Connected Vehicles

CC 4

Photo: Courtesy of Neil Hetherington, WTI

Description: Connected vehicles have the ability to "talk" to other vehicles, infrastructure, smartphones, and other devices. Communication is transmitted over a variety of mediums and is used to gain awareness of other vehicles (vehicle to vehicle, V2V) and nearby infrastructure (vehicle to infrastructure, V2I). Connected vehicles can work to improve safety by providing a basic safety message to the driver of potential hazards such as a risk of a collision, dangerous driving conditions, when a light is about to turn red, or if the vehicle is leaving the lane (e.g. addresses drowsy drivers). Sensors in infrastructure can communicate with connected vehicles to provide up-to-date traffic information to the vehicle, smartphone or Global Positioning System (GPS) device. Connected vehicles are different than autonomous vehicles because the former still requires a driver to take action whereas the latter may not.

Rural Transportation Critical Needs

- ☑ Crash Countermeasures
- ☑ Emergency Services
- ☑ Operations & Maintenance
- ☑ Rural Transit & Mobility
- ☑ Surface Transportation & Weather
- ☑ Tourism & Travel Information
- ☑ Traffic Management

Issues Addressed

- ☑ Road Geometry Warning
- ☑ Highway-Rail Crossing Warning
- ☑ Intersection Collision Warning
- ☑ Pedestrian Safety
- ☑ Bicycle Warning
- ☑ Animal Warning
- ☑ Collision Avoidance
- ☑ Collision Notification
- ☑ Weather Warning

Strategies Achieved

- ☑ Road User
- ☑ Road
- ☑ Vehicle
- ☐ Safety Culture
- ☑ Engineering
- ☐ Emergency Response
- ☐ Enforcement
- ☐ Education

Applicability	Partnerships	Key Components
•Connected vehicles are applicable to many transportation safety applications in both urban and rural environments. Vehicle to vehicle (V2V) applications work to increase safety by providing collision, blind spot, or do-not-pass warnings. Vehicle to infrastructure (V2I) applications can warn a driver of an oncoming train, provide information on sudden geometric changes in the roadway, prioritize signal timing, reduce congestion, or provide notifications of poor weather conditions.	•Applications benefit from collaboration among numerous agencies, which may include: •Vehicle manufacturers •Departments of transportation (local, state, federal) •Emergency services •Law enforcement •Rail agencies •Schools •Trucking companies	•Vehicle owner •Smartphone •After market communications devices •Vehicle manufacturer •Manufacture vehicles with communication devices •Infrastructure owner •Install infrastructure that is able to communicate with connected vehicles

Examples of Implementation

- **I-80 Corridor Connected Vehicle Pilot**

The I-80 corridor in Wyoming was chosen as a pilot site for the United States Department of Transportation connected vehicles deployment project. This corridor is impacted frequently by winter weather and high wind conditions. The Wyoming Department of Transportation in coordination with ICF International, the University of Wyoming, the National Center for Atmospheric Research, Trihydro, the University of Maryland – Center for Advanced Transportation Technologies, and McFarland Management will deploy V2I and V2V technology to warn drivers about road weather advisories and reduced speed conditions.

- **Tampa-Hillsborough Expressway Authority (THEA) Pilot**

The THEA pilot program will deploy connected vehicle technology to 1,500 vehicles, 10 buses, 10 trolleys, 500 pedestrians with smartphones, and 40 roadside units along the Selmon reversible express lanes. This project aims to reduce congestion and collisions, as well as increase pedestrian safety.

- **Minnesota Department of Transportation Connected Vehicles Test**

Minnesota Department of Transportation conducted a study of 500 vehicles equipped with connected vehicle technology, primarily a smartphone with an application that can track vehicle trips. The study tested the feasibility of using connected vehicle technology with mileage based user fee programs and to provide vehicle probe data.

Implementation Considerations (Pro)	Implementation Considerations (Con)
•Increases safety. •Improves mobility. •Does not rely on "line of sight" communication. •Ability of the car to take corrective actions.	•Warnings received while driving could be distracting. •Need to address privacy concerns of the public. •Need to ensure that there are no connection issues between device and infrastructure. •Not all vehicles will have the ability to talk to other vehicles or infrastructure. •Rural areas have more communication and power challenges than urban areas.

Opportunities for Future Expansion

- Connected vehicles use a new technology with ongoing and rapid developments. There is a lot of research and testing currently in progress, with results slowly being rolled out. In the future, connected vehicles have endless possibilities. The biggest limitation will be funding. Connected vehicles can be used in coordination with many other Intelligent Transportation Systems. For example, a connected vehicle could communicate with a highway-rail crossing system to warn a driver of an oncoming train. Connected vehicles could be used in coordination with roadway weather information systems to let drivers know of inclement weather conditions on their route. In the future, connected vehicles will also be able to identify and warn each party in a pedestrian/vehicle or bicycle/vehicle conflict.

Additional Resources

- United States Department of Transportation *Connected Vehicle Basics*, found here: http://its.dot.gov/cv_basics/index.htm
- *Automated and Connected Vehicles – Summary of the 9th University Transportation Centers Spotlight Conference*, found here: http://www.trb.org/Main/Blurbs/174288.aspx
- 2015 Federal Highway Administration *Vehicle-to-Infrastructure Deployment Guidance and Products*, found here: https://transportationops.org/research/vehicle-infrastructure-deployment-guidance-and-products
- *Intelligent Transportation Systems, Vehicle-to-Infrastructure Technologies Expected to Offer Benefits, but Deployment Challenges Exist*, found here: http://www.gao.gov/assets/680/672548.pdf
- *Connected Vehicle Benefits*, found here: http://www.its.dot.gov/factsheets/pdf/ConnectedVehicleBenefits.pdf
- *Connected Vehicle Application Roadmap for Oregon as Part of Preparing a Possible Oregon Road Map for Connected Vehicle/Cooperative Systems Deployment Scenarios*, found here: https://ruralsafetycenter.org/wp-content/uploads/2018/03/CC4.pdf
- *V2V Communications Fact Sheet*, found here: http://www.safercar.gov/v2v/index.html

Useful Tip

If an individual already owns a vehicle without connected vehicle technology, there are low-cost opportunities to add an aftermarket communication device to the vehicle.

Cost Range

(Cost/financial information, where noted, is based on 2016 dollars (unless otherwise specified). Cost/financial information is estimated, and will vary based on size and scope of project, number of units, etc. In general, capital costs include initial purchase costs of hardware, software, and other required equipment. Maintenance and operations costs include staff time to operate, monitor and maintain systems; data collection; system upgrades; evaluation; etc.)

Capital Costs: The total capital cost for this tool is low (Less than $50,000) to medium ($50,000 to $100,000). The additional base vehicle price for connected vehicle technology is estimated to be $350 by 2017. As an example, the United States Department of Transportation, in partnership with Transport Canada, the American Association of State Highway and Transportation Officials (AASHTO) and other stakeholders, conducted research on the creation of a connected vehicle field infrastructure. The estimated cost to deploy V2I at a signalized intersection with the ability for traffic control was $51,600. The cost without traffic control upgrades was $48,400[1].

Operations Costs: The operations and maintenance costs for this tool can range from low (Less than $50,000) to higher (above $250,000). These costs include those for the owner to upgrade/keep the technology in the car working, costs to the vehicle manufacturers to continuously research and update what is offered in a vehicle, costs to the department of transportation for staff time, and costs for power and communication.

This material is based upon work supported by the U.S. Department of Transportation under Cooperative Agreement No. DTFH6114H00021. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the Author(s) and do not necessarily reflect the view of the U.S. Department of Transportation.