Experimental Exploration of 5G-and-Beyond Wireless

Design Document

sdmay24-23
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Executive Summary

Development Standards & Practices Used

Participate in the ISU-led $16M project ARA on advanced wireless and rural broadband (https://arawireless.org), and “play” with bleeding-edge hardware and software platforms for 5G-and-beyond wireless systems such as free-space optical communications, massive MIMO, mmWave, and LEO satellite communications. Open-source 5G software and hardware platforms such as srsRAN (https://www.srslte.com). OpenAirInterface (https://openairinterface.org), and USRP software-defined radios (https://www.ettus.com) will be available to students in the project.

Summary of Requirements

* August - December 2023:

- Study basics of the ARA project (https://arawireless.org) and related 5G-and-beyond hardware and software platforms (https://arawireless.org/equipment), as well as 5G wireless systems (https://5g.systemsapproach.org) and computer networking (https://book.systemsapproach.org) in general;

- Contribute to 5G learning materials to prepare undergraduate students for using and researching advanced wireless systems, based on your own learning experience in the project;

- Participate in the development and field deployment of 5G-and-beyond wireless infrastructures of ARA;

- (Optional) Learn about novel 5G-and-beyond algorithms for safety-/mission-critical applications;

* January – April 2023:

- Conduct field testing and scientific performance measurement of 5G-and-beyond wireless systems in precision agriculture and smart city applications (e.g., public safety, smart transit, water security surveillance), and participate in broad community engagement activities (e.g., tutorials);

- Prepare example experiments as learning materials for undergraduate students new to 5G-and-beyond wireless systems;

- (Optional) Prototype, demonstrate, and evaluate the performance of novel 5G-and-beyond algorithms using advanced wireless platforms in ARA, and write related technical reports.

Applicable Courses from Iowa State University Curriculum

List all Iowa State University courses whose contents were applicable to your project.

CPR E 308: Operating Systems

CPR E 458: Real-Time Systems

CPR E 489: Computer Networking and Data Communications

EE 224: Signals and Systems

CYB E 331: Applications of Cryptographic Concepts

CPR E 430: Network Protocols and Security

CPR E 431: Basics of Information Security

New Skills/Knowledge acquired that was not taught in courses

List all new skills/knowledge that your team acquired which was not part of your Iowa State curriculum in order to complete this project.

TBD until project is finished.

Table of Contents

List of figures/tables/symbols/definitions (This should be the similar to the project plan)

- **5G**: 5th Generation Mobile Network.
- **NR:** New Radio; referring to the radio technology of 5G networks
- **MIMO**: Multiple–Input Multiple-Output.
- **mmWave**: millimeter-Wave; refers to the 24-100 GHz range, a range that can carry an incredible amount of data.
- **LEO**: Low Earth Orbit (LEO) satellites used to efficiently transmit signals.
- **UE**: User Equipment's that can establish a connection to the network.
- **RAN**: Radio Access Network links the user equipment to the core network.
- **Core Network**: Or mobile core, is a critical component of a 5G network, it is responsible for connecting the radio access network such as the internet.
- **USRP:** Universal Software Radio Peripheral; used to connect to a computer through a high-speed link, which software uses to control the USRP hardware and transmit/receive data.
- **OpenAirInterface**: an open-source software-based implementation of the LTE system.

1 Team

1.1 Team Members

-Joshua St. John

-Lukas Zerajic

-Christopher Sell

-Jared Melcher

-Zach Zemlicka

-Varun Advani

1.2 Required Skill Sets for Your Project

- Cloud Equipment and computing
- Basics of networking and terminologies
- AraHaul and AraRAN
- 5G mobile networks
- Basics of Real-Time Systems and Schedulable, Predictability.
- Understand and how to operate “Open Air Interface”

1.3 Skill Sets covered by the Team

- Basics of networking and terminologies (Zach, Chris, Varun)
- Real-Time Systems and Schedulable, Predictability (Joshua, Varun)

1.4 Project Management Style Adopted by the team

- Collaborative, where everyone holds everyone accountable.

1.5 Initial Project Management Roles

- Chris (leader/manager)
- Lukas (secretary, records meeting notes and uploads them to Cybox)
- Josh/Jared (editors of senior design website)
- Varun (edit preamble as needed)
- Zach (edit/add to Teams channels as needed)