

Distributed Spectrum Monitoring and Channel Sounding

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Introduction

- The rapid development of wireless communication technologies has increased the need to use the radio frequency spectrum in an efficient way
- The goal of our project is to use SDR to observe the transmission process and collect the transmitted data and use ML to improve the efficiency of transmission

Objectives

- Spectrum Monitoring:** Basically, means monitoring frequencies as it provides the information needed to optimize spectrum for maximum utilization
- Channel Sounding:** Channel sounding is a technique that enhances the radio environment for wireless communication
- Use ML to for channel characterization

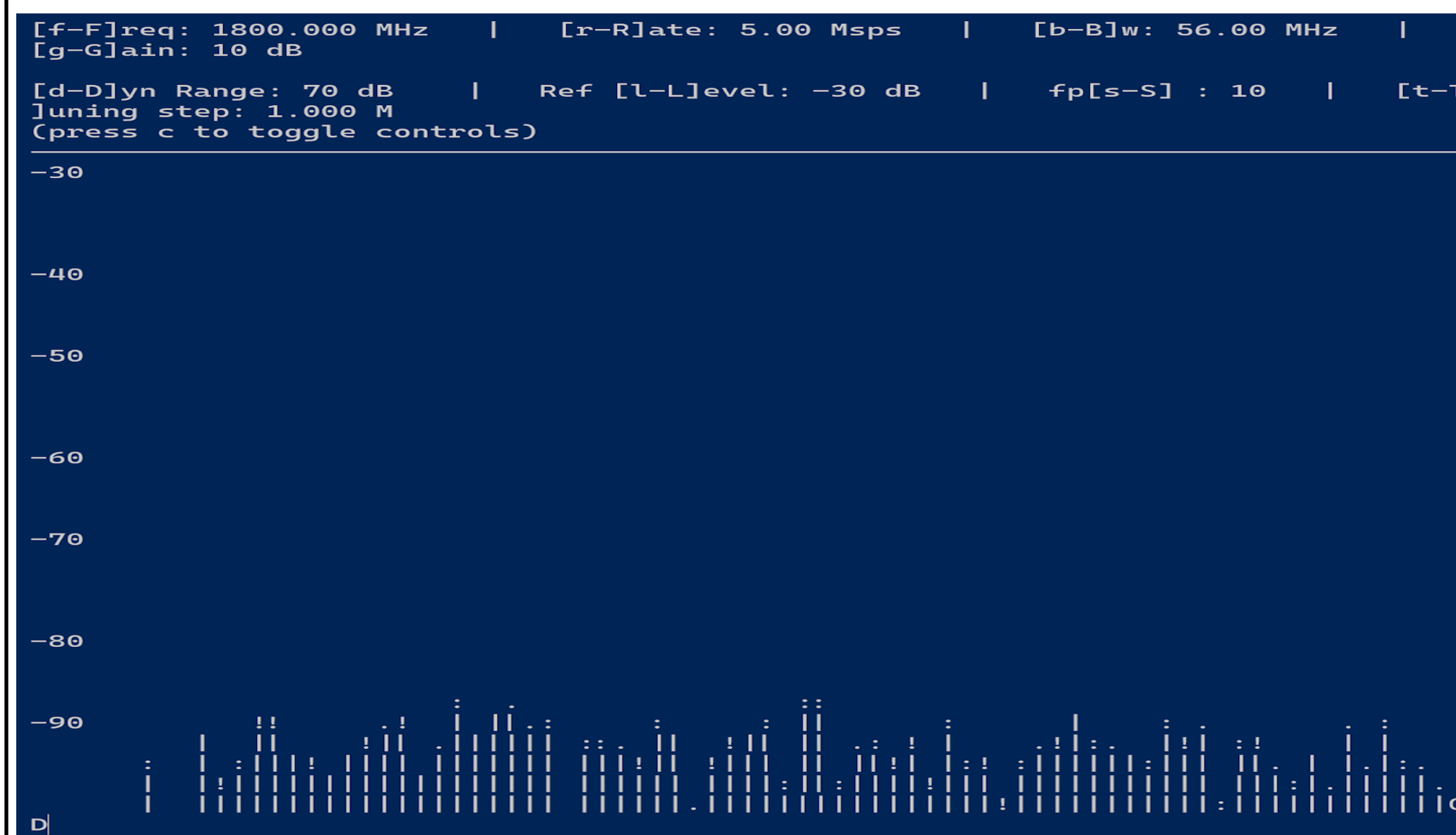
Devices utilized

- Sandboxes in Orbit facilities
- USRP2
- USRPX310

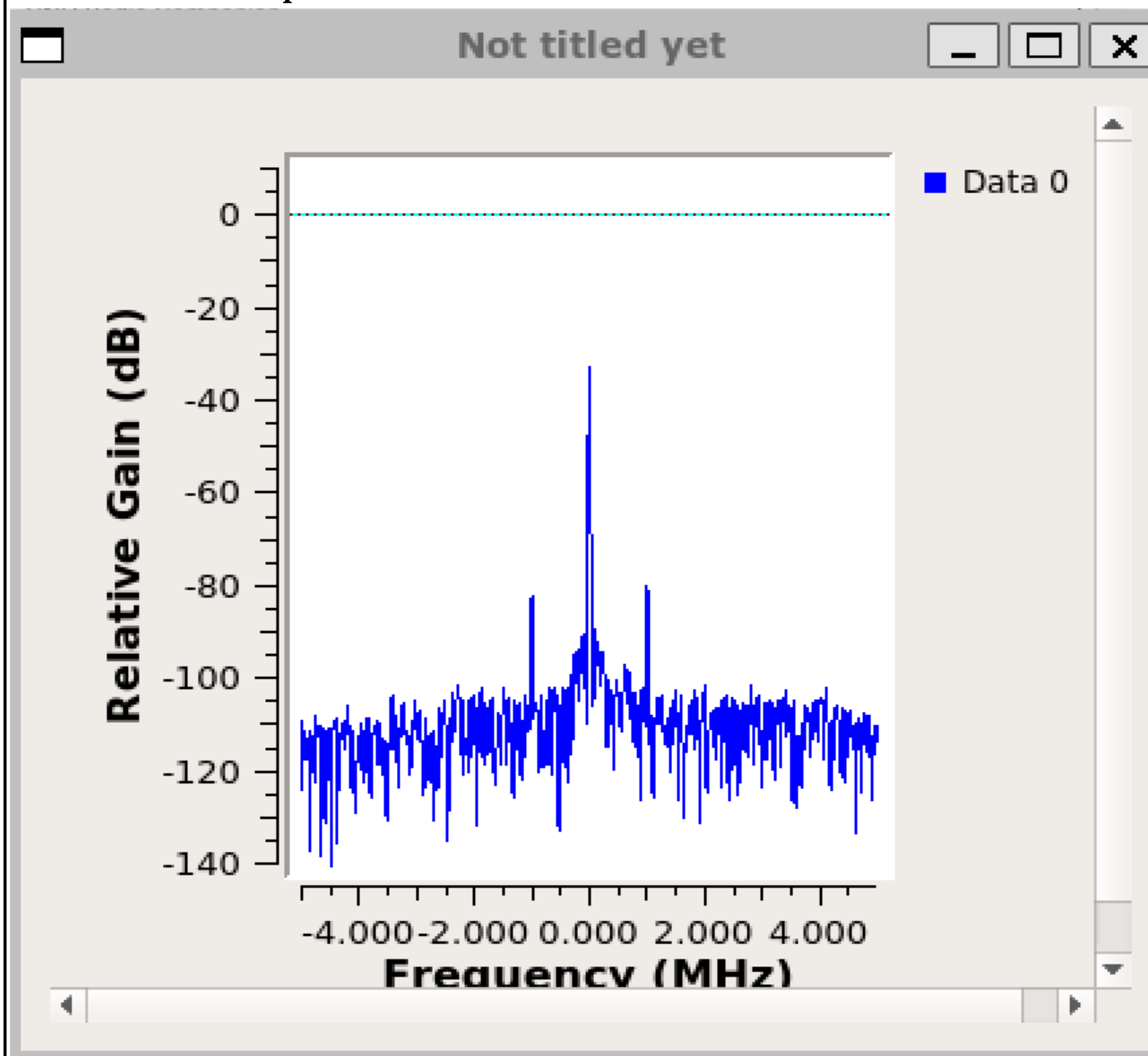


Experiments

- Working with USRP2
 - Transmit and receive a single frequency over the air to demonstrate the use of Universal software Radio peripheral Hardware Drivers (UHD)
 - The output displays a frequency spectrum in the terminal. It shows a peak at 1800MHz.



- Working with USRP X310
 - Used two USRP X310s on ORBIT Sandbox 2 to transmit and receive a single frequency over the air
 - The spectrum was plotted using GNU Companion



Data Collection

- Using USRP2 and WISERD we collected the spectrum data

```
GNU nano 2.2.6 File: spectrum
protocol: 5
domain: spectrum
start-time: 1658173933
sender-id:
app-name: spectrum
schema: 0_experiment_metadata subject:string key:string value:string
schema: 1_client_instrumentation measurements_injected:uint32 measurements_dropped:uint32 bytes_allocated:uint64 bytes_freed:uint64 bytes_in_use:uint64 bytes
schema: 2_spectrum_data sampling:int32 cfreq_MHz:double gain_dB:int32 FFTLength:int32 FFTNum:string FFTBands:[double]
content: text
0.819220 2 1 5000000 700000000 000000 20 256 --- 256 0.00495257927104831 0.0096654021269883 0.00866702478379911 0.005
0.819360 1 1 1 137606 1211468 16138 23182 --- 256 0.00372871616855264 0.0076146088540554 0.00813467241823673 0.005
0.819324 2 2 5000000 700000000 000000 20 256 --- 256 0.0096654021269883 0.0096654021269883 0.00866702478379911 0.005
0.819572 2 3 5000000 700000000 000000 20 256 --- 256 0.0070504772096951 0.00951774880415322 0.00625793066146798 0.005
0.819716 2 4 5000000 700000000 000000 20 256 --- 256 0.0096654021269883 0.0096654021269883 0.00866702478379911 0.005
0.819867 2 5 5000000 700000000 000000 20 256 --- 256 0.005239812708103 0.0069420892722558 0.003507531235552 0.005
0.820115 2 6 5000000 700000000 000000 20 256 --- 256 0.006101232858413 0.00742800966308545 0.0051878880740571 0.005
0.820363 2 7 5000000 700000000 000000 20 256 --- 256 0.0071896087458407 0.0070920714704555 0.00730879777345067 0.005
0.820611 2 8 5000000 700000000 000000 20 256 --- 256 0.007546355775565 0.007733130399234 0.005633737316337 0.005
0.820820 2 9 5000000 700000000 000000 20 256 --- 256 0.0072866901755329 0.010484740152955 0.00788742400112782 0.005
0.821163 2 10 5000000 700000000 000000 20 256 --- 256 0.0083727470673207 0.0080520707660879 0.0073986163225808 0.005
0.821320 2 11 5000000 700000000 000000 20 256 --- 256 0.0029923123055650 0.004524389272137 0.00620639836615048 0.005
0.821616 2 12 5000000 700000000 000000 20 256 --- 256 0.006809795539195 0.0109998617708683 0.00525967916473746 0.005
0.821865 2 13 5000000 700000000 000000 20 256 --- 256 0.0083727470673207 0.0080520707660879 0.0073986163225808 0.005
0.822114 2 14 5000000 700000000 000000 20 256 --- 256 0.0094819792192633 0.005113518562128 0.0062525495077996 0.005
0.822414 2 15 5000000 700000000 000000 20 256 --- 256 0.00814751721918583 0.00760817620993254 0.0107585564255714 0.005
0.822669 2 16 5000000 700000000 000000 20 256 --- 256 0.0076432402779211 0.0080758145347236 0.0062563800912666 0.005
0.822912 2 17 5000000 700000000 000000 20 256 --- 256 0.0053053571070951 0.0033147080407991 0.006071660168766 0.005
0.823210 2 18 5000000 700000000 000000 20 256 --- 256 0.00666795391589403 0.00609563617035747 0.00684852013364434 0.005
0.823410 2 19 5000000 700000000 000000 20 256 --- 256 0.005803874081636 0.0083510048972797 0.0060770487527797 0.005
0.823709 2 20 5000000 700000000 000000 20 256 --- 256 0.0055356140777355 0.0071713998931765 0.00602083746383521 0.005
0.823866 2 21 5000000 700000000 000000 20 256 --- 256 0.0041060031841185 0.00634027272462845 0.00812353780120611 0.005
0.824200 2 22 5000000 700000000 000000 20 256 --- 256 0.0066959981375372 0.0074623708608076 0.0051309308218111 0.005
0.824410 2 23 5000000 700000000 000000 20 256 --- 256 0.00435181567405397 0.00513637671247125 0.00466464060623921 0.005
0.824664 2 24 5000000 700000000 000000 20 256 --- 256 0.00808663209724026 0.00608327891677618 0.00716408519622564 0.005
```

UHD, USRP and GNU

- USRP:** Universal Software Radio Peripheral (USRP) is software-defined RF architecture which is used to design, prototype, and deploy wireless systems with custom signal processing
- UHD:** USRP Hardware Driver (UHD) is a software API (Application Program Interface) that supports application development on all USRP SDR products
- GNU Radio:** Is a simulation software for SDR development (Software Defined Radio)

Future Work

- With the collected data, use AI and ML approaches to build intelligent networks, in order to adapt their spectral behaviour
- Based on the behavior of different wireless user, use algorithm to assign limit spectrum capacity in a more efficient way