SDR Notes

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March 2025

1 Introduction

Hello! My name is Luke Ragan. At the time of this writing, I am a senior electrical engineering student at Liberty University. I am writing these notes to document the approach that I have taken to set up Dr. Bae's software defined radios (SDR). It is my hope that this guide will help future researchers to go further and achieve more. If at any point, you have questions about my work please feel free to send me an email at LARagan1@liberty.edu. Without further ado, please enjoy!

2 Setting up the Laptops

The first step in this process has been to set up the Lenovo T410 Thinkpads that belong to Dr. Bae. These machines have had Ubuntu 24.04.02 installed on them. This procedure was fairly straightforward, and one could easily repeat this by result by navigating to ubuntu downloads and following the instructions.

The next steps were to install GNU Radio, visual studio code, and latex on the laptops. To install GNU Radio follow the instructions at the link below.
https://wiki.gnuradio.org/index.php?title=InstallingGR
To install visual studio code, please use the app center included on the ubuntu machine.
To install LaTex, please follow the instructions at the link below.
https://github.com/James-Yu/LaTeX-Workshop/wiki/Install
Please note, I used TinyTeX as the LaTex distribution on this laptop.
Resorces for how to use LaTex can be found at the following addresses.

- https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes
- https://www.learnlatex.org/en/
- https://ctan.math.illinois.edu/info/lshort/english/lshort.pdf

3 GNU Radio Tutorials

I have begun my learning exercises for SDR by going through the tutorials for GNU Radio here. All of these tutorials are fairly self-explanatory. Additionally, the initial tutorials even cover how to launch GNU radio companion.

4 Learning SDR Basics

I found a textbook from Analog Devices, that breaks down the necessary portions of communication systems and signal processing that you need to know to effectively use the SDRs. I would greatly recommend taking a look at this text and at least reading the chapters that you do not feel as strong on. Especially if you are someone who has not yet taken communication systems or dsp, I would recommend reading the book. It is a great tool for learning what you need without having to learn everything. The text can be found at https://www.analog.com/media/en/training-seminars/design-handbooks/Software-Defined-Radio-for-Engineers-2018/SDR4Engineers.pdf.

5 github

I also created a github for communications research at Liberty, but the only files that I ended up creating for said github are these notes. That being said, the repository can be found at https://github.com/LARagan1/Comms-Research/tree/main. If you would like to join, just send me an email, and I can give you permissions.

6 Ettus Research Tutorial

In addition to the GNU Radio Tutorials, I also started a starter course that Ettus Research has published at this site.

Note: On page 100, there are a couple things that should be corrected.

1. python-mako should be python3-mako instead
2. python-docutils should be python3-docutils instead
3. The third line should be corrected to git clone https://github.com/EttusResearch/uhd.git
4. Many of the commands need sudo to work
5. You should probably run "sudo apt upgrade" before the cmake process
6. Instead of using release_003_009_005 as they suggested, I just made a new branch. I used sudo git checkout -b LARagan1/customBranch

Notice that the ethernet connection of the laptop needs to be set to 192.168.10.1 with a net mask of 255.255.255.0
As I am writing this, I have not done so since I need Wi-Fi connectivity.

3/14/25: I have established connectivity with the USRP! It is definitely necessary to set the ip address to the afformentioned address.
Also note that running any of the example files should include ./ before the command

When I attempted to download and build GNU radio according to the instructions in the Ettus Tutorial, I had a lot of difficulty with making sure that all of the required packages were installed. There are a couple things I think would help. Use python3 instead of python for install commands. For instance, sudo apt install python3-opengl instead of python-opengl. For packages that are not able to be found, I found that the easiest way to go about it was to just use google. One of note is that you should run sudo apt-get install libqt5gstreamer-dev
Overall, I made sure that after the cmake command, everything was enabled except for gr-soapy for gnuradio.

6.1 Installing Packages:

I am now going to work on setting up the second laptop ENGR2 with UHD and GNURadio. To be as helpful as possible, I will do my best to create a list of every package that needed to be installed and the commands used to install them.

- sudo apt-get install -y git
- sudo apt-get install -y libboost-all-dev libusb-1.0-0-dev python3-mako doxygen python3-docutils cmake build-essential
- sudo apt-get install curl
- sudo curl -O http://launchpadlibrarian.net/648013231/libtinfo5_6.4-2_amd64.deb && sudo dpkg -i libtinfo5_6.4-2_amd64.deb && sudo curl -O http://launchpadlibrarian.net/648013227/libncurses5_6.4-2_amd64.deb && sudo dpkg -i libncurses5_6.4-2_amd64.deb
- sudo apt-get install libncurses-dev
- sudo apt-get install python3-ruamel.yaml
- sudo apt-get install dpdk && sudo apt-get upgrade && sudo apt-get install -y libdpdk-dev
- sudo apt-get install -y python3-gevent

- sudo apt-get install python3-pyudev
- sudo apt-get install -y python3-pyroute2
- Make sure you run sudo apt upgrade before any cmake
- I installed libuhd4.8.0 instead of libuhd003
- I installed tree to view the uhd images in tree format (like in the presentation)
- To run the executables in the examples, navigate to /usr/local/lib/uhd/examples and make sure to put ./ in front of the command
- I was able to sucessfully run $\mathrm{rx}_a scii_a rt_d ftandtx_w aveformssimultaneouslytoverifythattheSDRsandsen$

- On page 145, I made the following changes
  - libcppunit-1.13-0v5 was replaced with libcppunit-1.15.0
  - Replace any "python" with "python3"
  - Run sudo apt-get install libqt5gstreamer-dev for qt4
  - Replace python-wxgtk3.0 with python3-wxgtk4.0
  - There are several things that did not install. I am just moving on, and I will fix any problems that occur later on.
- Checkout the most recent version of gnuradio, not the one they recommend in the tutorial.
- To make the cmake work correctly, I installed the following packages
  - qjackctl
  - portaudio19-dev
  - python3-libiio
  - libsndfile-dev
  - libqwt-qt5-dev
  - libiio-dev
  - libad9361-dev
  - qtcreator
  - libqt5charts5-dev libqt5datavisualization5-dev libqt5gamepad5-dev libqt5gstreamer-dev libqt5networkauth5-dev libqt5opengl5-dev libqt5remoteobjects5-dev libqt5scxml5-dev libqt5sensors5-dev libqt5serialbus5-dev libqt5serialport5-dev libqt5svg5-dev libqt5texttospeech5-dev libqt5virtualkeyboard5-dev libqt5waylandclient5-dev libqt5waylandcompositor5-dev libqt5webkit5-dev libqt5webchannel5-dev libqt5websockets5-dev libqt5webview5-dev libqt5x11extras5-dev libqt5xmlpatterns5-dev

  - libzmq3-dev

- Make sure that the only disabled component is gr-soapy before moving on from the cmake

7 Concluding

Unfortunately, I did not get nearly as far as I was hoping to with this project. I successfuly setup uhd and GNU Radio on Dr. Bae's laptops, verfied that the SDRs can send and receive simple signals, and hopefully gathered a few helpful sources for future researchers to loook at. I hope that this serves as a helpful foundation. I look forward to seeing what research you are able to do! Thank you!