Micro Cognitive Radio Network Testbed (MICRONET) for education, experimentation, and demonstration

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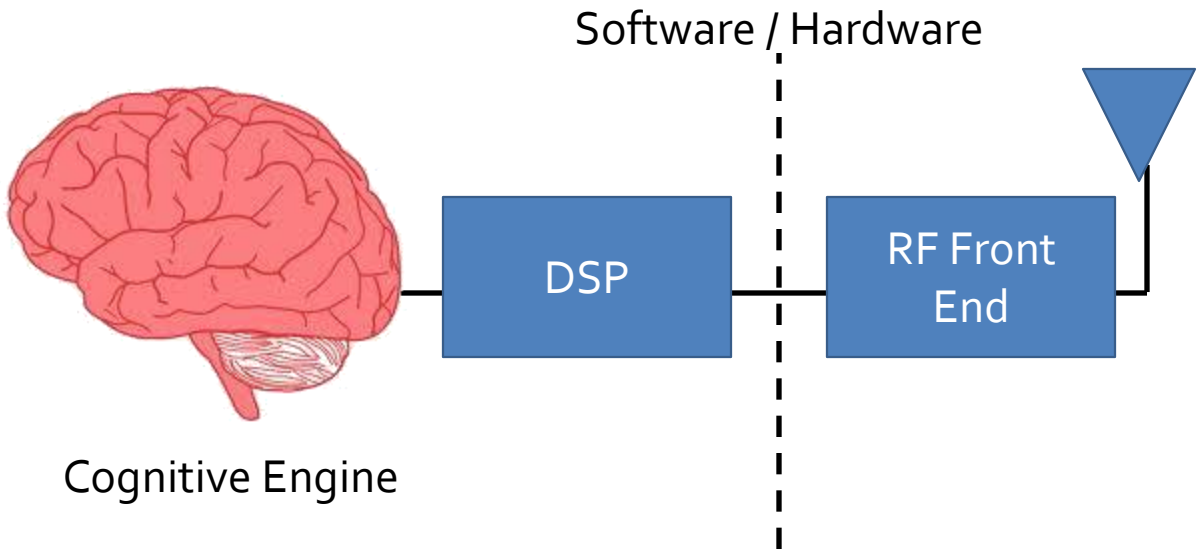
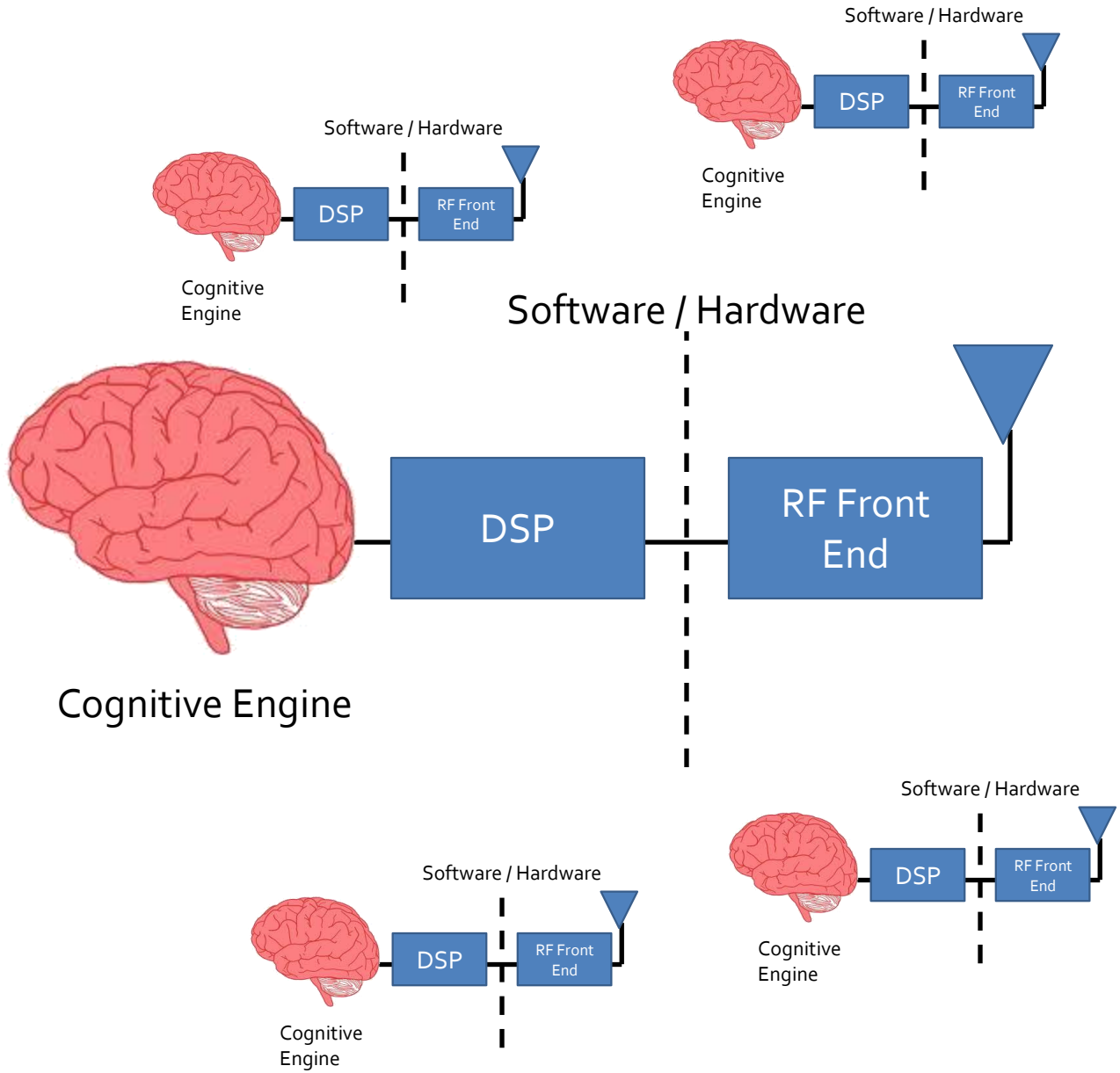
Outline

- Background and Motivation
- Implementation
- Initial experimentation
- Limitations
- Additional plans
- Conclusion

Cognitive Radio: Concept



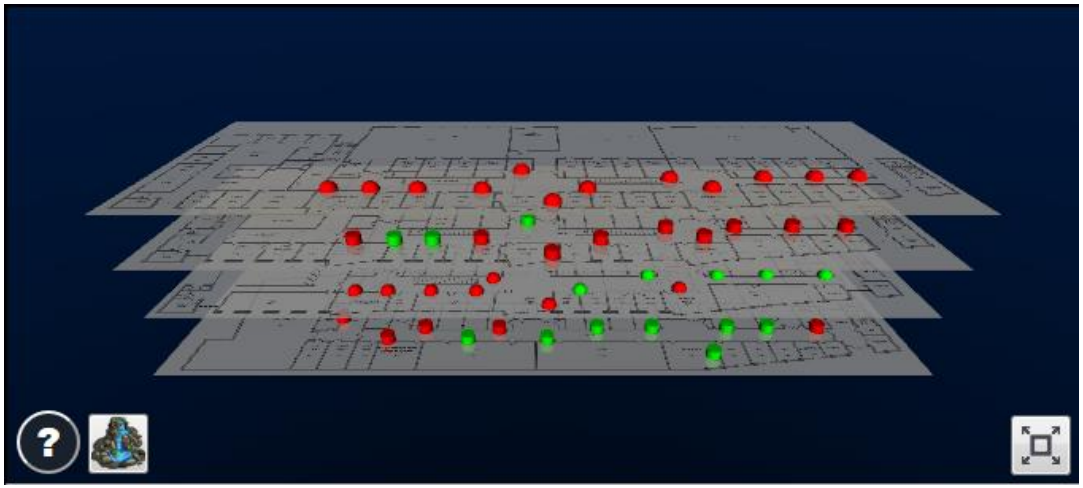
Cognitive Radio: Testbed



Existing Cognitive Radio Testbeds

Prominent Testbeds

- WINLAB *ORBIT* testbed – Rutgers University
- University of California, Riverside
- *Emulab* research facility – University of Utah
- CORNET – Virginia Tech



Cognitive Radio Network Testbed (CORNET) located at Virginia Tech

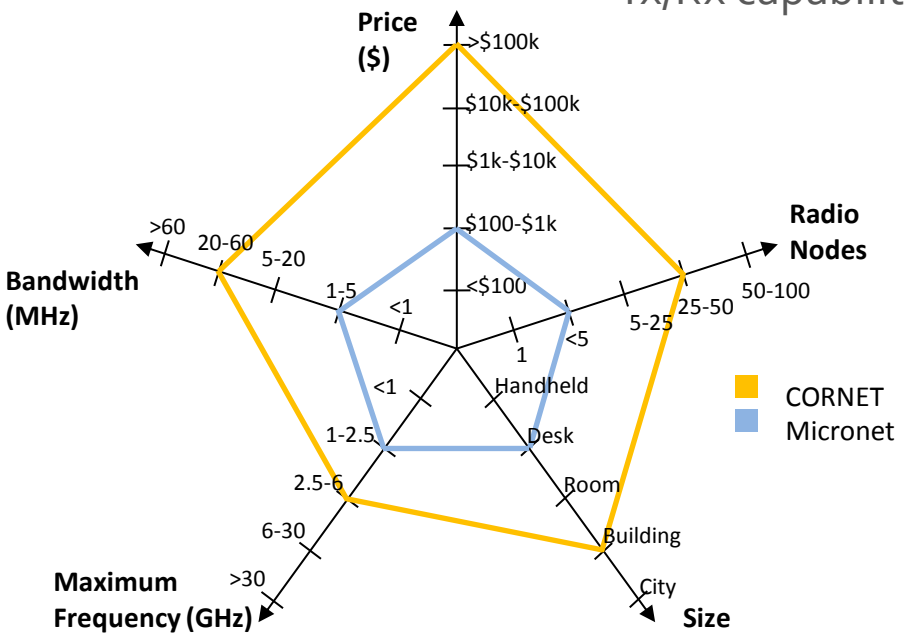
Micronet: Motivation

Applications

- Education
- Demonstration and Experimentation

Testbed Design Goals

- Inexpensive
- User friendly
- Portable
- Multiple node support
- Tx/Rx capabilities



Micronet: Hardware Selection

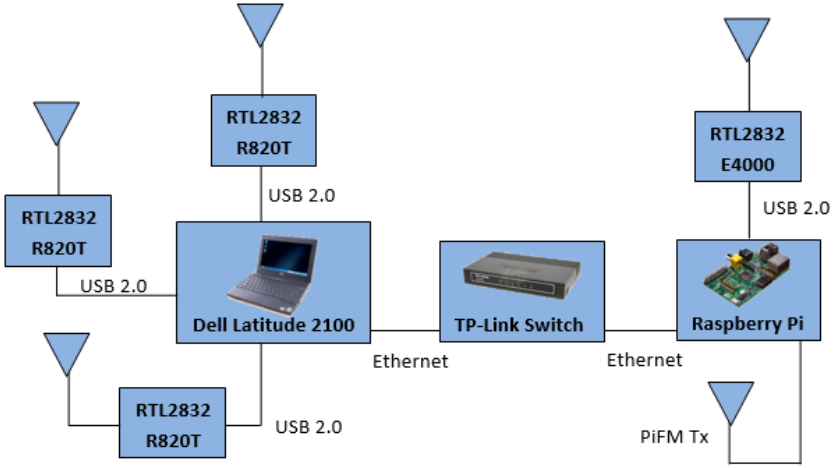
Processor(s)

- Single PC
- Dedicated servers
  - Multiple PC's
  - Raspberry Pi
  - Beaglebone Black

RF Front Ends

- Transceiver
  - USRP
  - BladeRF
  - HackRF
- Receive Only
  - RTLSDR
- Transmit Only
  - FM transmitter
  - Raspberry Pi – PiFM
    (Imperial College Robotics Society)

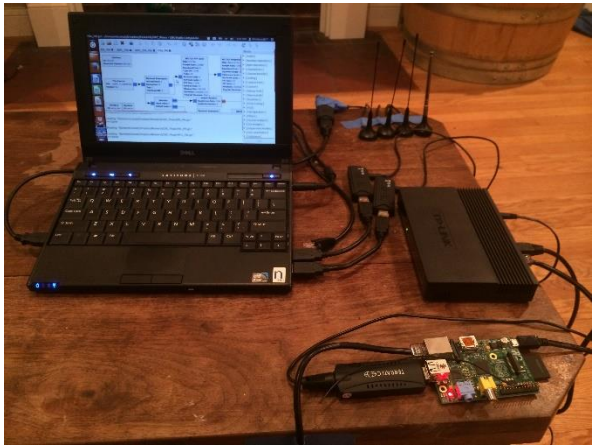
Micronet: Hardware



Block Diagram

Item	Qty	Supplier
Dell Latitude 2100	1	Ebay (used)
Raspberry Pi	1	Newark
RTL2832 R820T	3	Ebay
RTL2832 E4000	1	Ebay
8 Gb SD Card	1	Best Buy
10' USB Extension	3	Sweetwater
Micro USB power cable	1	MCM Electronics
Ethernet cable	2	Rakuten.com
TP-Link Ethernet Switch	1	Newegg

Bill of Materials



Photo

Micronet: Transmit Capabilities

PiFM

- C++ code
- Tx frequency range: 1 - 250 MHz
- Approximate Tx distance: 100 m
- Reads .wav files

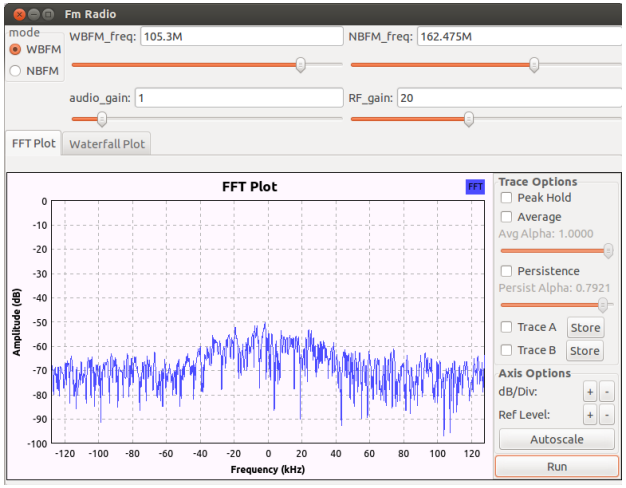
Added functionality

- FSK/OOK modulation

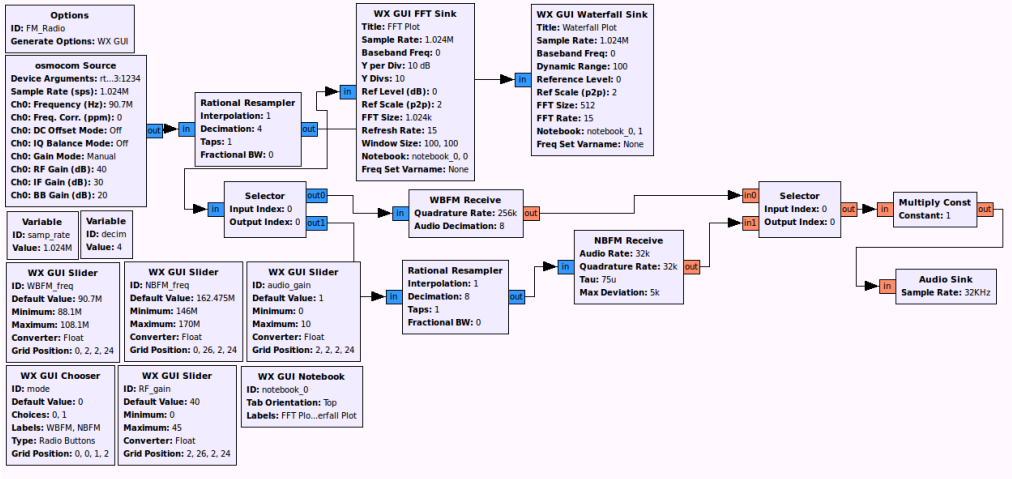
Micronet: Software

Installed Packages:

- GNU Radio
- liquid-dsp
- Pyrtlsdr
- RTLSDR Scanner
- kalibrate-rtl
- XRDP



GNU Radio : FFT plot

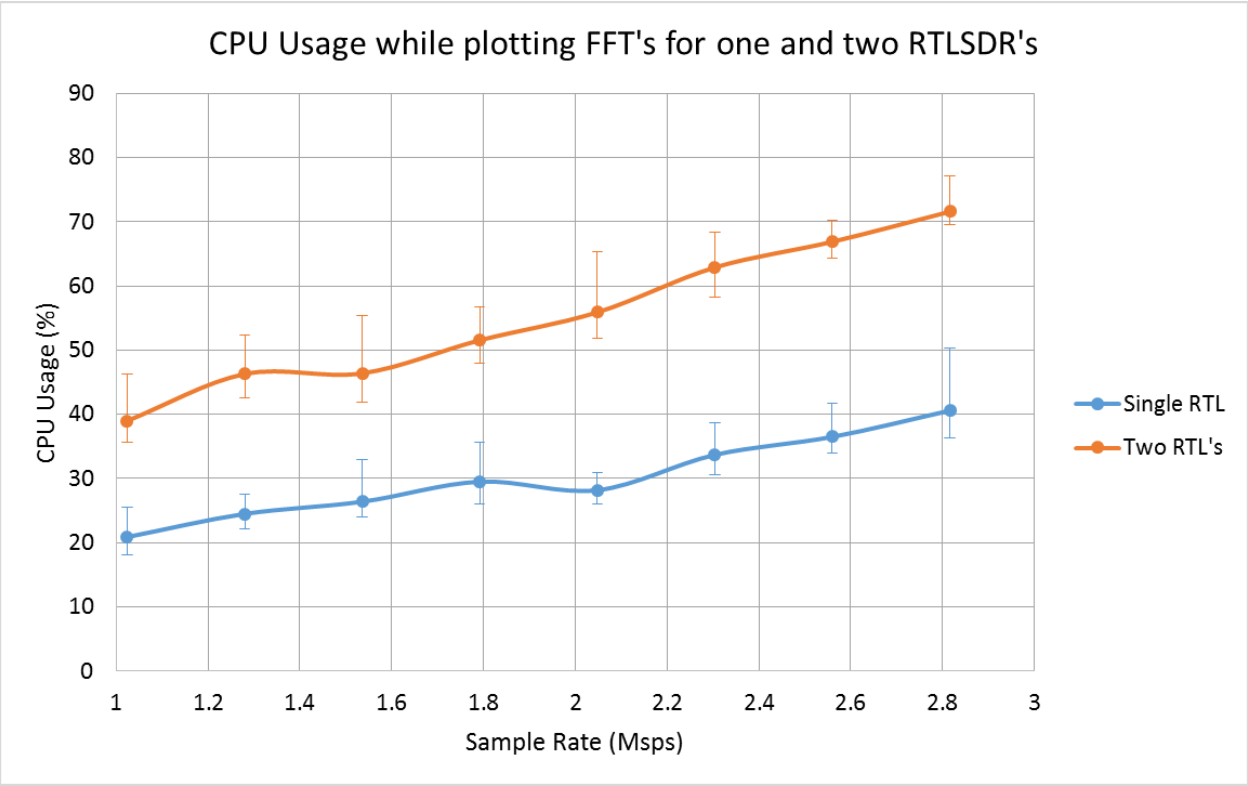


GNU Radio Companion: FM Receiver Flowgraph

Micronet: Sample Experiments

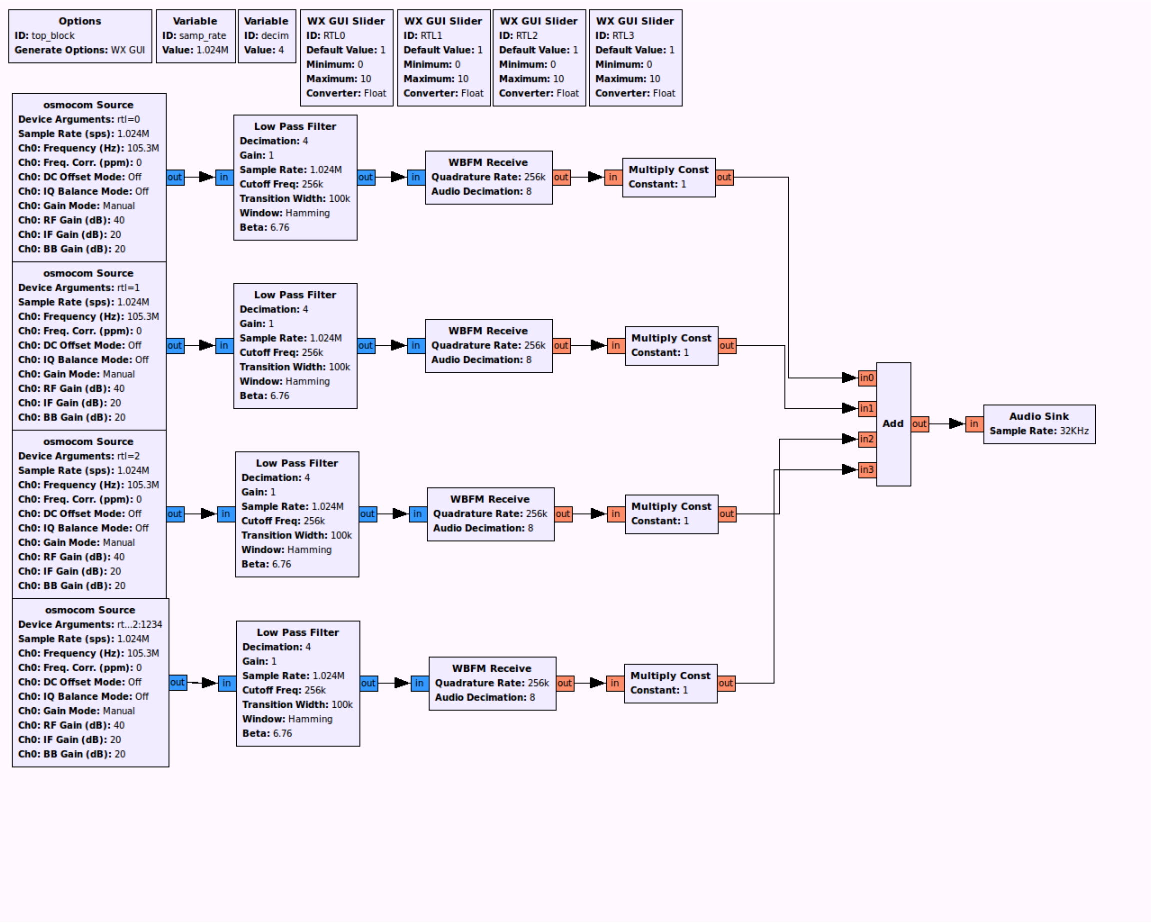
- FFT visualization
- FM demodulation/mixer
- Raw sample file writes
- Spectrum sensing
- Antenna diversity
- FSK/OOK
- Basic DSA

Micronet: FFT Visualization

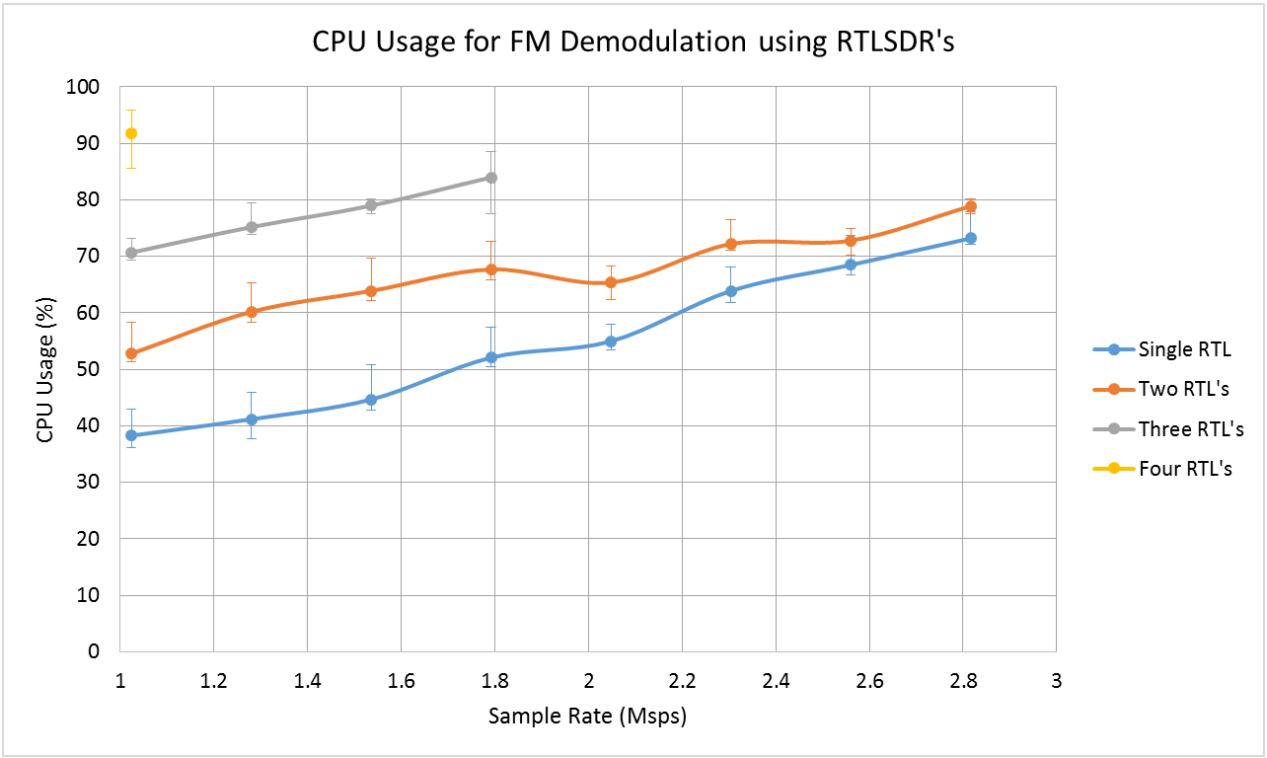


Refresh rate of 1 Hz, FFT length of 1024

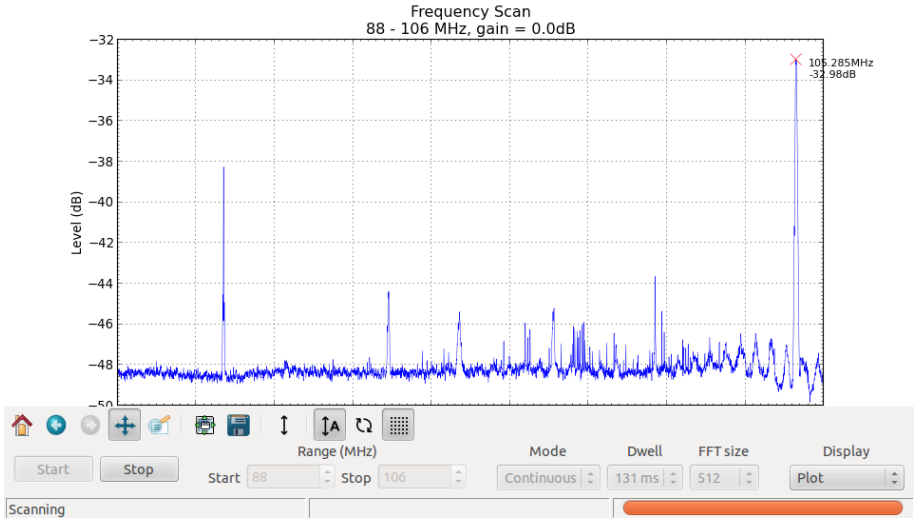
Micronet: FM Mixer



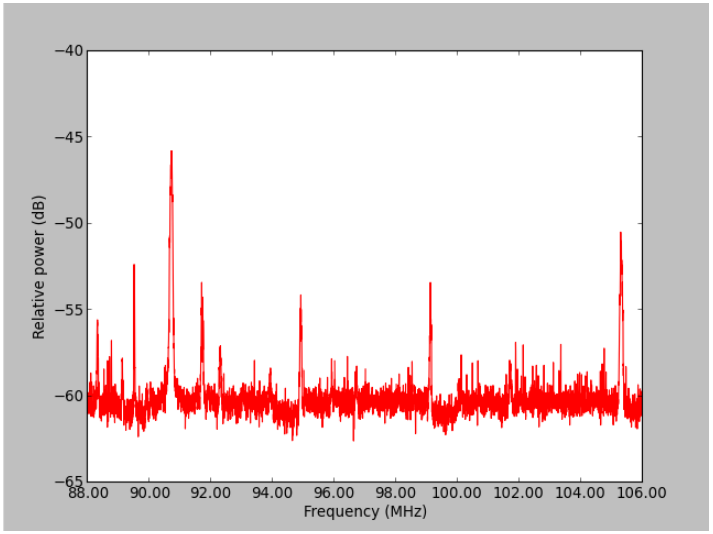
Micronet: FM Mixer



Micronet: Spectrum Sensing

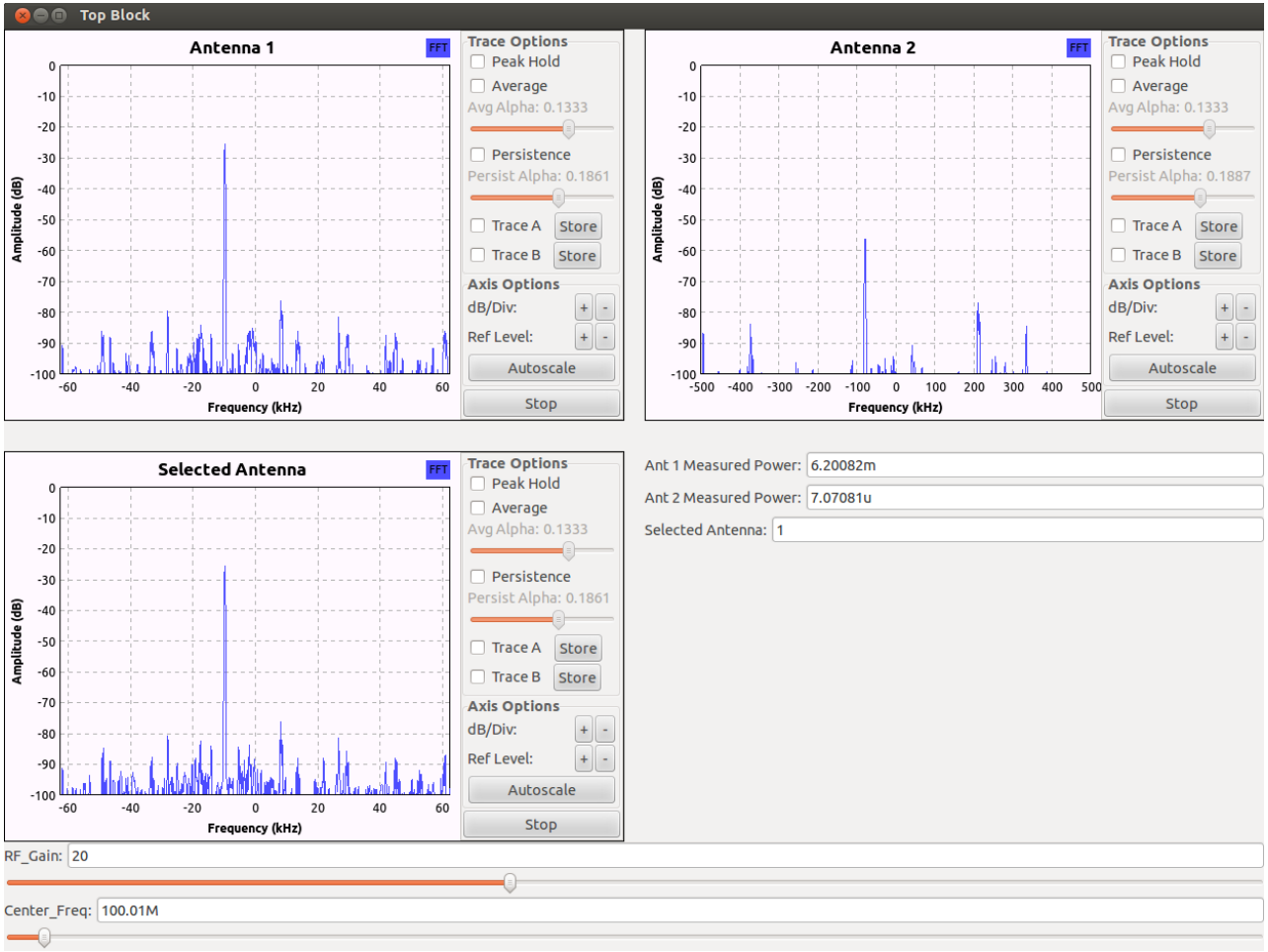


RTLSDR Scanner

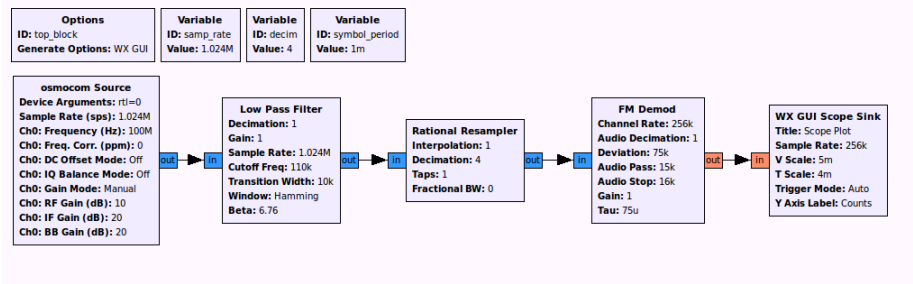


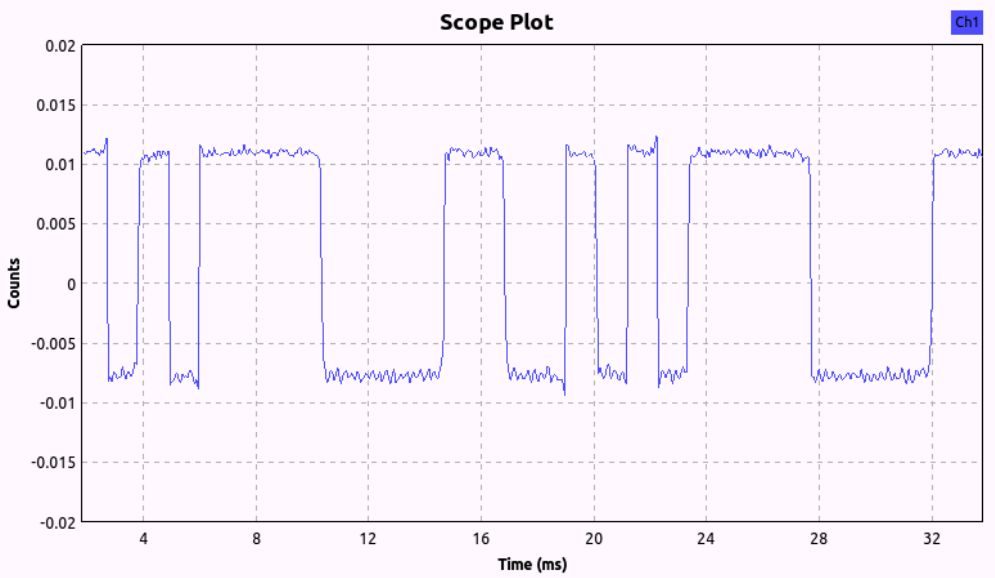
RTLSDR Spectrum Sense

Micronet: Antenna Selection Diversity



Micronet: FSK Tx/Rx





Micronet: Basic DSA

Procedure

- Scan allowable transmit frequency range
- Determine optimal transmit channel based on channel power and adjacent channel powers
- Transmit a single burst
- Recheck vacancy of channel

Micronet: Additional Plans

Experiments

- SDR position estimation
- Antenna diversity
- Phased antenna arrays
- Basic DSA algorithms
- CR coexistence with CORNET

Development

- Raspberry Pi Transmission
  - Integration with SDR tools
  - Optimization/Measurement of performance (BER)
  - Demo's/applications
  - Hardware augmentation

Conclusion

What has been achieved/demonstrated

- Creation of a CR testbed that is:
  - Low cost
  - Flexible/portable
  - Supports multiple radio nodes
  - Has the potential for many diverse experiments
- Identified limitations
  - Processing power
  - Bandwidth
  - Tx capabilities
    - Limited modulation schemes
    - Lack of power control
    - Spurious signal
- Resource compilation

  https://github.com/ericps1/Micronet