Using the System Manager Approach for Testing, Design, and Integration of Connected Vehicle Technologies

This article focuses on the System Manager approach as it applies to the SR 434 CV Pilot in Central Florida. The SR 434 CV Pilot was scoped with the deployment of CV equipment at six signalized intersections along a major arterial roadway adjacent to the University of Central Florida

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Emerging technologies are continuously changing how we live our lives and interact with the world around us; and just as quickly, these technologies are changing to meet new needs. This ever-evolving cycle of change has challenged the traditional design, construction, and integration methods used to deploy Intelligent Transportation System (ITS) technologies within the state of Florida. This is particularly true for the deployment of connected vehicle (CV) technologies.

Recently, the state has focused on deploying CV technologies throughout Florida with the goal of improving mobility and safety for all road users through pilot projects. The CV infrastructure being deployed as part of these pilot projects includes some of the following items:

- Roadside Equipment (RSE), deployed at signalized intersections or ITS sites, allows for wireless communications between roadside infrastructure and vehicles or other devices moving along the roadway.
- On-board Units (OBU), installed in vehicles, allow for wireless communications with the roadside equipment and may include mobile devices carried by pedestrians or bicyclists.
- Connected vehicle applications are programs that run on the roadside equipment, such as Signal Phasing and Timing (SPaT), which provide real time traffic signal status to road users via an onboard unit.

With the deployment of CV technologies though these pilot projects, the Florida Department of Transportation (FDOT) is using the System Manager approach, which changes the role of the engineer during the three distinct phases of an ITS project: design, construction,

and integration.

The goal of the System Manager approach is to manage the project risk. Connected vehicle equipment and software applications are emerging technologies that are continuously evolving. With this constant change, there is a level of uncertainty that equipment selected and deployed by the contractor will meet the needs of the project and be interoperable with other deployments within the state. The System Manager works with equipment manufacturers, FDOT, and the contractor to identify, select, test, and integrate equipment that will meet the project objectives to ensure successful deployment.

This article focuses on the System Manager approach as it applies to the SR 434 CV Pilot in Central Florida. The SR 434 CV Pilot was scoped with the deployment of CV equipment at six signalized intersections along a major arterial roadway adjacent to the University of Central Florida. The project followed the traditional design, bid, build process but also incorporated the System Manager approach.

Design

Traditionally, during the design phase of a FDOT project, the engineer selects ITS equipment for deployment from the FDOT Approved Product List (APL). For the equipment to be listed on the APL, it must undergo rigorous testing to demonstrate it meets the state's specifications. This allows the engineer to confidently select equipment that has proven capabilities.

However, at the start of the SR 434 CV Pilot, the specifications for CV equipment were still under development, and there were no products on the APL available for deployment. The first objective for the System Manager was to work with FDOT to define the operational requirements of the CV equipment. The System Manager then set up two rounds of testing to identify manufacturers that could provide CV equipment to meet these operational requirements.

The first round occurred in a laboratory environment, where equipment was tested for basic functionality. The second round of testing occurred in the field and demonstrated how the equipment functioned as part of a traffic signal system. Multiple manufacturers were invited to participate, and each provided equipment and technical support for the two rounds of testing. During these tests, the manufacturers were asked to demonstrate the CV applications selected for deployment with the SR 434 CV Pilot. These included Signal Phasing and Timing, CV emergency vehicle preemption, and CV transit signal priority.

The results of the tests were documented and used to develop a technical special provision, which was included in the specifications for the project. In addition, the testing results were included in the contract documents that were provided to the contractor during bidding to assist in device selection.

Also during the design phase, the System Manager performed field testing to determine the optimal mounting locations for the CV equipment. Similar to Wi-Fi, roadside CV equipment sends and receives wireless signals to all devices within its line of sight. At each of the project intersections, the wireless signal was tested to identify potential signal obstructions created by items such as utility poles, trees, and buildings. It was during these tests that the System Manager team discovered that mounting devices too close to existing signal equipment could reduce the broadcast range by half. Once again, the results of these tests were used to guide the design and incorporated into the contract documents.

Construction

In a traditional project approach, the engineer's role during construction is typically limited to reviewing shop drawings, answering requests for information, and providing any

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needed plan revisions. In addition to these tasks, the System Manager leads the testing and configuration of the proposed equipment. It is important to note that the System Manager does not replace the role of an independent Construction Engineering and Inspection (CEI) team.

For the SR 434 CV Pilot, once the contractor selected a manufacturer to provide the CV equipment, the System Manager reviewed and approved the device specifications. The contractor then procured a limited number of devices for functional testing, and the System Manager verified that these devices performed the same functions as devices tested during the design phase.

After functional testing was complete, the contractor procured the remainder of the devices needed to complete the SR 434 CV project and provided them to the System Manager for configuration and setup. The System Manager worked with the equipment manufacturer to ensure the devices were properly configured for deployment in the field. This included programming IP addresses, installing CV applications, and calibrating site-specific settings unique to each project intersection.

Integration

One of the most significant changes from the traditional project approach occurs during the system integration. Normally, after construction has finished, the contractor integrates the equipment, and FDOT tests it to ensure proper functionality. At this point, the engineer is traditionally no longer involved in the project, but with the System Manager approach the engineer oversees and participates in the integration and testing efforts.

On the SR 434 CV Pilot, the System Manager was responsible for integration of the equipment, which included programming the traffic signal controllers to allow for communications with the preconfigured CV equipment. The team then confirmed that traffic signal controllers were generating and sending the appropriate messages, such as Signal Phasing and Timing (SPaT), to the CV equipment. In addition to SPaT, CV-based emergency vehicle preemption and transit signal priority applications were integrated at select project intersections along SR 434.

After integration was complete, validation of the system was performed. A test vehicle equipped with an onboard unit was utilized to drive the project corridor. This allowed the System Manager to test the wireless broadcast of the CV equipment. Data exchanges between the test vehicle and CV equipment were monitored to ensure the appropriate messages were received at each of the project intersections. Test cases for the CV applications deployed as part of the project were utilized to confirm that each application performed the proper functions.

When the CV applications do not perform as intended, the System Manager works with the CV equipment manufacturer to address the issues. During this phase of the SR 434 CV Pilot, the contractor was retained to perform adjustments to the field equipment until successful operation was achieved.

Conclusion

The System Manager approach allows for the successful deployment of emerging technologies, such as CV equipment, by changing the approach to traditional ITS project development and implementation. Testing of the equipment through all three stages of the project allows for the development of equipment specifications, confirmation that the procured equipment meets the specifications, and verification the equipment operates as intended. It also increases collaboration between the engineer, Department, contractor, and equipment manufacturer during configuration and deployment of emerging technologies to ensure a successful project.

About the Author:

Nick Spatola, PE, PTOE, has experience with the design and deployment of ITS and signal systems and has developed ITS and signalization plans throughout the state. Mr. Spatola currently manages the SR 434 Connected Vehicle Pilot which utilizes the System Manager approach. Additional ITS experience includes the FDOT District 2 and District 7 FRAME projects and the PedSafe/Greenway Deployment in FDOT District 5. He also has experience performing traffic operations studies and signal timing.