Application Exploration of 5G-and-Beyond Wireless Systems and Rural Broadband

DESIGN TALK

Introduction/Problem Statement

- 5G allows us to not only transfer large data efficiently, but at faster speeds. We are looking to make commercial farming more efficient through the capabilities enabled in 5G.
- Currently working w/ Dr. Hongwei and his ARA project
  - Wireless living lab, real-world wireless experimental infrastructure for smart and connected rural communities

Design Context

Broader Context

Societal:

- Public health, safety, welfare: Better yields + health of crops or livestock.
  - Higher quality of amounts of food, as well as initial crop quality, leading to better food for us to consume
- Global, cultural, social: Reduce work needed to run daily operations, increase accountability across the globe

Environmental:

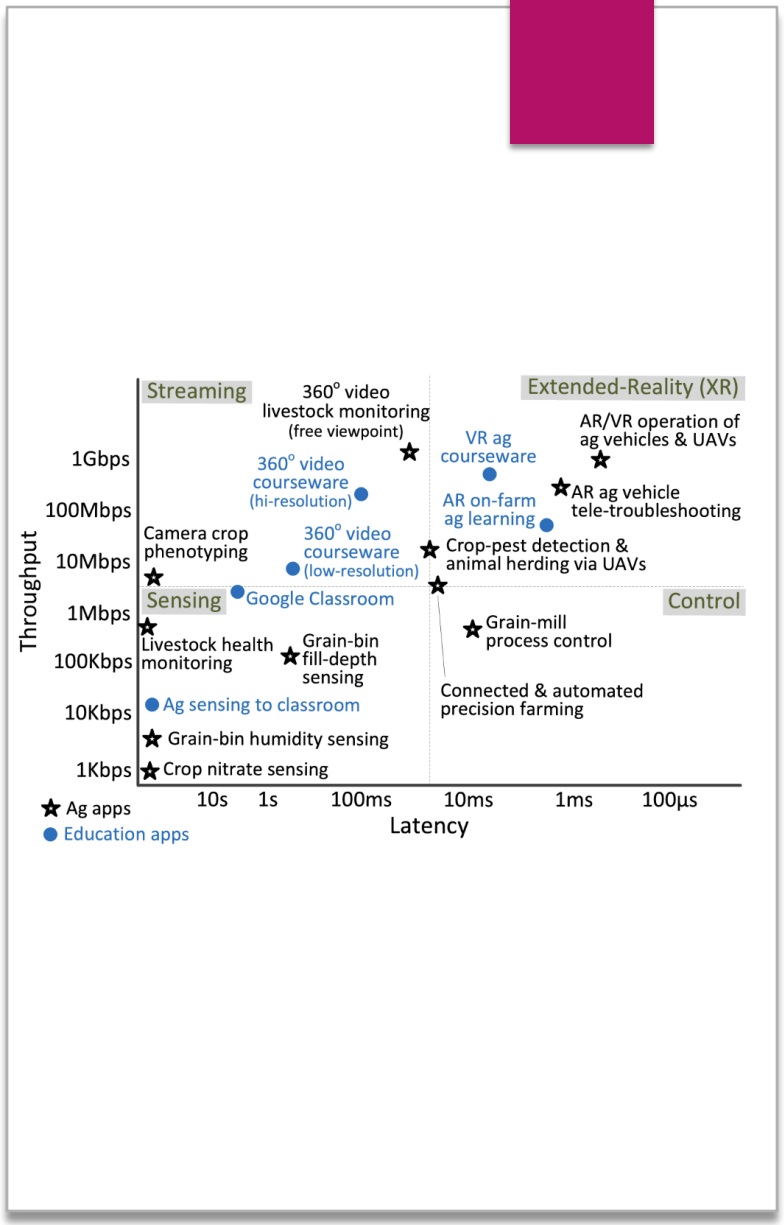
- Farming becomes more sustainable and allows for more consistent results, leading to less time dealing with the repercussions of a bad year

Economic:

- Daily Tasks can be automated
- Higher quality products for us and other livestock to consume

Design Context
User Needs

- Commercial Farmer
  - Run his farm in an efficient manner
  - Utilize new technology as it becomes available
- Dr. Hongwei
  - Dr. Hongwei needs our solution to demand a data rate and latency that would require a 5G network
  - Low latency and high throughput application



Design Context
Prior Work/Solutions

- Previous ways to connect video feed and sensor data into a network.
- Use of drones to capture images of the farmland and apply pesticide in a targeted manner.
- Use of IoT sensors scattered around farm to collect data on pH levels, soil moisture, and nutrient levels.
- Phenotyping bot is in development.
- John Deere is working on automating seeders, sprayers, and combines.
- Microsoft conducting research on lowering data collection and transmission costs for smaller farms.

Design Context
Technical Complexity

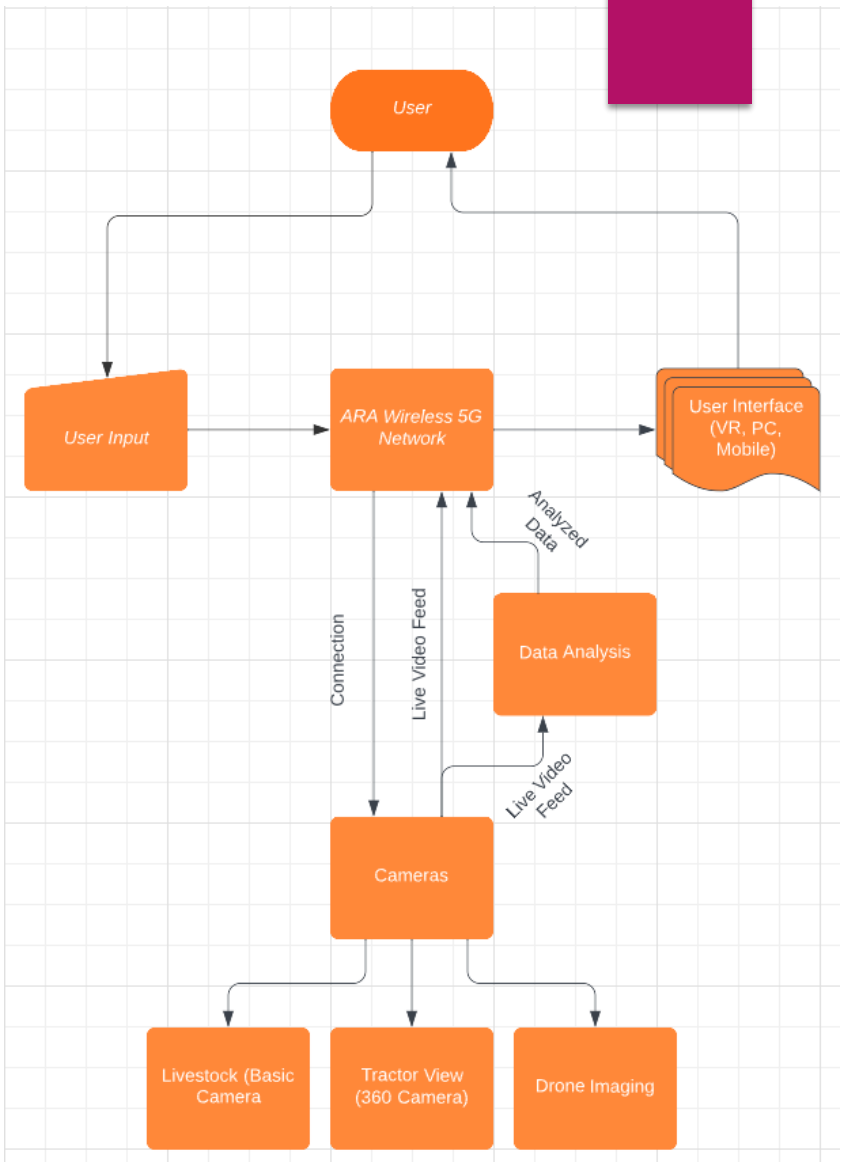
- Multiple challenging requirements that match or exceed current solutions or industry standards.
- External Complexity
  - Using cutting edge 5G technology
  - Using unfamiliar technology
- Internal Complexity
  - Multiple sensors and cameras transmit data
  - Data is processed and sent to devices and users over ARA Network

Design Exploration

- Design Decisions
  - Current ARA project focuses
  - Client requests: XR, video feed, IoT devices
  - Software structure
  - User experience: Monitors, VR equipment, displayed information, etc.
- Ideation: Agricultural Applications
  - Lotus Blossom
  - Current Agricultural Issues: Soil contamination, livestock monitoring, crop growth, automation, XR farming
- Decision Making
  - Feasibility
  - Client's preferences
  - Current equipment and resources

Proposed Design

- User has access to real-time data analysis and live-video feed through ARA network
- Goal is to take advantage of low latency and high data rate
- Performance characteristics:
  - Throughput
  - Delay
  - Delay Jitter
  - Reliability
  - Quality of Experience



Design Analysis

- Projects like IoT soil testing are useful but fail to utilize the full range of 5G capabilities
- Plan on pursing the wireless real-time video feed application and data analysis:
  - Feasible hardware installation
  - Real-time remote video feed, real-time data
  - 5G allows greater mobility and coverage
  - Plethora of resources within ARA team alone