Changing the Way We Travel – A look at Connected and Autonomous Vehicles

October 2, 2018
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Agenda

1. Overview / Definitions
2. Guidance and Policy Considerations for Connected and Automated Vehicles (CAV)
3. When Does CAV Become Real?
4. Potential Benefits and Impacts; Other Issues
5. What Some States and Agencies are Doing
6. What’s NEXT?
What is Connected Vehicle (CV)?

CV’s utilize communications between:
- Vehicles (V2V)
- Vehicles and infrastructure (V2I)
- Vehicles and Pedestrians (V2X)
- Vehicles to anything! (V2X)

To enable the use of “applications” to provide improvements to:
- Mobility
- Safety
- Environment
- Economy
CV Technology

- 5.9 Ghz Dedicated Short Range Radio (DSRC)
- Austria, The Netherlands, and Canada are adopting Wi-Fi adapted for vehicle environment
  - Dedicated FCC radio spectrum
  - 300m reliable range
- Basic Safety Message v1 (BSM)
  - Vehicle Position
  - Speed
  - Heading
  - Acceleration
CV History and Status

• US DOT program since early 1990’s
  – Infostructure
  – Intellidrive

• 2016 – NHTSA issued notice of proposed rule making requiring V2V communications technology on new light vehicles
  – Over 400 comments received
  – Mandated regulations still pending

• Several auto manufacturers have started limited deployment of V2V-enabled vehicles

• Several V2I pilot programs are underway
What is Automated Vehicle (AV)?

Vehicles with computers that augment or replace the human driver in some aspect of vehicle operation and control
SAE Levels of AV

<table>
<thead>
<tr>
<th>Level</th>
<th>Automation Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>Zero autonomy; the driver performs all driving tasks.</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.</td>
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<tr>
<td>2</td>
<td>Partial Automation</td>
<td>Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.</td>
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<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.</td>
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AV Technology

• Geolocation
  – Geo-fencing creates autonomous events
  – GPS can be used but not 100% reliable – particularly in “urban canyons”
  – Differential GPS could be used to supplement
  – Many use dead reckoning

• LiDAR
  – Essential for dead reckoning
  – Collision avoidance
  – Creates objects for internal intelligence
AV Technology

• Machine learning
  – Many claim this is being done
  – Example – speed bump vs. person laying in the road

• Cognitive intelligence
  – Used for human machine interface
  – IBM Watson example – “It’s raining, did you bring an umbrella?”
Cars are evolving as both. Now “CAV”

- Integrated technology
- In-vehicle sensors and computers capture information
- Vehicle communicates with infrastructure, other vehicles, and the cloud (V2X)
CAV Concepts Envisioned Since 1950’s
What’s Happening at National Level?

The House passed the SELF DRIVE bill, by voice vote, in September 2017.

• Pre-empts states from implementing certain laws governing the new technology.
  – States will still be responsible for vehicle registration, insurance, driver education, law enforcement and other local issues.
  – National Highway Traffic Safety Administration will be in charge of regulating the industry’s traffic safety standards.

• Allows car manufacturers to deploy up to 100,000 self-driving cars a year that don’t meet normal safety standards.
  – In the first year, however, that number will be capped at 25,000.

• Manufacturers will be required to include cybersecurity and privacy protections in their vehicles.
What’s Happening at National Level?

• Senate bill (START Act) on hold
  – Issues concerning safety, privacy, self-driving trucks, and voiding state and local rules and regulations

• NHTSA issued “Automated Driving Systems 2.0 – A Vision for Safety” in September 2017
  – Section I: Voluntary Guidance for *Automated Driving Systems*

• FHWA issued Request for Information in January 2018
  – To better understand what is needed to accommodate Automated Driving System technologies

• US DOT AV Framework (Version 3) in progress (“coming soon”)
What’s Happening at National Level?

6 principles for USDOT (announced by Elaine Chao this summer)

• Safety is top priority
• Flexible and tech neutral
• When regulations are needed, they will be non-prescriptive and performance-based
• DOT will work with states/other agencies to avoid patchwork approach
• DOT will prepare proactively, leveraging complementary technologies, but no assumption of universal implementation
• DOT will protect the freedom of open road and ability to drive – mobility choices for Americans
Government activities in CV

DSRC Deployments

- SpAT Challenge
- Smart Cities initiatives
- The three USDOT sponsored pilots:
  - NYC - 5,850 taxis, 1,250 city buses, 400 UPS trucks, and 500 city vehicles, all communicating with one another as well as 350 roadside units
  - Tampa Bay - 10 buses, 10 streetcars, and 1,600 cars
  - Wyoming – 400 fleet vehicles and 75 road side units on a heavy trucking corridor
Industry activities in CV

Industry split on 5G (cellular) vs. DSRC*

- DSRC - GM, Toyota, VW
- 5G - 5G Automotive Association (5GAA) – Audi, BMW, Ford

DSRC in vehicles

- GM – This year’s Cadillac will have DSRC
- Toyota – Big announcement! Voluntary production in 2021
- VW – Will deploy in 2019 in EU

*Source: http://www.autoconnectedcar.com/2017/12/enhanced-d2d-will-transform-more-v2v-5g2v-v2x-for-autonomous-cars/
Industry activities in AV

Year of AV introduction

- Tesla: 2018
- Volkswagen: 2019
- GM: 2020
- Honda: 2020
- Mobileye: 2021
- Toyota: 2020
- Audi: 2020
- BMW: 2021
- Ford: 2021
Industry activities in AV

Shuttles or “shared autonomous vehicles” SAV
This is our future!!
But when does it become reality?
Observations and Predictions from Industry

- Ride share / shuttles will be the conduit for increased use of the technology
  - Cars spend 96% of their time NOT in use
  - Dense urban areas tend to have the best mapping

- Uber CEO – AV’s will start picking up passengers in 2019
  - Recent deal with Volvo to buy up to 24,000 AV’s

- Half of Lyft will be AV by 2021
  - Their first self-driving car pilot started in Boston (December)
  - Still has a “safety driver”

- Car manufacturers are investing $$$
  - Despite lack of federal framework
CAV Have the Potential to....

- Save lives by reducing collisions
  - 9 out of 10 serious crashes occur due to human error (NHTSA)
  - What happens to the auto insurance industry?
- Improve mobility - especially disabled and elderly populations; and rural
- Reduce fuel consumption and environmental impacts
  - Trend is for CAV to be primarily electric
  - Potential impact on gas tax revenues for transportation
- Decrease vehicle ownership through shared CAVs
  - Reduce amount of parking required / new land uses
- Congestion?
CAV Impacts on VMT and Congestion

• Less non-recurring congestion
• Increase in available capacity on roadways
  – Platooning, narrower lanes
• What about induced demand from additional capacity?
  – Increased development and traffic has always happened with new roadways
• Travel in CAV can be used for work or sleep
  – Might result in longer trips, urban sprawl, more VMT
• Shared use of vehicles might result in fewer trips
  – People buy “rides” rather than cars
  – New issues with curbside management
And What About Public Transit?

- "Governments would be wise to keep their underground systems in good working order"
  - “Jam Tomorrow”, The Economist, January 20, 2018

MARTA rail services approx. 6 million passenger trips per months
Gartner Hype Cycle

- Connected Home
- Deep Learning
- Machine Learning
- Autonomous Vehicles
- Neuromorphic Hardware
- Deep Reinforcement Learning
- Artificial General Intelligence
- 4D Printing
- IoT Platform
- Virtual Assistants
- Smart Robots
- Edge Computing
- Augmented Data Discovery
- Smart Workspace
- Conversational User Interfaces
- Brain-Computer Interface
- Volumetric Displays
- Quantum Computing
- Digital Twin
- Serverless PaaS
- 5G
- Human Augmentation
- Virtual Reality
- Augmented Reality
- Virtual Reality and Ontology Management
- Security
- Enterprise Taxonomy
- Software-Defined Networking
- Blockchain
- Commercial UAVs (Drones)
- Cognitive Expert Advisors

As of July 2017

Years to mainstream adoption:
- less than 2 years
- 2 to 5 years
- 5 to 10 years
- more than 10 years
- obsolete
- before plateau
Many Issues Need to be Addressed

- Communications
  - Lack of standards for V2I and V2V wireless communications
  - Uncertainty with spectrum allocation for DSRC
- Cyber-Security and Data Encryption
  - Potential for hacking
- Privacy
  - Government snooping on travel routes and times
- Data Governance
  - Who owns the data?
- Safety Standards
  - Crashworthiness
  - Certification of CAV
- Interoperability between auto manufacturers
- Liability and Insurance Clarifications
- Market Penetration and Transitioning
  - Driver education
  - CAV and driven vehicles on the same roadway
Potential Unintended Consequences

• Improved safety, reduced congestion, and better environment
  – Same claims were made when internal combustion engine (ICD) was introduced (to replace horses)

• Impact on driving jobs

• Impact on auto dealers
  – Personal purchase of AV’s a long way off – cost
  – Fleets are in use continuously, with revenue stream

• City planning
  – Cities and suburbia have been developed for the auto
  – Parking, shopping malls, drive-through establishments

• Potential for pricing
This is our future!!!
But What Others Are Doing to Prepare?
Delaware DOT Program Support

Program Management for Connected & Automated Vehicles

- CAV Strategic Plan
- USDOT Connected Vehicles Pooled Fund Study Coordination
- Artificial Intelligence FHWA software partnership – Signal Operations & Incidents
- Marketing – Internal DOT and Public brochures & presentations
- V2I Enhancement to Delaware’s Multimodal Integrated Transportation Management System
- Automated Proving Ground: “US 13 and SR 1 in Smyrna, Delaware”
- SPaT Challenge Coordination – signal upgrades, roadside and on-board units
I-70 Mountain Corridor Connected Vehicle Project
Mountain pass needs

- High levels of congestion
- Few or no alternate routes
- Defined high incident areas
- Significant weather events
- Inability to properly advise truckers
MDTA

Early Stage Deployment – Just beginning

- Roadside Units at Baltimore Tunnel portals
- On-Board Unit deployed in state vehicles
- Cloud-hosted data – quantity; frequency; location of messages
- Reporting on:
  - Types of collected data
  - Connected Vehicle Penetration
  - Derived Information and potential applications
Nevada

- SWOT and Risk Analyses
- Strategic Planning
- Granted the nation’s first autonomous vehicle-restricted driver’s license
- Authorized the first licensed, autonomous commercial truck to operate on an open public highway in the United States.
- Working with private sector
  - Hyperloop One
  - Intelligent Mobility Living Lab
  - “Ollie” (Autonomous People Mover)
  - Test Corridor (different CV communications)
This is our future!!
But What’s the Next Steps?
MOST importantly . . .

There is a difference between:

- Regulations

- Voluntary consensus standards

- Recommendations – “guidance documents”
What can we do for CV?

Get ready for “the stuff”:

- Network equipment (NTCIP compliant)
- Improve existing equipment network connectivity
- DSRC radios (not so fast)
  - Antennae
  - GPS device
- Local/edge computing (optional)
What can we do for CV?

Helpful FHWA “products” located at https://www.its.dot.gov/v2i/

- Connected Vehicle Impacts on Transportation Planning Primer
- Connected Vehicle Impacts on Transportation Planning Desk Reference
- Connected Vehicle Planning Processes and Products and Stakeholder Roles and Responsibilities
- Analysis of the Need for New and Enhanced Analysis Tools, Techniques, and Data
What can we do for CV?

• Pay attention to the V2I Deployment Coalition
  – Single point of contact to discuss V2I issues
  – Focused on the agency practitioner
  – “Phase 1” completed earlier last year
  – Significant outcomes:
    • Define research initiatives
    • Input to standards needs
    • SPaT Challenge
Use the USDOT Connected Vehicle Reference Implementation Architecture (CVRIA)

- Defines architecture for CV technologies
- Analyzes where standards are needed
- Mature standards incorporated into national architecture
- Best used in planning for CV
What can we do for CV?

Get Funding

- Highway Safety Improvement Program (HSIP)
- National Highway Performance Program (NHPP)
- Surface Transportation Program (STP)
- Congestion Mitigation and Air Quality (CMAQ) Improvement Program
- Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program
What can we do for AV?

Road capacity may increase

Less human interaction may mean:
- Less signals/signage
- More roundabouts
What can we do for AV?

Less stationary cars = less parking = more green space

For example, repurposing is happening in airports due to Uber/Lyft.
What can we do for AV?

On-demand transit

FALM