CONNECTED VEHICLE PILOT DEPLOYMENT PROGRAM
PHASE 2: INTEROPERABILITY TEST

Over the course of four days in the summer of 2018, a watershed moment in the maturation of connected vehicle technologies occurred at the Turner-Fairbank Highway Research Center (TFHRC), a federally owned and operated national research facility in McLean, Virginia. Through a collaborative effort, the U.S. Department of Transportation (U.S. DOT) and the three Connected Vehicle Pilot sites conducted an interoperability test to demonstrate whether a vehicle with an onboard device from one site was able to receive messages from the onboard unit (OBU) and roadside units (RSUs) of another site in accordance with the key connected vehicle interfaces and standards. A test of this nature and scope, involving three deployment sites and six device vendors, had never been done before.

A Tampa vehicle receives an intersection movement assist warning being triggered by a New York City vehicle

Defining Interoperability

For the purposes of the test activities, interoperability is defined as:

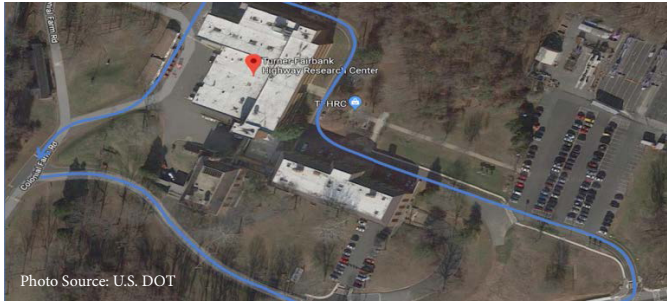"A vehicle with an OBU from one of the three Connected Vehicle Pilot sites is able to interact with OBUs and/or RSUs from the other sites in accordance with the key connected vehicle interfaces and standards."

Purpose and Scope

The purpose of the Connected Vehicle Pilots Phase 2 Interoperability Test was to demonstrate vehicle-to-vehicle (V2V) interactions between different sites' OBUs and vehicle-to-infrastructure (V2I) interactions between selected OBUs and RSUs. OBUs were expected to:

• Receive Basic Safety Messages (BSMs) transmitted by each of the other sites' OBUs
• Authenticate messages as needed (i.e., when acting on the data or "hearing" a device for the first time)
• Parse messages (i.e., decode messages to the individual data element level)
• Process messages (i.e., use the data as an input to applications, triggering responses according to the device's own application).

Connected Vehicle Pilot Deployment Program

The Connected Vehicle Pilot Deployment Program was launched in September 2015 to deploy, test, and operationalize cutting-edge mobile and roadside technologies and to enable multiple connected vehicle applications. Sponsored by the Intelligent Transportation Systems (ITS) Joint Program Office (JPO), the U.S. DOT awarded cooperative agreements to three agencies:

• New York City Department of Transportation (DOT)
• Tampa Hillsborough Expressway Authority (THEA)
• Wyoming DOT.

During Phase 1, each site prepared a comprehensive deployment concept plan that addressed all aspects of deployment including applications, security, operation and maintenance, procurement, and testing.

In Phase 2 (fall 2016 to spring 2019), the three sites designed, built, and tested the nation's most complex and extensive deployment of integrated and wireless in-vehicle, mobile device, and roadside technologies.

In the spring of 2019, all three sites enter Phase 3, wherein the Connected Vehicle Pilot sites operate and maintain their pilot deployment, assess impacts, and evaluate deployment performance.

U.S. Department of Transportation

Photo Source: U.S. DOT

The TFHRC facility used for the CV Pilots Phase 2 Interoperability Test

Applications Tested

The testing leveraged the following applications to demonstrate interoperability:

- **Forward Collision Warning (FCW)** – This application presents alerts to the driver to help avoid or mitigate the severity of potential crashes into the rear end of other vehicles on the road. FCW responds to a direct and imminent threat ahead of the host vehicle.
- **Emergency Electronic Brake Lights (EEBL)** – This application alerts the driver to hard braking in the traffic stream ahead. This provides the driver with additional time to look for and assess developing situations.
- **Intersection Movement Assist (IMA)** – This application warns the driver when it is not safe to enter an intersection—for example, when something is blocking the driver's view of opposing or crossing traffic. This application only functions when the involved vehicles are each V2V equipped.
- **Red-Light Violation Warning (RLVW)** – This application broadcasts signal phase and timing and other data to the in-vehicle device, allowing warnings for impending red-light violations.

Testing

Testing was conducted at TFHRC on June 25 to 28, 2018. The first day allowed time for the Connected Vehicle Pilot sites to finalize installation of their devices in TFHRC-provided vehicles and to configure their applications. Each of the six TFHRC-provided vehicles was outfitted with an OBU from one of the Connected Vehicle Pilot site's OBU vendors. In addition, the New York City and Tampa sites each loaded their software on TFHRC-supplied RSUs from a single vendor. In total, two RSUs were used—both from the same vendor but with software from New York City and THEA. All devices used test certificates and were enrolled with a security credential management system that employed highly innovative methods of encryption and certificate management to facilitate trusted communication.

Test Results

Over four days, more than 100 tests were conducted at TFHRC. Data was collected for all tests and then sent to the cloud-based system where it is available to support future research activities. Results of the testing indicated successful, interoperable transfer of V2V messages between the six vehicles from five different vendors, four of which used dedicated short-range communications (DSRC) and one used a combination of DSRC and satellite communications. Additionally, equipment from each vendor demonstrated the successful transfer of messages between RSUs and each site's OBUs.

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