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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Results

Development and Testing of an Unmanned Aerial System (UAS) Cellular & Wi-Fi Repeater: Phase 1

Investigating the use of unmanned systems to provide a communications repeater to expand Caltrans communications coverage in rural areas

Rural

MAY 2023

Project Title:
Development and Testing of an Unmanned Aerial System (UAS) Cellular & Wi-Fi Repeater

Task Number: 3280

Completion Date: November 30, 2022

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WHAT WAS THE NEED?

Communication options in the California Department of Transportation (Caltrans) rural districts are intermittent and, in some cases, unavailable. Using satellites incurs high equipment and service costs, which typically impact efforts negatively and sometimes preclude use completely. There is a need to provide enhanced communications availability outside of current cellular offerings without investing in satellite equipment. Based on prior research, a large cellular network in California's rural districts exists, but the typical range of these sites is significantly limited by surrounding terrain and foliage. The aim of this project was to extend the edge of existing cellular infrastructure service boundaries further into rural districts. This involved a Unmanned Aerial System (UAS) with a communications payload developed to provide a cellular data service range extension via routing between a cellular modem wireless wide area network (WWAN) and a Wi-Fi base access point interface.

WHAT WAS OUR GOAL?

To develop a prototype payload system to investigate the use of UAS that would provide an aerial cellular / Wi-Fi communications repeater platform to expand Caltrans communications coverage in rural areas.

WHAT DID WE DO?

The research evaluated the potential of extending the range of existing wireless communications infrastructure for various remote communications use cases in existing rural projects. The issues addressed include:

Caltrans

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- What work has already been done in this area?
- What are currently identified best practices?
- What are Caltrans' desired use cases?
- What commercial UAS options are available to support this application?
- What operator training is required for this system?
- What are the current guidelines or regulations for operating a UAS near state highways?
- Is there an exemption process for the Department of Transportation?
- What range can be provided by the system?
- What bandwidth can be provided by the system?
- How much time does it take to deploy the system?
- How much time does it take to stow the system?
- How much flight time does the system provide?
- What use cases can the system support?

WHAT WAS THE OUTCOME?

To achieve the goal of this project, the following work was broken down into several tasks, which are documented in the final report, including:

- Developing a Concept of Operations for the project
- Performing literature and product searches based on project needs
- Developing system requirements for selected research concept
- Developing a detailed system design for selected research concept
- Procuring hardware based on the system requirements
- Obtaining required training and maintain certification for aerial repeater research
- Integrating hardware sub-systems for the project
- Developing software for the project
- Demonstrating the prototype system
- Performing aerial repeater research scenarios
- Analyzing the results of the overall project testing

WHAT IS THE BENEFIT?

This research provided a means to enhance wireless network coverage using existing cellular infrastructure without reliance on satellite communications services. Expanding current systems would provide significant benefits in rural areas with more challenging cellular communications. Additional benefits also include:

- Improved daily rural maintenance operations
- Improved maintenance incident response
- Improved ability to dispatch the correct equipment for a given situation based on facts from the field
- Enhanced safety of the traveling public
- Increased mobility of the traveling public
- Advanced equity and livability in rural communities

LEARN MORE

The final report is posted to this website when available:
https://dot.ca.gov/programs/research-innovation-system-information/research-final-reports

UC Davis Report Link:
https://ahmct.ucdavis.edu/sites/g/files/dgvnsk8581/files/inline-files/UCD-ARR-22-11-30-01.pdf

IMAGES

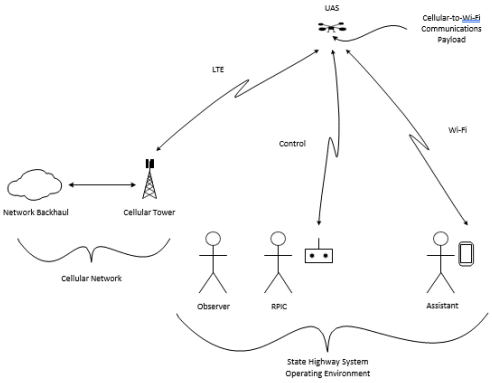

Image 1: The high-level architecture of the system