U.S.Department of Transportation
Federal Highway Administration

TRANSPORTATION OPERATIONS
RESEARCH AND DEVELOPMENT
Turner-Fairbank Highway Research Center

WINTER 2014-2015 UPDATE

Research Vehicle to be Displayed at TRB Annual Meeting

Cooperative adaptive cruise control is the first operational concept that FHWA will test using the five-vehicle research fleet.

A vehicle from Federal Highway Administration's (FHWA) Office of Operations Research and Development (R&D) research fleet will be displayed at the Transportation Research Board (TRB) Annual Meeting, which takes place January 11–15, 2015 in Washington, DC. The vehicle, one of five Cadillac SRX Crossover vehicles that comprise the fleet, was equipped by FHWA with a technology platform to guide connected automation research over the next 5 to 10 years. The platform enables fully automatic control of acceleration and braking, with the flexibility to support steering controls for future connected automation research. The platform provides researcher-friendly access to longitudinal control of the vehicle and manufacturer-equipped sensors, and it supports software development with common tools such as MathWorks Simulink and MATLAB. In addition, the platform supports vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications using dedicated short-range communications (DSRC) and cellular communications.

Cooperative Adaptive Cruise Control (CACC) will be the first operational concept to be tested using the five-vehicle fleet. Researchers will leverage the longitudinal control capabilities and a data elements library provided by the platform to deliver and implement speed and torque commands. The vehicles will also use V2V communications to share speed, heading, location, and gap information to achieve smoother operation in a five-vehicle platoon. The resulting CACC functionality of the research vehicles can be leveraged by future projects to study additional operational, connected vehicle, and automation concepts and applications.

For more information, contact Taylor Lochrane at **taylor.lochrane@dot.gov**.

In December 2014, FHWA Office of Operations R&D team members received a 2014 Administrator Team Award for the establishment of the Saxton Transportation Operations Laboratory. Award recipients include FHWA's Joe Bared, Bob Ferlis, Taylor Locrhane, Gene McHale, Ben McKeever, Joe Peters, Randy VanGorder, and Mohammed Yousuf. ***Congratulations to all!***

LANE CHANGE/MERGE FUNDAMENTAL RESEARCH TASK KICKS OFF

The FHWA's Office of Operations R&D recently kicked off a task to initiate real-world, foundational research on lane change/merge maneuvering in vehicles with automated longitudinal control. The objective of the project is to obtain a basic, experimental understanding of the needs and methodologies for performing automated lane change/merge maneuvers. The research team will develop a "Vehicle Maneuvering Ideas/Concepts Matrix," in which they will define concepts for lane change/merge (i.e., scenarios, use cases, etc.); develop hypotheses for each concept; determine the hardware, software, and data needs for each concept; and evaluate the concept by quantifying its impacts on traffic throughput, safety, and fuel consumption. In addition, the team will develop and simulate algorithms for lane change/merge. These algorithms will be implemented and tested on two of FHWA's research vehicles at Turner-Fairbank Highway Research Center (TFHRC). FHWA's project partners include Auburn University, Leidos, University of California–Riverside, and Ohio State University.

For more information, contact Dan Dailey at **daniel.dailey.ctr@dot.gov**.

NEW TEST VEHICLE ARRIVES FOR GLIDEPATH PROJECT

An Automated Prototype Vehicle was delivered to TFHRC in early November for preliminary development and integration of the GlidePath application, which is being developed as part of FHWA's Office of Operations R&D Project (for more information, see **http://www.its.dot.gov/aeris/pdf/07_FHWAsGlidePathProject.pdf**). The project is being conducted in coordination with the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) Applications for the Environment: Real-time Information (AERIS) program. The research vehicle is a Ford Escape Hybrid equipped with full-range speed control, on-board computing, and an after-market Driver-Vehicle Interface that will support many future applications in addition to the current GlidePath project. Saxton Lab staff will implement software on the vehicle's on-board computer to enable electronic control of the vehicle's speed during an approach to the facility's Intelligent Intersection. The purpose of the application is to improve environmental performance by reducing idling at the intersection, or by approaching and departing the intersection in the most eco-friendly manner. Testing is currently scheduled for early spring to support demonstrations in June 2015.

This Ford Escape Hybrid will be equipped to support FHWA's automated GlidePath project.

For more information, contact Osman Altan at **osman.altan@dot.gov**.

FHWA INITIATES NEXT PHASE OF SPEED HARMONIZATION RESEARCH

Speed harmonization is an infrastructure-to-vehicle communications method by which speeds of vehicles approaching a bottleneck are slightly decreased in order to smooth traffic flow, reduce stop and go traffic, and slow the onset of major congestion. During the summer of 2014, FHWA's Office of Operations R&D led a speed harmonization field test with three vehicles in live traffic.

Under the new project, "Speed Harmonization Fundamental Research," researchers will build on experiences and lessons learned from the field test. The objective of the task is to develop new speed harmonization concepts for testing and identify ancillary technologies required for testing. The new speed harmonization concepts will demonstrate that vehicles can safely operate in an automated fashion to provide cooperative speed harmonization and provide insight into the potential performance benefits if more vehicles are equipped with automated longitudinal control. In order to accomplish these objectives, the team will revise the speed harmonization algorithms developed for the field test and will conduct additional testing using FHWA's five-vehicle research fleet. Testing phases will include: closed-course verification at TFHRC at slow to moderate speeds; a "shadow mode" phase in which the vehicles will receive speed guidance in live traffic but automated longitudinal control will not be applied; and a full automated control phase in which the vehicles will receive speed guidance in live traffic and automated longitudinal control will be applied to adjust speeds.

The FHWA project team for this task includes Leidos, California Partners for Advanced Transportation Technology (PATH), Texas

USDOT HOSTS PUBLIC WORKSHOP ON AERIS PROGRAM

On October 22, 2014, ITS JPO hosted a free, public workshop on the AERIS program in Washington, DC. Presenters discussed the potential environmental benefits of connected vehicle applications and described real-world environmental projects currently deployed in the U.S. and Europe. In addition, the workshop sought to brainstorm ideas with the adopter community on environmental applications that may be considered for connected vehicle pilot demonstrations.

FHWA's Office of Operations R&D coordinates closely with ITS JPO on the development, testing, and evaluation of AERIS operational scenarios and applications. FHWA's Osman Altan presented at the workshop on FHWA's GlidePath project, which will result in a working GlidePath application with automated longitudinal control. The project team will demonstrate and evaluate the prototype application at TFHRC in 2015

To view the presentation from the workshop, visit **http://www.its.dot.gov/aeris/aeris_oct2014_workshop.htm.**

A&M Transportation Institute, TORC Robotics, and Virginia Tech Transportation Institute.

For more information, contact Dan Dailey at **daniel.dailey.ctr@dot.gov**.

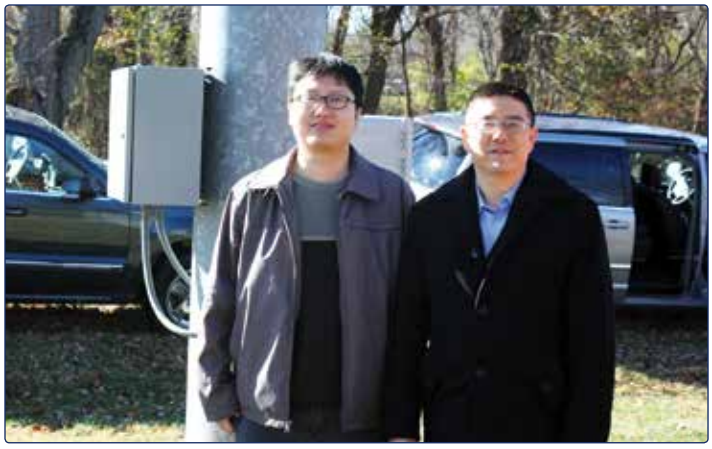
UNIVERSITY RESEARCHERS EXPLORE CAPABILITIES OF CONNECTED INTERSECTIONS

Connected vehicle technologies have the potential to reduce congestion at intersections through V2I communications, which in turn could improve safety and decrease fuel consumption and emissions at intersections. However, until market penetration of connected vehicles increases enough to show significant benefits, State and local departments of transportation (DOTs) may not be able to allocate resources to equip their infrastructure for V2I applications. Therefore, there is a need to identify how connected vehicles can benefit implementers in an early stage of deployment. One possible "early win" is more robust data. Even a limited number of connected vehicles can generate a significant amount of data, and there is an opportunity to harness these data to improve operational decision making.

Two visiting researchers from Mississippi State University, Dr. Li Zhang, an associate professor, and Zhitong Huang, a graduate research fellow, are working at TFHRC's Saxton Laboratory to explore this opportunity in relation to signal timing. Under the project, "Safety and Mobility Benefits of Connected Vehicles at Signalized Intersections," they are developing a prototype signal phase and timing (SPaT) application for installation in existing traffic signal controller hardware. The application collects vehicle trajectory data from basic safety messages (BSMs) transmitted by connected vehicles. These data provide a comprehensive picture of traffic patterns at an intersection, which can be used by a traffic signal controller to generate more responsive, real-time signal timing plans. In contrast, most traffic signal controllers currently base signal timing plans on very limited data collected from loop or video point detectors located near the intersection.

To test the capabilities of the SPaT application, the research team is installing a proof-of-concept version in the traffic signal controller at TFHRC's Intelligent Intersection. The software underlying the application is open source so it can be modified for future installations in other locations. The team will measure the mobility, energy, and safety benefits associated with the SPaT application.

For more information, contact Deborah Curtis at **deborah.curtis@dot.gov**.



University of Mississippi Researchers Dr. Li Zhang (right) and Zhitong Huang (left) at the TFHRC Intelligent Intersection.

JAPANESE DELEGATION VISITS TFHRC

On October 16, 2014, a delegation from the Japan Ministry of Land, Infrastructure, Transport and Tourism (MLIT) visited TFHRC as part of a 3-day tour that also included visits to the U.S. Department of Transportation's (USDOT) headquarters and the Virginia Department of Transportation. Two of the visitors including Yasuhiko Iwasaki, Director of the National Institute for Land and Infrastructure Management, were formerly visiting researchers at TFHRC as part of the United States-Japan ITS Joint Research Program.

As part of their tour, the guests saw the Saxton Laboratory, where FHWA's Bob Ferlis provided an overview of the facilities and ongoing connected vehicle research projects, such as eco-drive, speed harmonization, advanced freeway ramp merge, and CACC. In addition, FHWA's Dr. Gene McHale described the United States-Japan-European Union (EU) Probe Data working group, which seeks to jointly identify applications of probe data for further focused information sharing, and to share data, research findings, experiences, and lessons learned. Dr. McHale also discussed the Connected Vehicle Basic Safety Message (BSM) Data Emulator, which examines the effectiveness of BSM and Japanese and EU messaging protocols in estimating key transportation measures under various scenarios. The delegation's visit also included a tour of the Saxton Laboratory Test Vehicle Garage, where they learned about the testing capabilities of FHWA's research vehicle fleet.

For more information, contact Bob Ferlis at **robert.ferlis@dot.gov.**

RECENT PRESENTATIONS

On October 7, 2014, FHWA Office of Operations R&D Director Joe Peters presented at the 2014 Planning and Programming Conference, co-hosted by West Virginia DOT, FHWA, and West Virginia Association of Metropolitan Planning Organizations in Parkersburg, WV. In his presentation, "Pathways to Automation: The Role of Vehicles and Infrastructure in a Future Transportation Environment," Dr. Peters discussed the importance of connectivity in enhancing the mobility and safety benefits of automation. He highlighted ongoing FHWA connected automation research projects and stressed the importance of collaboration among government, industry, and academia in achieving the benefits of a connected and automated transportation environment.

For more information, contact Joe Peters at **joe.peters@dot.gov**.

USDOT COLLABORATES WITH EUROPEAN UNION ON CONNECTED VEHICLE RESEARCH

On November 2-6, 2014, FHWA's Ben McKeever traveled to Brussels, Belgium with other USDOT representatives to participate in technical exchange meetings with the European Commission (EC) Directorate General for Mobility and Transport (DG MOVE). The meetings included presentations by Ben McKeever, Brian Cronin, Bob Sheehan, and Jane Lappin of USDOT, and representatives of DG MOVE on their respective connected vehicle research activities. The USDOT team also observed the inaugural meeting of the Platform for Cooperative ITS (C-ITS Platform) in the European Union (EU), a new EC initiative that brings together over 80 ITS stakeholders to map out a strategy for deploying connected vehicle technologies throughout the EU. Lastly, the USDOT representatives met with the Amsterdam Group, a collection of EU road authorities, tolling authorities, localities, and auto manufacturers focused on deploying and testing interoperable connected vehicle technologies and applications across multiple EU countries.

Over the course of the trip, the USDOT team met with experts and leaders from all of the European countries participating in the pan-European field operational tests of connected vehicles. The USDOT and EC agreed to share data collected during US and EU field trials, as well as methods to evaluate the trials. As a result of the meetings, a new Deployment Working Group was established under the USDOT/EC Bilateral Memorandum of Agreement for Collaborative ITS Research. Through the working group, the USDOT and EC will continue to collaborate on cooperative vehicle-highway systems research.

For more information on the meetings between USDOT and the EC, contact Ben McKeever at **ben.mckeever@dot.gov**.

EDC 2 TEAM RECOGNIZED

The Every Day Counts (EDC) 2 Intersection and Interchange Geometries (IIG) Team was recognized for outstanding performance by FHWA's Office of Technical Services. The team includes Joe Bared of FHWA's Office of Operations R&D. Bared leads the Transportation Operations Concepts and Analysis Team. The objective of this EDC 2 initiative is to increase deployment of alternative designs of IIGs, which can increase safety and improve mobility. Designs promoted by the team include the diverging diamond interchange, the displaced left-turn intersection, U-turn intersections, and the modern roundabout. Data from the January 2014 EDC 2 progress report showed that 23 States have achieved "post-demonstration" on two or more IIG types, with a high likelihood of additional States reaching this level by the end of 2014.

For more information, contact Joe Bared at **joe.bared@dot.gov.**

STAFF UPDATES

In October, FHWA's Taylor Lochrane successfully defended his Ph.D. in Civil Engineering from the University of Central Florida. Dr. Lochrane has been with the FHWA's Office of Operations R&D for 4 years. He came to FHWA under the Student Career Experience Program (now referred to as the Pathways Program) and was hired into a full-time position in November 2013 while still working on his dissertation. Dr. Lochrane leads modeling, simulation, and vehicle automation testing projects in the area of connected vehicle applications.

FHWA's David Gibson, a Highway Research Engineer with FHWA's Office of Operations R&D, will retire in February 2015. Gibson started at FHWA over 35 years ago as an engineering technician for the Mobility Equipment R&D Center in Fort Belvoir, VA. During his career at FHWA, he worked on three editions of FHWA's Traffic Detector Handbook and has advanced new technologies for traffic signal sensors, including stereo vision and radar and vehicle signature sensors for identifying, re-identifying, and anonymously tracking vehicles. He has also led numerous projects under the Small Business Innovation Research and EDC programs.

ROB KLUGER, a Ph.D. Candidate at the University of Virginia, has begun a 1 year assignment at TFHRC under the Eisenhower Grants for Research Fellowship. His research will focus on designing a system that uses data elements collected in the Basic Safety Message (BSM)to conduct a network screening process (i.e., a large-scale, system-wide search of the road network to identify sites that are operationally unsafe).

CHRIS MELSON recently completed a 5-month Professional Development Program assignment at FHWA's Office of Operations R&D. During his assignment, Melson completed a study on the design of a one-sided interchange which could be used where footprints prevent the use of full clover leaf designs. Chris has submitted technical papers on the results of his study to the ITE Journal and International Symposium on Highway Geometric Design (currently under review). Melson is returning to the Eastern Federal Lands Safety/ Transportation Operations Team, where he will soon be conducting an assignment with FHWA's Office of Operations and the FHWA's Resource Center, involving cluster analysis as it relates to traffic simulation.

Publication No. FHWA-HRT-15-029
HRDO-1/12-14 (Web)