



Strategies to Advance Automated and Connected Vehicles: A Primer for State and Local Decision Makers

NCHRP Report 845

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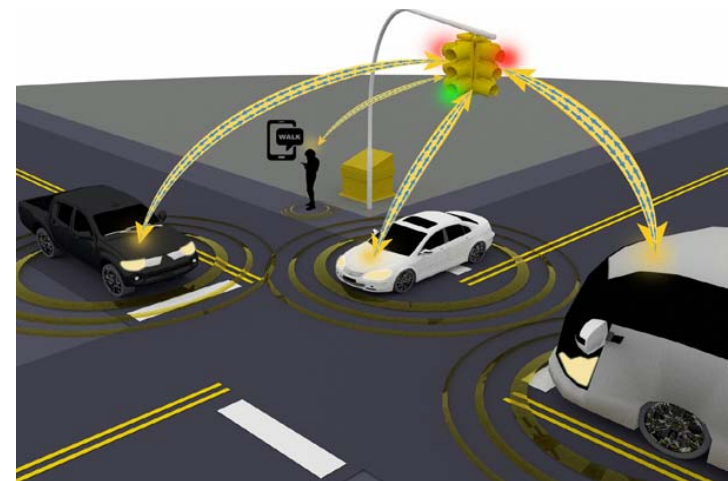
Vehicles that are increasingly automated and connected have the potential to profoundly change personal, freight and public transportation



NCHRP CV & AV Research



- \$6M invested by state DOTs through NCHRP since Dec. 2014
- Project selection guided by a Research Roadmap developed in 2014, will be updated this year
- Selection of research tasks by NCHRP 20-102 panel considering input from U.S. DOT, V2I Deployment Coalition, AASHTO & TRB Committees, ITE CV/AV Steering Committee, and Automated Vehicle Symposium



Source: www.its.dot.gov





NCHRP CV/AV Completed

- Challenges to CV and AV Application in Truck Freight Operations
- Road markings for Machine Vision (phase 1)
- Impacts of Regulations and Policies on CV and AV Technology Introduction in Transit Operations
- Advancing Automated and Connected Vehicles: Policy and Planning Actions for State and Local Transportation Agencies



Source: en.wikipedia.org



NCHRP CV/AV Products Coming Next Year



- **Dedicating Lanes for Priority or Exclusive Use by CVs and AVs**
- **Implications of Automation for Motor Vehicle Codes**
- **Providing Support to the Introduction of CV/AV Impacts into Regional Transportation Planning and Modeling Tools**
- **Connected Road Classification System Development**



Source: en.wikipedia.org



NCHRP CV/AV Work In the Pipeline



Source: www.econolite.com

- Business Models to Facilitate Deployment of CV Infrastructure to Support AV Operations
- Cybersecurity of Traffic Management Systems
- Impact of Mobility-on-Demand Services and Highly Automated Vehicles on the Transportation System
- Understanding the Impacts of the Physical Highway Infrastructure Caused by the Increased Prevalence of Advanced Vehicle Technologies
- Planning Data Needs and Collection Techniques for CV/AV Applications
- Data Management Strategies for CV/AV Applications for Operations

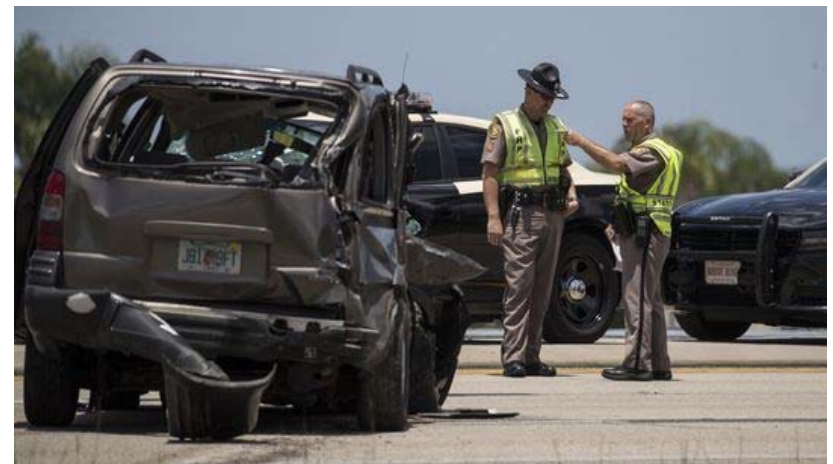


New NCHRP CV/AV Projects

Panel nominations welcomed! (rderr@nas.edu)



- Preparing Traffic Incident Management Responders for Connected Vehicles and Automated Vehicles
- Deployment Guidance for Connected Vehicle Applications in the Open Source Application Development Portal
- Minimum Safety Data Needed for Automated Vehicle Operations and Crash Analysis



Source: <http://www.news-press.com>





Our Research Study: Objective

Assess potential policy and planning strategies for use by state and local governments that guide the deployment of AV and CV to create positive outcomes for society



Context: Technology



Automated Vehicle (AV)

One that takes control of aspects of the driving tasks

- For this research, only higher levels of automation are considered



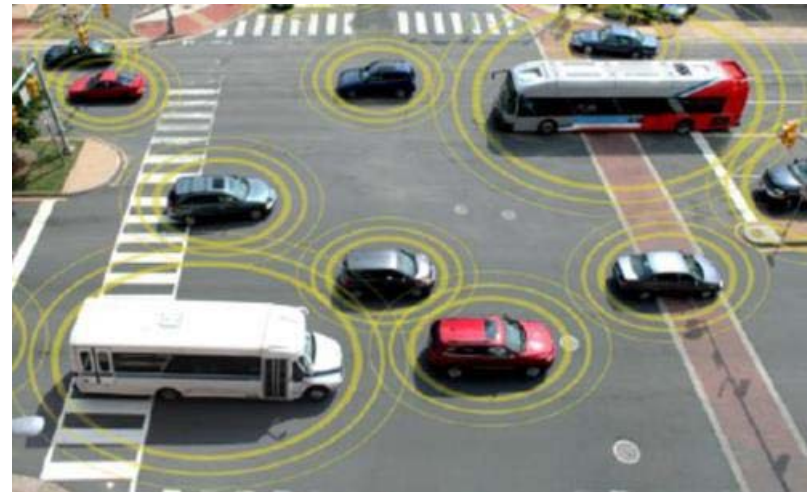


Context: Technology

Connected Vehicle (CV)

Internal devices connect vehicles to other vehicles, to infrastructure, to cloud, and to other road users

- Provide driver alerts but do not control the operation of the vehicle



Context: Regulatory

- New guidance September 2017
- NHTSA regulates vehicle safety and equipment
 - Scaled back safety assessments required for testing
 - Level 2 no longer considered AVs
- States responsible for licensing registration, rules of the road
 - Model state policy replaced by best practices





Effects of AV and CV

- Traffic Crashes
- Congestion
- Pollution
- Land Development
- Mobility





Potential Benefits of Connectivity and Automation

Driving Externality	Connectivity (Full V2X)	Autonomy* (L4,5)	Shared Autonomy (L4,5)	Electrification**
Safety				
Congestion				
Emissions				
Land				
Mobility				

*Autonomy is defined for this purpose as individually owned vehicle.

**While not a focus of this NCHRP research, the team provides assumptions of potential benefits of electrification based on known literature.



Strong benefits



Some expected benefits



Weakest benefits/no impact



Uncertain impact



Policy and Planning Strategies



OUTCOME: To mitigate safety risks through testing, training and public education

- Enact legislation to legalize AV testing
- Enact legislation to stimulate CV or AV testing
- Modify driver training standards and curricula
- Increase public awareness

OUTCOME: To encourage shared AV use (and mitigate increased VMT and vehicle emissions)

- Subsidize SAV use
- Implement transit benefits
- Implement a parking cash-out strategy
- Implement location-efficient mortgages
- Implement land use policies and parking requirements
- Apply road use charging

OUTCOME: To address liability issues that may impact market development

- Implement a no-fault insurance approach
- Require motorists to carry more insurance

OUTCOME: To enhance safety, congestion, and air quality benefits by influencing market demand

- Subsidize CV- equipped vehicles
- Invest in CV infrastructure
- Grant AV- and CV-equipped vehicles privileged access to dedicated lanes
- Grant signal priority to AV- and CV-equipped vehicles
- Grant parking access to AV- and CV-equipped vehicles
- Implement new contractual mechanisms with private service providers





Companion Documents

Strategy Summary

Enact Legislation to Stimulate CV or AV Testing

Mitigate Safety Risks	Encourage Shared AV Use	Address Liability Issues	Influence Market Development
Effectiveness ○○○○○			
Efficiency ○○○○○			
Political Acceptability ○○○○○			
Operational Feasibility ○○○○○			
Geographic Impact Urban, suburban, rural			
Who Legislature, state and local transportation agencies			
Hurdles Passing legislation, upgrading or installing new infrastructure, creating new governmental agreements and partnerships			

Description
This strategy aims to accelerate the development, adoption, and implementation of automated and connected vehicles by enacting legislation to directly fund testing for CV or AV development.

Technologies targeted/ownership model
Legislation providing direct funding designed to stimulate testing can target AV or CV technologies, although as the likely implementer of CV systems, state and local governments may wish to prioritize CV spending to gain experience and institutional knowledge with the emerging technology.

How will this help?
Directly funding AV or CV testing could incentivize companies or public agencies to engage in testing AV or CV systems. Funding CV testing would build institutional knowledge and experience with these emerging technologies, which could increase the likelihood of the systems being implemented in the future. Additionally, private companies are already investing large sums to develop and test AVs, but similar investments are not being made in CV systems. As an economic intervention, providing funding for testing would increase testing activities, and as such, would be an effective strategy to advance the societal benefits of the technology. For these reasons, state and local agencies may wish to prioritize their investments in testing CV systems.

Implementation issues
The state legislature, along with the agencies it directs to carry out or oversee testing, would bear the responsibility for implementing the strategy. Some likely challenges to implementation of this strategy include: identifying funding sources for testing activities, training staff, developing new governmental structures or agreements, installing and upgrading communications systems and infrastructure, and integrating data with existing ITS operations. USDOT, through its model state policy and V2I deployment guidance,

has offered advice for implementation. State agencies could also independently fund testing, if they have resources available, or if they procure funding for a federal testbed. In these settings, state and local agencies may have the opportunity to learn how to operate and efficiently run these systems.

In addition, the 2015 federal transportation authorization legislation, known as the FAST Act, could provide a potential funding source for pilot activities. The act loosened restrictions on federal funding categories, like Category 2, to provide wider latitude for local agencies to fund ITS with federal dollars through their MPOs. This change is essential for the direct funding option: state and local agencies—under direction from their policy makers—can use their own state and local funding (or federal dollars) for testing if there is a clear value proposition to doing so, given the many other system needs that require financial resources.

Testing a new system will provide useful information to state agencies about how these technologies function and perform: implementation and operational processes and procedures, data on system effectiveness and efficiency, more accurate cost information—and in addition, the agencies will gain valuable institutional knowledge and experience with the new technologies.

Stakeholder benefits/concerns
Stakeholders include vehicle manufacturers and developers, CV system suppliers and contractors, the agencies involved in testing, and the general traveling public. Legislation to support testing would either require new funding or using existing funds for a different purpose, which may prove contentious, especially in a legislative setting. The policy does not harm stakeholders, but the financial concerns alone resulted in a relatively lower score on political acceptability.

Optimal timing
These policies address testing AVs and CVs, and as such, the optimal timing would be in the near term and up to ten years. AVs are developing rapidly, so policies designed to

stimulate testing should occur in the near term, over approximately the next five years. CV systems are developing on a longer cycle, so CV testing could begin now but continue throughout the development life cycle, at least now to ten years hence.

Legality
There is no legal barrier to enacting legislation.

EXAMPLE
Utah HB 375, enacted in 2015, authorized the department of transportation to conduct a connected vehicle testing program outside of an authorized area, and requires the state DOT to report the results to a committee of the legislature.

Funding CV testing would build institutional knowledge and experience with these emerging technologies, which could increase the likelihood of the systems being implemented in the future.

TRB

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Viability Assessment

ENACT LEGISLATION TO STIMULATE CV OR AV TESTING

Strategy Overview
The strategy aims to accelerate the development, adoption, and implementation of automated and connected vehicles by enacting legislation to directly fund testing for CV or AV development.

General Description
The strategy of a state enacting legislation to stimulate CV or AV testing aims to accelerate the development, adoption, and implementation of CV/AV. Specific desired private-sector behaviors that the strategy would influence (from Tables 2 and 3 in Chapter 2) include the following:

- Producers develop and sell interoperable V2V or V2I mobility and environment applications.
- Producers develop and sell safe AVs.

Stimulating testing through direct funding would have legislators pass a law subsidizing or otherwise funding testing and deployments of AV or CV systems on public roads. State agencies could also independently fund testing if they have resources available or if they procure funding for a federal test bed. Some state government agencies have already begun testing AV systems, like truck platooning in Texas, for example (Texas A&M Transportation Institute [TTI] 2016). State and local governments can also receive funding from federal CV test beds, where they often serve as partners (USDOT Research and Innovative Technology Administration n.d.). In these settings, state and local agencies may have the opportunity to learn how to operate and efficiently run these systems. A state department of transportation (DOT) employee involved in CV testing reported that the testing in his state increased the likelihood that further CV systems would be advanced.⁴ Additionally, the testing helped the agency and its partner state agencies gain valuable knowledge, skills, and expertise that would help with future deployments.

In addition, the 2015 federal transportation authorization legislation known as the Fixing America's Surface Transportation (FAST) Act could provide a potential funding source for pilot activities. The act loosened restrictions on federal funding categories, like Category 2, to provide wider latitude for local agencies to fund ITS with federal dollars through their metropolitan planning organizations (MPOs). This change is essential for the direct funding option: state and local agencies—under direction from their policy makers—can use their own state and local funding (or federal dollars) for testing if there is a clear value proposition to doing so, given the many other system needs that require financial resources.

Testing a new system will provide useful information to state agencies about how these technologies function and perform: implementation and operational processes and procedures, data on system

Effectiveness ○○○○○
Efficiency ○○○○○
Political Acceptability ○○○○○
Operational Feasibility ○○○○○
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⁴ Confidential interview with a state DOT representative involved in CV testing. Interview conducted by Jason Wagner, August 31, 2016.

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Policy Briefing Document

Research Report





Viability Assessments

Enact Legislation to Stimulate CV or AV Testing

Mitigate Safety Risks	Encourage Shared AV Use	Address Liability Issues	Influence Market Development
<p>Effectiveness ● ● ● ● ●</p> <p>Efficiency ● ● ● ● ●</p> <p>Political Acceptability ● ● ● ● ●</p> <p>Operational Feasibility ● ● ● ● ●</p> <p>Geographic Impact Urban, suburban, rural</p> <p>Who Legislature, state and local transportation agencies</p> <p>Hurdles Passing legislation, upgrading or installing new infrastructure, creating new governmental agreements and partnerships</p> <p><small>stimulate testing should occur in the near term, over approximately the next five years. CV systems are developing on a longer cycle, so CV testing could begin now but continue throughout the development life cycle, at least now to ten years hence.</small></p> <p>Legality There is no legal barrier to enacting legislation.</p> <p>EXAMPLE Utah HB 375, enacted in 2015, authorizes the department of transportation to conduct a connected vehicle testing program outside of an urbanized area, and requires the state DOT to report the results to a committee of the legislature.</p>			

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TRB

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- Effectiveness and efficiency of strategy
- Political acceptability
- Implementation considerations
- Geographic impact
- Challenges



Enact Legislation to Legalize Testing



Mitigate safety risks and accelerate development, adoption and implementation by enacting legislation to establish legality of AV testing.



Key hurdle: Passing legislation



Outcome: Mitigate Safety Risks

Enact Legislation to Stimulate Testing



Mitigate safety risks and accelerate development, adoption and implementation of CV and AV by enacting legislation to directly fund testing.



Key hurdle: Passing legislation



Outcome: Mitigate Safety Risks



Modify Driver Training Standards and Curricula

Mitigate safety risks by addressing the requirements for operating vehicles by establishing, codifying and enforcing operator/owner/passenger requirements.



Key hurdles: Operational (how and when)



Outcome: Mitigate Safety Risks



Increase Public Awareness of Benefits and Risks

Mitigate safety risks, stimulate consumer action and public support through education, communication and outreach on benefits and risks.



Key hurdles: Expense, Trusted messages given uncertainties



Outcome: Mitigate Safety Risks



Subsidize Shared AV Use

Subsidize shared AV (SAV) to ensure alternatives to individually owned AV and to support ridesharing / transit services.



Not needed? Market driven



Outcome: Encourage shared AV use



Implement Transit Benefits

Encourage SAV by extending transit benefits to cover fares for SAV, either as a direct subsidy or a pre-tax benefit.



Not particularly successful with transit



Outcome: Encourage shared AV use

Implement Parking Cash-Out Strategy



Use parking cash-out benefits (employers to employees) to encourage SAV use.



Key hurdle: Institutional



Outcome: Encourage shared AV use

Implement Location-Efficient Mortgages



Encourage SAV by extending LEM strategy to persons purchasing homes in denser urban areas, where SAV fleets would likely operate first.



No evidence LEMS make a difference

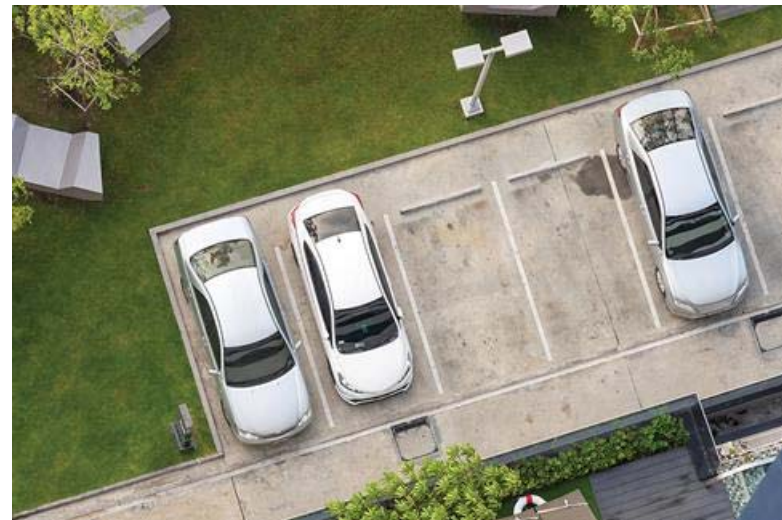


Outcome: Encourage shared AV use

Implement Land Use Policies and Parking Requirements



Implement land use policies and parking requirements to support market penetration of SAV at transit nodes and other activity centers.



Limited evidence of success in promoting share mobility



Outcome: Encourage shared AV use



Apply Road Use Charging

Achieve specific objectives related to AV and CV impacts by employing direct pricing of AV and CV for use of roadway infrastructure.



Key hurdles: Public and political opposition



Outcome: Encourage shared AV use

Implement a No-Fault Insurance Approach



Spur market development by reducing manufacturer liability.



Key hurdle: Political feasibility



Address liability issues

Require Motorists to Carry More Insurance

Raise mandatory insurance minimums to cover a higher proportion of harms associated with serious crashes, thereby incentivizing the purchase of safer AV and CV and encouraging market development.



Unintended consequences: Increase of consumer not purchasing insurance



Address liability issues

Subsidize CV-Equipped Vehicles



Encourage market adoption by providing subsidies for CV equipment.



Not needed for new vehicles if V2V mandate



Influence market demand



Invest in CV Infrastructure

Encourage development and adoption of CV and AV by supporting investment into required physical and digital infrastructure.



Key hurdles: Funding availability and ROI



Influence market demand

Priority Access to Dedicated Lanes



Incentivize market development by offering reduced travel times.



Effectiveness depends on willingness to dedicate lanes to AVs and CVs



Influence market demand

Signal Priority to AVs and CVs



Incentivize market development by offering reduced delay at signalized intersections.



Limited effectiveness: Travel time benefits minimal



Influence market demand



Priority Access to Parking

Incentivize market development by granting reserved parking to AV and CV.



Limited effectiveness: AVs can park themselves



Influence market demand

Use New Contractual Mechanisms with Private Sector



Incentivize market development by pursuing arrangements with the private sector.



Effectiveness depends on finding suitable revenue stream



Influence market demand



Conclusions

- **Strategies offer considerations for decision makers based on best information available**
 - Technology direction may change
 - Consumers may not adopt certain products
- **Public policy making for AV and CV will be informed through a cycle of learning**
- **Early-adopter agencies will support knowledge creation through support of testing, research and evaluation**





NCHRP 20-102(01)
Policy and Planning Actions to Internalize Societal Impacts of CV and AV
Systems into Market Decisions
<http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3934>

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