

COM-304 Software Radios & Radars Project Guidelines

<https://github.com/samhy99/COM-304-BladeRF>

<https://github.com/hailanzs/comm-proj-radar>

EPFL, Lausanne, Switzerland

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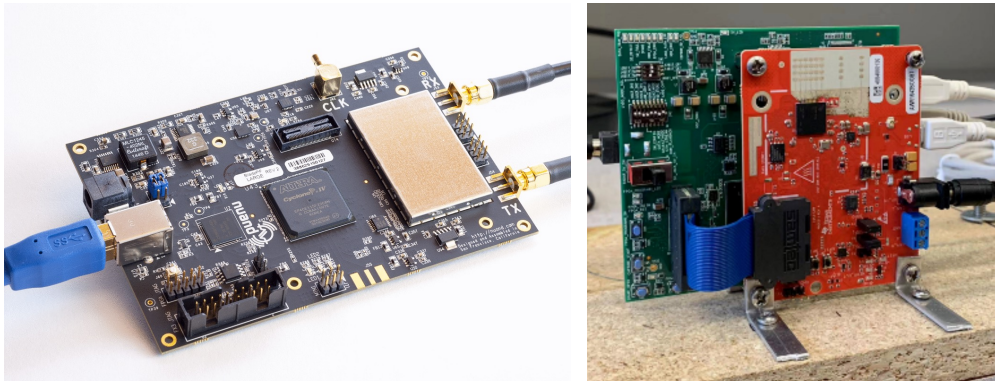


Figure 1: Hardware platforms available: BladeRF (left), mmWave Radar (right).

1 Introduction

The primary goal of this course is to give students hands-on experience with solving real-world challenges by working in teams to program different hardware platforms and ultimately build their own projects. We want you to get familiar with working on a project from start to finish. How do you organize a project's timeline, and team and ultimately design and implement something from scratch? By the end of this course, you should have a taste of each of these aspects of project and group work.

The goal of the communications & sensing project is to get familiar with the hardware of your choosing software-defined radio or millimeter-wave radar and propose a communications/sensing project that you will implement. This is a flexible project and here you can get creative! For both platforms, we have multiple devices available. We propose some example projects in this guideline document that you can use or build upon, however, it is encouraged to think outside the box and come up with your own project!

1.1 Hardware Platforms

Millimeter-wave (mmWave) Radar: The radar platform we will use is TI's AWR1843BOOST radar board combined with the DCA1000EVM data capture board.

Software Defined Radio Platform (SDR): The SDR platform used is BladeRF which you will use in conjunction with an omnidirectional antenna.

Both of these hardware platforms have guidelines on setup and more information on how they work linked in their corresponding github repos which you can find at:

- <https://github.com/samhy99/COM-304-BladeRF>
- <https://github.com/hailanzs/comm-proj-radar>

2 Project Proposal Guideline

We expect you to come up with all the details of the project: implementation, techniques, etc. The course staff are not responsible for providing the details of these projects, that's your responsibility for whichever project you decide to work on. You are welcome to consult with the course staff on ideas and plausibility of your ideas and how they might be implemented. Nevertheless, we will provide a few ideas and starting points in this document.

Below we have detailed a few ideas to motivate or inspire you in your project selections.

2.1 SDR: Potential Project Ideas

- Explore implementing and using MIMO
- Explore advanced coding schemes
- Build a GPS receiver
- Use CDMA or Chirps Spread Spectrum for super long range low power communications
- Use machine learning to classify signals transmitted on the air & map the user's location based on overheard signals
- Use Bakom to map 5G, 4G, 3G base stations; use machine learning to predict the signal strength at any point on the map
- Eavesdrop on ADS-B messages from nearby airplanes & predict airplane routes above Switzerland.
- Estimate the wireless channel for joint communications & sensing: localization, tracking, etc
- Extract audio from WiFi packets
- Finger print EPFL using WiFi access points
- Check out <https://www.rtl-sdr.com/> for some more ideas!

2.2 Radar: Potential Project Ideas

- Around the corner tracking and imaging
- Vital signs monitoring; extract breathing & heart rate
- Material sensing
- Extracting sound from radar signals
- SLAM: Simultaneous Localization And Mapping with Radar
- Multi-person tracking
- Fall detection
- Distributed radars

In addition to checking these suggestions out, it might be useful for you to skim the recent (last couple of years) proceedings of the following conferences for some project inspiration: MobiCom, MobiSys, SIGCOMM, NSDI, SenSys for papers related to wireless.

These are just a few ideas, but there are many more possibilities out there!

3 Evaluation

Evaluation of this project will be dependent on the project. However, at a high level, we will evaluate based on the following criteria:

1. **Project Reports:** You will have to submit 3 reports: proposal, progress report, and final report. More details will be found in 4. Your project proposal will essentially guide what you and the course staff should expect from you in this project.
2. **Implementation:** You will be graded on your implementation: attention to details, understanding of the system, design choices, and does your project do what your proposed?
3. **Demonstration:** We will have demos and a final presentation for each of the project towards the end of the course. This will also give you a chance to check out the projects other students are working. Please stay tuned for details!

Because each project can be vastly different, we will take each project as a case by case basis. However, the structure of what you should be expected to be graded on will be outlined in your project proposal, which course staff will discuss and adjust accordingly with the groups.

4 Reports Instructions

During the project, you will need to submit three reports and make the final presentation of your project. Each of these reports are expected **one from each group**. The individual work is expected in the weekly progress updates. Below, you can find instructions for each stage.

4.1 Project Proposal

The goal of the project proposal is to create an outline of what your plans are during the semester. You should roughly organize it as follows:

1. **Introduction & Problem Statement:** Outline the problem statement. What are you trying to do, and why is it an interesting problem to look at? What techniques will you need to use to implement this idea? Here you should more specifically say *what* you plan to do.
2. **Project Plan:** Here you should give us an outline of what your goals are for the project. This is where you need to be more specific. What is the exact end system you plan to have? Include a timeline that will help course staff to gauge whether your project is too ambitious or needs a bit more to it. Additionally, you should say what you expect to get done by the progress report. You should also tell us what *you expect is the baseline of a working project*. This should be specific. While not necessary, it will be good to put any initial technical detail that you have about your project.
3. **Extra Features:** These can be out of the box ideas that you think might not be possible in the timeline proposed, but sometimes things go well! If you have time, what extra features would you be interested in implementing on top of your current proposal.

This proposal will be reviewed by the course staff. We will approve it or suggest adjustments based on the difficulty we expect. As part of your grade is on both the ambitiousness and success of your project, we recommend you to be descriptive in this proposal.

4.2 Progress Report & Progress Demo

The progress report is intended to make sure that you are making adequate progress throughout the semester. Finishing a project in the last week is impossible given the breadth of this project. Your progress report should be at **most 2 pages** that includes:

- The steps taken so far in implementing the project and deviations from the original proposal, together with explanations.
- A discussion about the problems you encountered, the solutions you explored, and problems that you are likely to encounter as your project progresses.
- A tentative but concrete list of the action items you plan to work on until the final report and how they relate to the project's overall goal.

In addition to the written report, we will also conduct a short demo with each group. The goal of this demo is to show the course staff what basic implementation you have working. We **do not** expect everything to be working at this point. However, we should see that you have made significant progress in setting up the hardware and implementing your ideas. Your project proposal should state what you expect to have done by this point. *This will be an in-person evaluation during the first exercise session after the progress report deadline. We will communicate the exact time and date later.*

4.3 Final Report & Presentation Guidelines

More details will be provided later :)

5 Timeline

Here are a few important dates to keep in mind regarding the projects deliverables:

- The project proposal is due **March 22, 2024** at 23:59.
- The progress report is due **April 26, 2024** at 23:59.
- The final report is due **June 7, 2024** at 23:59.