1.1 Problem Statement

What problem is your project trying to solve? Use non-technical jargon as much as possible.

In rural areas with productivity highly influenced by 5G, there is a lack of accessibility to that 5G technology. How can we not only contribute to identifying a more accessible method of increasing this technology's accessibility, but also increase the awareness and technical knowledge of it to develop a more productive and connected community?

New: With the ARA project only recently being started up in July 2021, there are limited resources to prepare undergraduate and graduate students to join the project with the baseline knowledge needed to use ARA technology and make meaningful contributions to further expand the use of ARA in rural communities.

1.2 Requirements & Constraints

Deliverable: ARA and 5G learning platform

- Includes material from following open-source platforms
  - SrsRAN
  - OpenAirInterface (OAI) ***
  - O-RAN
- Lab based learning modules
  - Simulate the building blocks of a 5G network
- Assessments of knowledge
  - Testing effectiveness of platform among students not involved with the project

Deliverable: OAI Scheduler Changes (Used to create a Lab)

Accessibility constraints

- "Registration" process
  - Develop a way into the ARA project (application for individuals to get approved to work with ARA and all of its implemented technology)
- After registration making a lab accessible to anybody wanting to learn about the tech behind 5G.

Field tests (current technologies being used to implement 5G)

- **Small cells**
  - Functional requirement: helps alleviate some of the signal stress of 5G towers (RAN) by splitting up the load – extend 5G range, energy saving
- **MmWaves**
  - Functional requirement: high bandwidth connection, low latency, fragile (constraint)
- **Mid-Band**

    - Functional requirement: in the absence of mm Waves, helps keep the connection up, but increased latency (constraint)
- **Low earth orbit satellites**
    - Functional requirement: helps increase the range of 5G connections
- **Massive Multiple Input Multiple Output (MIMO) Antenna's (Common technology associated with 5G)**
    - Functional requirement: improves network capacity/performance, allowing for multiple users to communicate simultaneously at the same frequency band

Accessibility constraints

- **Mili-meter waves (mm Wave) (not the most efficient but it works)**
- **Cost (rural areas are not very profitable)**
- **The weather/plants/trees affect the transmission of certain 5G frequencies**

1.3 Engineering Standards

What Engineering standards are likely to apply to your project? Some standards might be built into your requirements (Use 802.11 ac wifi standard) and many others might fall out of design.

For each standard listed, also provide a brief justification.

New 11/12/2023:

3GPP- The name of the standard for 5G as a whole and the name of the body who creates the standard

Sphynx – The coding language for making documentation tied to our GitHub

1.4 Intended Users and Uses

- Who benefits from the results of your project?
- Who cares that it exists?
- How will they use it?

Enumerate as many "use cases" as possible to ensure your requirements are complete (each use case may need its own set of requirements).

New:

Who benefits?

- Undergraduate and graduate Iowa State students
- Other individuals outside of Iowa State wanting to learn about and work on ARA
- Classes that would like access to ARA to teach 5G with hands on work in the field

Who cares that it exists?

- Researchers already on ARA
- People trying to gain access to ARA for experiments

How will they use it?

- Prepare undergraduate/graduate students to get involved with ARA
- Define and teach the baseline knowledge needed for ARA
- Create a starting lab for the people just joining

Ideas:

- **Who benefits: rural residents**
    - **Agriculture industry – uses:**
        - **Ag vehicles using Ultra-Reliable, Low-Latency Communication (URLLC)**
        - **AI and machine learning/automation used to make real time agricultural decisions and apply appropriate timely responses**
    - **Livestock industry – uses:**
        - **Video-based livestock farming**
        - **Monitoring/studying individual animal behavior**
    - **Schools – uses:**
        - **Students/Teachers (Augmented reality in schools, streaming video and data from farms for students to access/monitor in class)**
        - **Parents (school bus coordination)**