 2017-01-30T16:40:42.0 sipauthserve.cpp:328:main: ./sipauthserve (re)starting
ALERT 11001:11001 2017-01-30T16:40:42.1 sipauthserve.cpp:353:main: can't bind socket on port 5064
Assertion failed: term_acks > 0 (own.cpp:171)
ALERT 11011:11011 2017-01-30T16:40:42.3 smqueue.cpp:2798:main: smqueue (re)starting
smqueue logs to syslogd facility LOCAL7, so there's not much to see here
smqueue: poll.c:282: poll: Assertion 'pArray != (struct pollfd *) ((void *)0)' failed.
start: Job is already running: asterisk
aarondraper@aarondraper-Inspiron-5759:~/Desktop$
```

# OpenBTS: Results

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Text you receive when you successfully register on the network

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# Issues & Lessons Learned

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- ▶ Linux & Terminal
  - ▶ Bash Files
  - ▶ Dependencies
- ▶ Network Configuration
  - ▶ Stability
- ▶ Broken USRP
  - ▶ Hardware Limitations
- ▶ Antenna Quality
- ▶ Interference

# Summary: Plant a SEED Program

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- ▶ 80 hours over 1 month
- ▶ Software Defined Radio
  - ▶ What
  - ▶ Why
  - ▶ How
- ▶ Next Steps
  - ▶ Multiple USRPs
  - ▶ LTE Implementation