DRISI
CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

SpaceX Starlink Satellite Broadband Communications for ITS Pilot

Providing broadband to rural ITS field equipment

Rural

MAY 2025

Project Title:
SpaceX Starlink Satellite Broadband Communications for ITS Pilot

Task Number: 4059

Start Date: August 15, 2022

Completion Date: June 30, 2025

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WHAT IS THE NEED?

Reliable high-bandwidth rural communications have been a significant challenge since early deployments of Intelligent Transportation Systems (ITS) at Caltrans. While there is an effort to install fiber-optic broadband services on select rural highways throughout the state, the effort will take years before it's useable, won't be installed on every rural state highway, and will be located in areas highly susceptible to damage from wildfire, floods, and landslides. Reliable communications are critical to the perceived reliability of ITS Elements for the traveling public. ITS Elements cease to function as intended when communications systems fail. This poses a problem in rural areas where ITS Elements are deployed to mitigate the effects of non-reoccurring congestion due to snow, fire, floods, and other major incidents. Caltrans needs to find an alternative reliable high-bandwidth wireless communications option that is less susceptible to weather-induced incidents.

WHAT ARE WE DOING?

We are proposing to procure, install, operate, and evaluate four SpaceX Starlink satellite broadband communication services for various ITS Elements in District 2. Most rural Caltrans field sites selected have been impacted by the lack of available high-bandwidth communications options. These ITS field sites include infrastructure related to changeable message signs, video sites, and roadside weather information systems. This project will evaluate the procurement, construction, installation, integration, operation, and maintenance of four selected sites in rural regions of the state

WHAT IS OUR GOAL?

To provide reliable, cost-effective broadband communications solutions to field sites in the State's remote rural areas.

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WHAT IS THE BENEFIT?

As heavy snow, wildfires, floods, and other major incidents continue to impact terrestrial infrastructure, having an alternative high-bandwidth communications option in rural areas will be crucial. Satellite broadband services are linked to fixed low earth orbit satellites. Satellite services do not rely on terrestrial infrastructure, providing immunity to the incidents described above. With throughputs of up to 20 Gbps, satellite broadband offers enough bandwidth for the most bandwidthintensive TMS applications.

WHAT IS THE PROGRESS TO DATE?

- The research team has contracted with AHMCT to provide research on the SpaceX Starlink system. The contract was executed in Fall 2022.
- District 2 has selected three hub locations and 10 field locations. Based on Starlink availability, the project team will eventually select one hub location and four field locations.
- The research team created an "issues and features" document providing insight on various Starlink kits, equipment, and features and documenting known issues with equipment.
- The research team visited the selected hub site and two field sites to test Starlink equipment procured to date and determine what additional mounting equipment would be necessary. The team's uplink/downlink test results were very promising at each site.
- The team has procured mounting equipment and lightning suppression equipment that will be used to mount the dish to the CCTV poles/ communication towers. Testing has begun on the interface of the lightning suppression and the Starlink cabling to see what impact the additional equipment has on the Starlink equipment.
- Discussions with the Caltrans SatCom team about how we are using Starlink are ongoing.
- Equipment has been procured, including four flat high-priority kits and one high-priority kit. Mounting kits and piece parts to complete the installations have also been procured.
- Equipment to five field sites has been deployed. Preliminary results are very promising and at this point have not had any significant issues or problems with the equipment.
- Performance stats collected during a six-week window starting in December 20 were 23 through January 2024. See images below.
- Ethernet interface on deployed antennas (at two locations) have experienced ethernet port instability in the port auto-configuration. At both locations, a Polyphaser lighting arrestor were present, thus identifying root cause of instability was not possible.
- Separately, one Polyphaser lighting arrestor failed. The root cause was not identified, and a lightning strike was not ruled out.
- A no-cost time extension for this project has been approved. Initially slated to run through March 2024, it will continue through April 2025.
- In addition to the 5 High Performance Antenna deployed in District 2, one additional Standard
- Antenna was deployed in D6 for a short test that has already concluded. The Standard Antenna was then loaned out to D3 for a 6 month trial in a location with solar power as the only power source. While these tests were not part of the original scope, results will be included in the final report.
- Preliminary data, analysis and results were presented at Western Sates Rural Transportation Consortium's Western Forum in Yreka, CA.
- A second no-cost time extension for this project was approved which extended the end date from April 30th, 2025 to June 30th, 2025.

- Research has concluded. Maintenance and reliability are on par with other communication mediums. Starlink has coverage advantage which makes it available where no other communication provider has coverage, thus making it the only option. Final report will be delivered by June 30, 2025.

IMAGES

Image 1: Starlink high-performance antenna (left side of image) after installation at the Redding Fiber Hub – Image Source - AHMCT

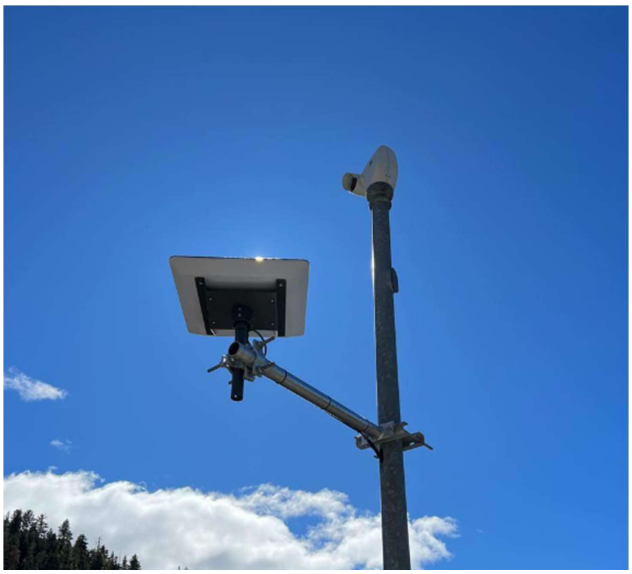

Image 2: Starlink high-performance flat antenna after installation – Image Source – AHMCT

Image 3: Starlink high-performance flat antenna after installation – Image Source – AHMCT

Kit	Location	Ave. Down link (kbps)	Ave. Uplink (kbps)	Ave. Obstruction (%)	Ave. Signal Quality (%)	Ave. Ping Loss (%)	Ave. Latency (ms)
HP	Redding Fiber Hub	108	10	0.3	99	0.3	32
Flat HP	Sims Rd	13	36	7	95	2.5	36
Flat HP	Lassen Pk	15	56	30	90	4.5	41
Flat HP	Cedar Pass	12	28	1	99	0.3	35
Flat HP	SR70-SR89	11	8	1.2	95	1.4	35

Image 4: Starlink performance stats during six weeks of testing in December 2023 and January 2024 – Source AHMCT