

## Introduction

Iowa State is leading a \$16-million ARA project researching 5G applications for agricultural and rural settings. We are a small branch of this larger project.

## Problem

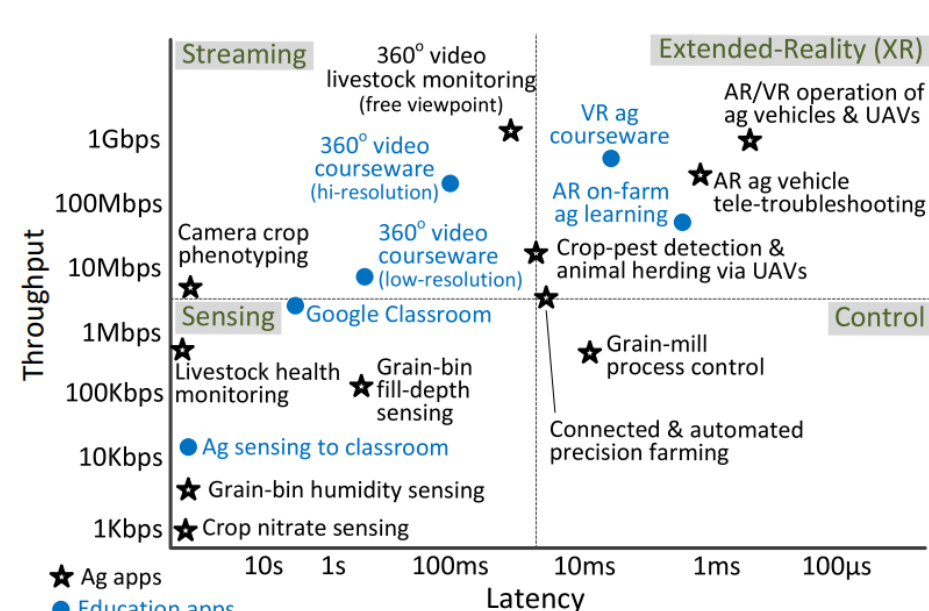
Actualize benefits of advanced wireless in rural and agricultural communities.

## Solution

Create a 5G XR application and perform data collection that shows benefits of the ARA network.

## Requirements

- Utilize the ARA network
- Stream 360 camera onto an XR headset via real-time streaming protocol (RTSP)
- Demonstrate sufficient Quality of Experience (QoE)
- Demonstrate high data throughput and low latency (Quality of Service, QoS)



\*H. Zhang et al., "ARA," Oct. 2021, doi: <https://doi.org/10.1145/3477086.3480837>.

## Engineering Constraints

- ARA network availability and infrastructure
- Camera streaming availability
- Current XR plugins for RTSP

## Technical Details

Our project made use of

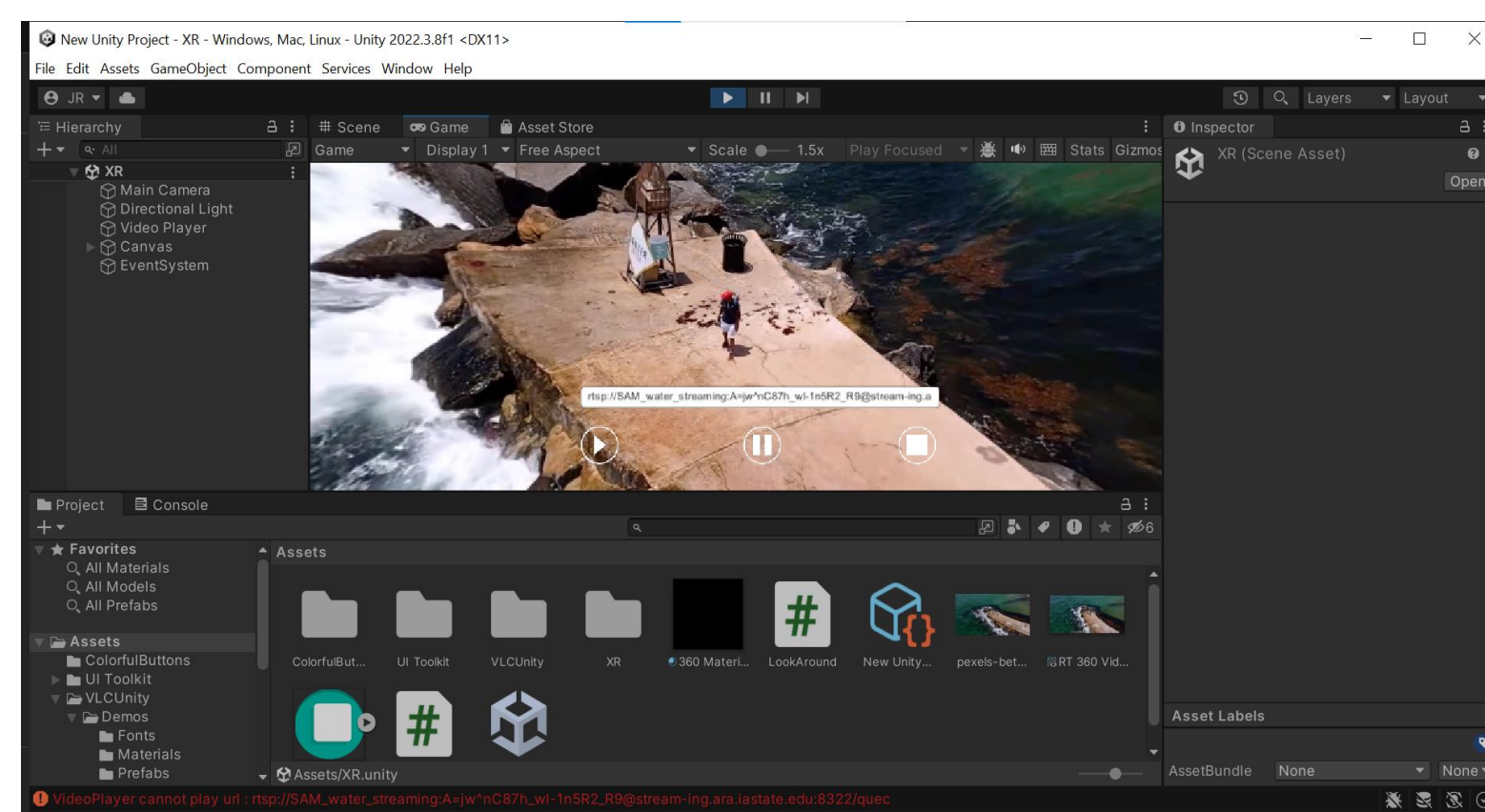
- The existing work done on the **ARA project**
- Unity**, gaming engine
  - VLC Unity**, plugin that allows use of VLC within Unity
  - Open XR**, open-source standard for XR and VR platforms and devices
- Wireshark**, a packet sniffer software, was utilized to monitor the system for metrics like average throughput and round-trip time
- Python** script was made to compute an average SSIM score of thousands of images before and after transmission over the ARA network

## Project Resources

Our project is supported by Dr. Hongwei Zhang and the ARA team, providing us with essential equipment. Throughout our endeavor, we collaborated closely with two exceptional graduate students that were also part of the ARA team, Evan Gossling and Elisabeth Adi.

## Implementation

- VLC Unity:**
  - Renders the streaming protocol with a focus on performance
  - Includes methods for displaying 3D videos
- Open XR:**
  - Handles XR control inputs
  - Additional UI elements



## Testing

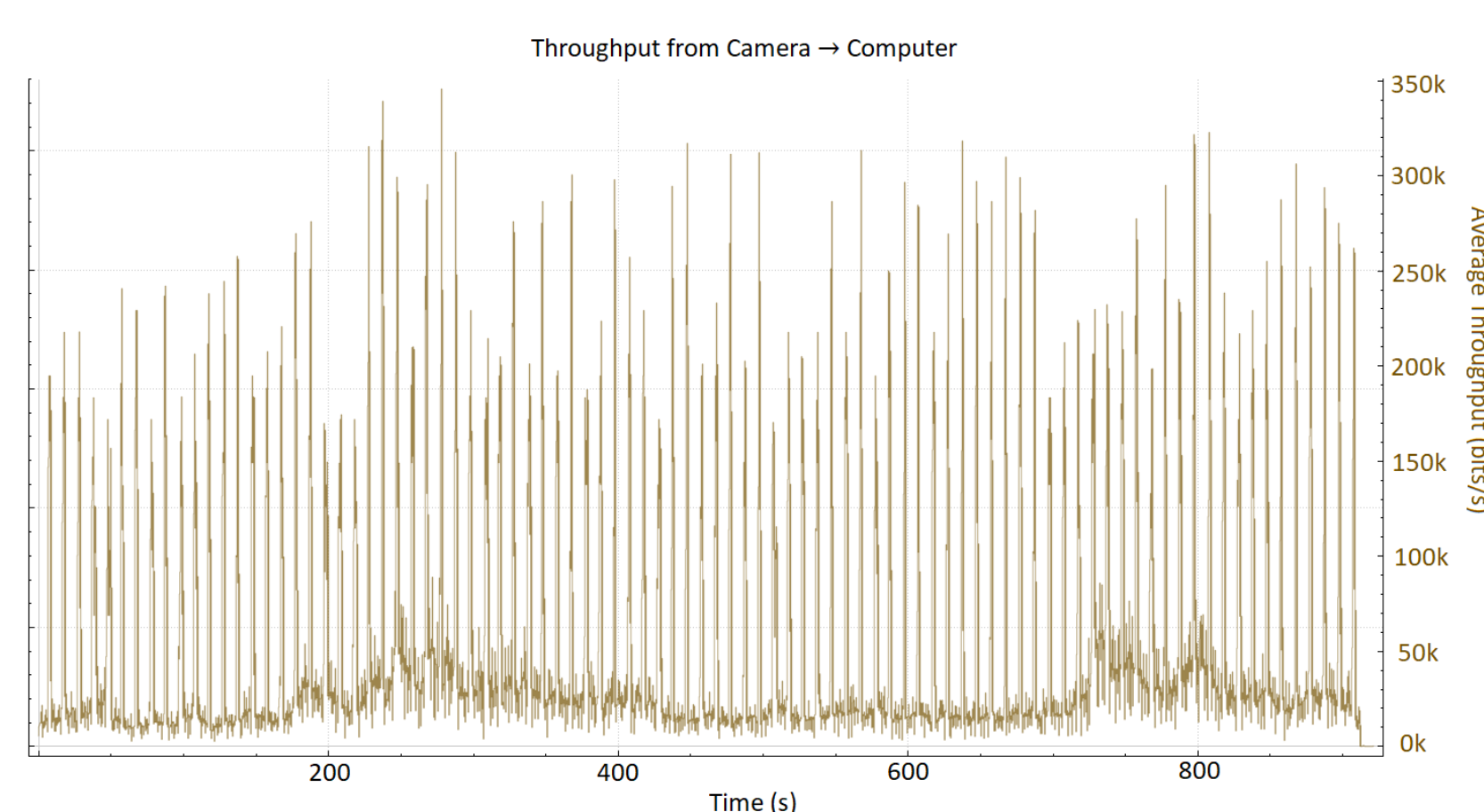
To compute QoE metric structure similarity index measure (SSIM), data was collected by recording the stream of the Insta360 Pro camera and saving footage locally while driving routes at Curtiss Farm. We then created a script to compute the average SSIM score of the overall trip by matching frames and calculating the SSIM score of the pairs individually.

### SSIM scores

Average: 0.9123  
High: 0.9589  
Low: 0.7775



Average throughput streaming over ARA network via Wireshark:



## Design Approach

