Welcome to Team 301 SDR SAR Review Session!

Marius Urdareanu - Hardware/Power Analyst
Grant Steans - Software Engineer
Tyree Lewis - Simulation Analyst and Data Collection
Nathaniel Henry - Front-to-Back End Integration

Background

Speaker: Tyree Lewis

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What is the SDR-SAR?

The Software Defined Radio Synthetic Aperture Radar, or SDR-SAR is an ongoing project sponsored by Northrop Grumman. It is a device used to detect metal objects at a distance. There are horns lined across the SAR which either transmit or receive an LFM pulse.

What is the SDR-SAR?

Speaker: Tyree Lewis

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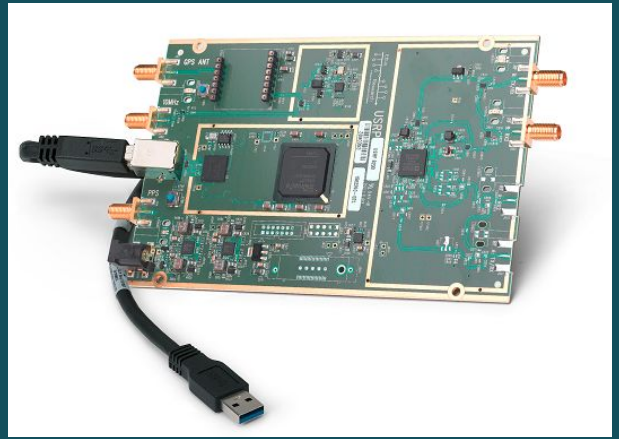
Identifying the Problem

During the first iteration of the project, the SAR was able to successfully detect metal objects, however, there was noise leakage occurring between the horns which made acquiring data more difficult.

Implementing a Solution

To resolve the problem, the team purchased a USRP B200 radio. This radio will be used to filter the noise between horns, thus removing the leakage that occurs between horns.



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Project Scope

Our goals for the project include:

- Refine the existing SAR to use SDRs to resolve the problems that occured in the previous iteration of the project.
- Ensure that metal object can be identified from at least 40 feet.

Goals Met in Phase I

The following goals were met in our Phase I outline:

- Install Universal Hardware Drive (UHD) and GNU Radio on Linux.
- Verification of GNU radio transmitting a simple sine wave to USRP B200.
- Verification of receive signal on GNU Radio.
- Verification of radar functionality.
- Determining parameters for radar, to see supported frequencies.
- Obtain all components needed for Phase II.

Ending of Phase II

The following are the goals met in our Phase II outline:

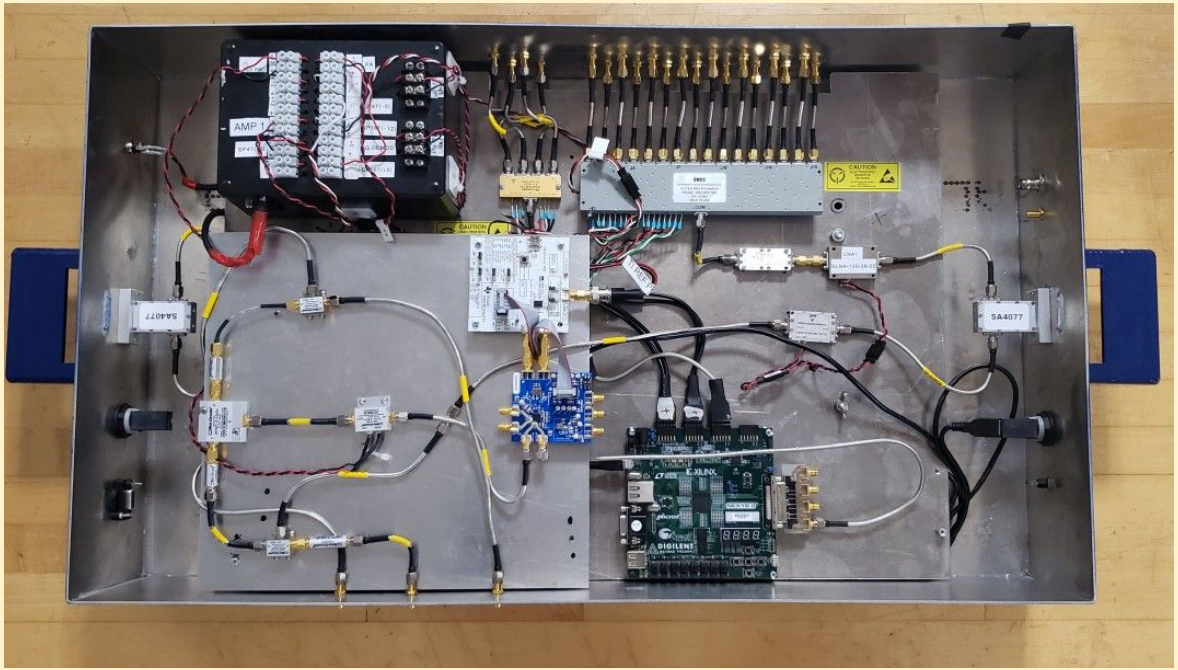
- Create a multiple pulse waveform in Simulink for the source file.
- Finish VHDL code that generates “pulse per second” (PPS) reference.
- Add existing VHDL for switching between TR paths.
- Get the Voltage Control Oscillator (VCO) source board from TI programmed with the needed frequency.
- Mechanize the RF components in the system box.

Finishing Phase III

Outline of the Phase III Test Plan

		Complete?
1	Test FPGA code that does transitions between pulses	✓
2	Order detectors and replacement amplifier to replace damaged one	✓
3	Attach components and standoffs to component plate	✓
4	Understand the image formation document and implement in	✓
5	Update the SNR prediction spreadsheet	✓

Current Progress



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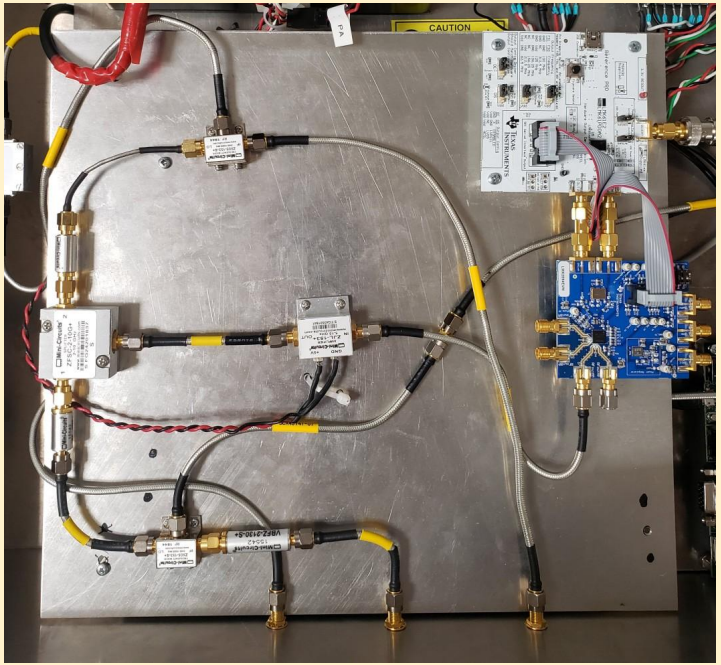
Current Progress



Current Progress

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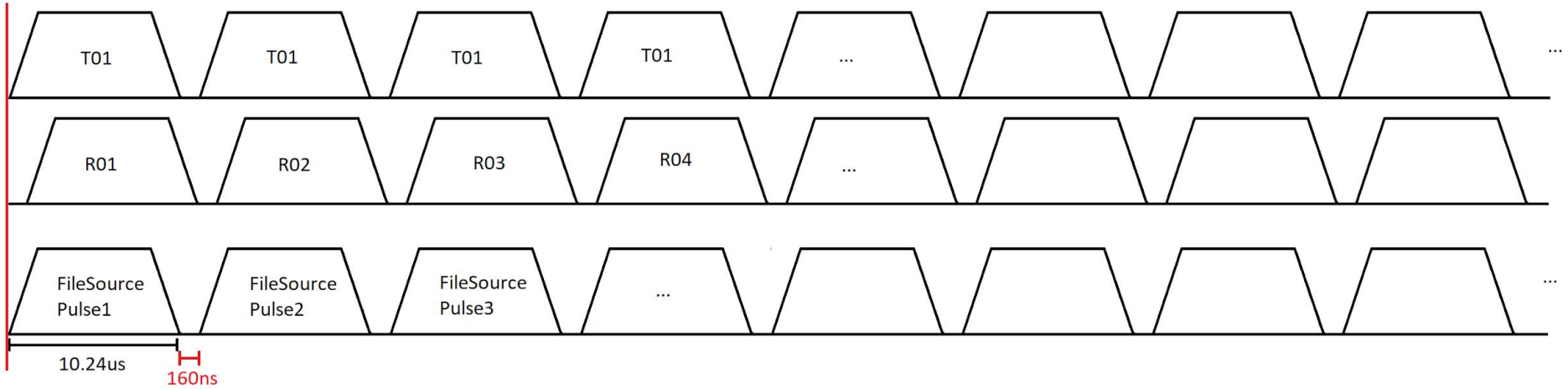
Current Progress

- Correct timing has been achieved between the transmit and receive horns.



Current Progress

- Pulse calibration and integration MATLAB script complete.

Pull the .bin file from GRC, convert to complex domain.

Reshape the result to 16 individual pulses.

Calculate phase difference using the first pulse as a reference.

Current Progress

- How is this file used in the project?

Repeat FFT reshaping code and align any new data to a zero phase (typically 5 snapshots).

Shift data by calibrated phase difference.

Sum pulses together to increase signal strength.

What's Left?

I. Set up the full SDR-SAR outside the lab, with a corner reflector ~40 feet down the hall.
   A. Test and verify with a transmit - receive path that will minimize noise.
II. Set up the full SDR-SAR by the machine shop outside the school, with a vehicle as the target ~40 feet away.
   A. Test and verify with a full loop.

Lessons Learned

1. Purchasing the B200 Software Defined Radio
2. Designing and implementing the 2.2 GHz to 10 GHz upconverter
3. Using snapshots for SAR imaging instead of streaming
4. Using Linux instead of Windows for data acquisition
5. Perseverance

USRP N210

Bill of Materials

ITEM #	DESCRIPTION	COST ($)	UNITS	TOTAL ($)
1	VCO	399	2	798
2	B200	828	2	1656
3	Mixer	48.95	3	146.85
4	Lo Amp	107.95	3	323.85
5	Splitter	78.95	2	157.90
6	Power Detector	102	2	204
7	DC-DC Converter	10.50	1	10.50
8	RF Cables	207.76	2	415.52
9	Filters	39.95	6	239.70
			SUBTOTAL	3952.32

Conclusion

The team will be meeting with our sponsor this Friday to perform tests with the SAR outside of the College of Engineering. Once these tests are complete, any refinement to our scripts will be performed as necessary to improve the accuracy of the SAR.

Special Thanks

We would like to thank:

- Our technical advisor, Pete Stenger.
- Our instructor, Dr. Jerris Hooker.
- Northrop Grumman as our sponsor and providing our budget.

Any Questions?