EE/CprE/SE 492 WEEKLY REPORT 1

Jan 2023 – Dec 2023

Group number: 12

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

Client &/Advisor:
ARA Wireless/ Dr. Hongwei

Team Members/Role:
Vibhu Dhavala, Software Engineer
Cristofer Espinoza, Hardware Engineer
Andrew French, Hardware Engineer
Caleb Kitzelman, Hardware Engineer
Samuel Rettig, Software Engineer
Jake Roskopf, Hardware Engineer

*ARA Project, experimental wireless infrastructure in Ames and surrounding communities to find benefits for 5G within agricultural and rural environments.

Weekly Summary

In our first meeting with Dr. Hongwei earlier this semester, we had shifted focus from creating an XR application to instead improving a recently developed end-to-end 5G XR system. We were tasked to perform extensive research on any applicable fields to better understand the system, how to characterize performance, and how to improve it.

On September 14th, we met with Dr. Hongwei with an initial agenda of discussing the ARA launch (2023 ARA Public Launch - ARA (arawireless.org)) as well as our research that we had individually conducted over the two weeks.

The ARA launch was from September 6th to the 8th, and covered network applications, how-to use the network, and progress. It was a very successful event that some of the team was able to participate in as well. A variety of companies, experts, as well as the government were able to attend and present.

Each of us then discussed our research and how we could use this knowledge to improve the current network for video transmission to an XR headset. A biproduct of this discussion was the future of the product and where Dr. Hongwei wished for it to go. He decided that the most important course of events that he would like to see right now is getting hard data on the network as it currently does not support this capability. To achieve this, we discussed having access to the hardware such as the 360-degree camera, the supporting computer,

and other necessary pieces like XR headset. Dr. Hongwei will set up the hardware in a secure location for us so that soon we will be able to try to implement said data taking measures. He also wished for us to create an internal roadmap so that we can keep track of our progress.

Past week accomplishments

Vibhu Dhavala – These past weeks I began research into how performance evaluation is done for XR on 5g networks. I read an IEEE article, Performance Evaluation of Extended Reality Applications in 5G NR System, which talked about testing for XR applications on 5G nr networks and how efficient various configurations were. The article also ways to improve XR efficency when using 5G netwoks, along with ways to improve user experience for XR applications with 5g in mind. I wasn't able to attend the meeting with Dr.Hongwei but I was able to meet with group members at another time and cover what I missed.

Cristofer Espinoza – Started research into concepts related to video transmission in 5G systems, specifically articles from the IEEE website. One of the articles I read investigated the difference between 5G stand-alone (SA) and not-stand-alone (NSA) mobile network systems, end-to-end. It also went into the variables that go into delay such as the codec, the microprocessor you are using to compress data for transmission. Most of the delay end-to-end is a cause of factors in the upload half of transmission.

Andrew French – I attended a portion of the ARA launch for insight on the ARA network. I read IEEE articles on dealing with Microbursts within the network, powering IoT sensors with heat, and security concerns regarding 5G networks.

Caleb Kitzelman – Research has been done into performing a data study on some of the possible applications for the ARA network. We've met with Dr. Hongwei a couple of times and have developed a plan for this semester, focusing on data collection for video streaming applications, as well as improving the performance of the applications in a few ways. We're currently working to get a workstation set up for our group for measurements and testing.

Samuel Rettig - Delved into research regarding XR 5G Network analysis. The research paper described using a newly developed formula to look at three separate parts of the overall network process to find and fix potential data leaks. Most of the testing uses either frames or lost data packets, with multiple options for each. Also investigated XR videos to see new developments in the space.

Jake Roskopf-These past two weeks I was researching how feedback loops can be implemented to monitor channel integrity and be used to improve XR QoS requirements. I also continued to watch some XR development videos to better understand ways that it needs to be improved. I also attended many of the ARA launch seminars to understand the long-term goals of the project.

Pending issues

Vibhu Dhavala - None

Cristofer Espinoza – None

Andrew French – None

Caleb Kitzelman – None

Samuel Rettig – None

Jake Roskopf - None

Individual contributions

NAME	Individual Contributions *(Quick list of contributions. This should be short.)*	Hours this week	HOURS cumulative
Vibhu Dhavala	Research into performance of 5G XR apps	5	44
Cristofer Espinoza	Research into video transmission on 5G networks	2	36
Andrew French	Additional research and ARA launch.	7	58
Caleb Kitzelman			
Samuel Rettig	Additional research + XR videos	8	46
Jake Roskopf	Additional research and ARA launch	8	52

Comments and extended discussion

After discussion with Dr. Hongwei these past couple weeks, he decided that taking detailed measurements of the ARA network would be more beneficial to the project than having a working application on an unfinished network. Because of this, our overall project goal is shifting, and we must adjust our road map. Part of this is looking more into how to get data on the network as well as creating a better-defined week-to-week outcome. We will be meeting as a team this upcoming Monday to regroup and adjust.

Plans for the upcoming week

Vibhu Dhavala: Continue researching articles relevant to performance of XR apps and try and find a way to integrate that with ARA testing.

Cristofer Espinoza: Continue research on video transmission with 5G networks and maybe focus on different methods of video compression and uploading to BS. I want to try and focus my effort to be a subject matter expert, to better support the team compared to small general knowledge of a whole system. For the next two weeks, I want to complete at least two articles. One more on video transmission in 5G networks and one investigating different video compression methods.

Andrew French: Help with testing the current system and continue research on 5G.

Caleb Kitzelman: Continue researching XR/network related articles

Samuel Rettig: Research more into how we can find hard data on the ARA network

Jake Roskopf: Find a number of test that can be run with current system and continue research study