DRISI
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 2

Investigating the use of unmanned systems to provide a communications repeater to expand California Department of Transportation (Caltrans) communications coverage in rural areas.

Rural

**September 2025**

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

**Task Number:** 4297

**Start Date:** November 2023

**Completion Date:** April 2025

**Task Manager:**

Andres Chavez
Senior Transportation Engineer
Electrical (Specialist)
Andres.Chavez@dot.ca.gov

## WHAT WAS THE NEED?

In rural areas, there are often no available network communications options beyond satellite services which can be costly due to high equipment and service costs.

Research performed under Task 3280, showed that a UAS could elevate a payload into the cellular signal that was typically blocked by terrain and created a Wi-Fi network on the ground for worker communications. The next step in development was to conduct field trials to verify the technology's success in various terrain situations and validate the next-generation design for improved setup time, weather resistance, and improved ground Wi-Fi network quality. With a temporary Wi-Fi network in construction and emergency response areas, communication could now occur through emails andWi-Fi calling, assisting in efficiency, resource management, and accurate equipment deployment the first time.

## WHAT WAS OUR GOAL?

This project had two major deliverables: 1) A complete UAS payload package was delivered that created a ground Wi-Fi network for Caltrans employees to use in construction zones and emergency response. 2) The researchers worked with Caltrans to determine field test areas and developed training for Caltrans staff to utilize the UAS aerial repeater in construction projects and emergency response incidents in areas that lacked a cellular network at the roadway. The training materials and resources to assist in the field trials and future deployment were finalized per workers' feedback.

Caltrans

DRISI provides solutions and knowledge that improves California's transportation system.

## WHAT DID WE DO?

The goal of this research was to expand upon the successful UAS aerial repeater that was created in Task 3280. To improve the ground Wi-Fi network, the researchers evaluated several commercial offthe-shelf (COTS) vehicles routers and antenna configurations. After the components were selected, a weather-proof, easily assembled payload package was designed. The researchers worked with Caltrans to determine field test areas and developed training for Caltrans staff to utilize the UAS aerial repeater in construction projects and emergency response incidents in areas that lacked a cellular network at the roadway.

## WHAT WAS THE OUTCOME?

These were the results outlined in this research work:

- The UAS system extends the cell signal range, provided that a cell tower signal is within approximately 10 miles and the location is within the signal sector.
- There was no need for the drone to ascend to 350 feet Above Ground Level (AGL) to send emails or use Voiceover Internet Protocol (VoIP) if there is no broadband shadow; these tasks were successfully carried out at both 0 and 200 feet AGL.
- Having a strong cellular antenna and a reliable modem helps improve signal without the need to deploy the drone
    - Taking flight was required to acquire a signal in only two instances: Once when the UAS was deployed on Highway 299 and once when deployed on Highway 70.

These were the recommendations outlined in this research work:

- From the research, the UAS system has minimal gain in providing a communication network for users. Therefore, utilizing a Sierra Wireless MP70 modem and Proxicast antennas, or any highperformance modem and antenna pairing, can create a usable network in many situations when mounted to a vehicle.
- Future work should focus on a Starlink network system instead of a UAS-based network system.

## WHAT IS THE BENEFIT?

The research increases worker safety, resource management, and communication. Caltrans staff are able to effectively communicate with personnel and agencies outside of the construction or emergency response area through the ground Wi-Fi network connection to the cellular network previously inaccessible at their location. Having the proper resources arrive quickly is critical in rural settings when response distances can be over 50 miles.

## IMAGES

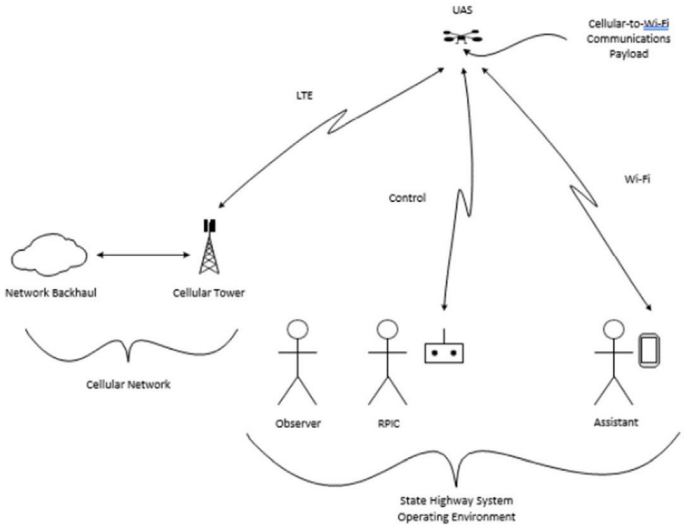


**Image 1:** High level architecture of the system