

Connecting South Dakota and the Nation

Electric, Connected, & Automated Vehicles

David Huft, SDDOT Research Program Manager AAA "Technology Takes the Wheel®" Autonomous Vehicle Seminar Sioux Falls, SD October 21, 2019

Presentation Outline

Vehicle Technologies o Electric Vehicles Connected Vehicles Automated Vehicles • Adoption Outlook USDOT Roles State Roles • Useful Resources

Definitions

- Electric Vehicle—Powered substantially or entirely by electricity
- Connected Vehicle—Actively communicates with other vehicles, infrastructure, road users
- Automated Vehicle—Drives with little or no driver interaction
- Definitions are not mutually exclusive



Electric Vehicles

Electric Vehicles





Electric Vehicles vs. Internal Combustion Engine Vehicles

Cheaper to fuel ○ \$1,565 VS \$15,000 • Fewer moving parts 0 2000 ICE 0 18 EV • 2.5 x life (>500K miles) More power



Projected Cost of Li-Ion Battery \$/kWh



7

Cost of Electric Vehicle with 200-Mile Range



Cost of Electric Vehicle

EV Issues

- Charging Infrastructure
 Cold Weather
- Crash Response
- Road Use Charges

Preparing for the Future of Transportation: Automated Vehicles 3.0 USDOT



Connected Vehicles

Connected Vehicle Messaging

- Vehicle-to-Vehicle (V2V)
- Vehicle-to-Infrastructure (V2I)
- Vehicle-to-Anything (V2X)

Basic Safety Message (by vehicle)

- Location
- Heading
- Speed

Other Messages

- Traffic Signals
- Speed Limits
- Incidents
- Work Zones
- Snowplows
- Distress Calls
- Railroad Crossings
- School Buses
- etc.

Traffic Signal Example



- V2V, V2I, V2X communication
- Signal Phase and Timing (SPaT)
- 20 signals in every state by 2020?

Connected Vehicles Truck Platooning

- Both trucks manned, steered
- Lead truck operated manually
- Follow truck speed and headway matched to lead

WILLI II



SAVINGS

10% rear



Connected Vehicle Issues

- Operational Changes
- Deployment Cost
- Technology Choices
 Digital Short Range Communications
 5G Cellular
 Satellite
 Data Backhaul
- Cybersecurity



Automated Vehicles

Automated (or Autonomous) Vehicles

www.cbinsights.com



CBINSIGHTS



Levels of Automation

Level 0 No Automation	Level 1 Driver Assistance	Level 2 Partial Automation	
	Assists driver in some situations	Can control speed and lane position in certain conditions	
In complete control at all times	Must monitor, engage controls, and be ready to take control	Must monitor and be ready to take control	

Preparing for Automated Vehicles: Traffic Safety Issues for States, Governors Highway Safety Association

Levels of Automation (Highly Automated)

Level 3 Limited Self-Driving	Level 4 Full Self-Driving Certain Conditions	Level 5 Full Self-Driving All Conditions
Can control in some conditions and inform driver when needed	Can be in full control and operate without a driver	Can operate without a human driver or occupants
Must be ready to take control quickly when informed	Not needed	Not needed

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Truck Automation

I-25 Colorado





Volvo Concept

I-10 California - Texas



5th Avenue NYC 1900 Where is the car?



5th Avenue NYC 1913 Where is the horse?



Technology Adoption is Accelerating



Source: Asymco

BLACKROCK'

24

LiDAR Cost Trend \$70,000 to \$90







Computing Cost & Power Trend

- 2000
 - ASCI RED Sandia National Labs
 - 0 1 TFLOP
 - <mark>o</mark> \$46M
- 2018
 NVIDEA Drive PX[™] Pegasus
 320 TOPS





Level 4 & 5 Vehicle Adoption

Stage	Decade	Vehicle Sales	Vehicle Fleet	Vehicle Travel
Large price premium	2020s	2 – 5%	1 – 2%	1 – 4%
Medium price premium	2030s	20 – 40%	10 – 20%	10 – 30%
Small price premium	2040s	40 – 60%	20 – 40%	30 – 50%
Standard on most new vehicles	2050s	80 – 100%	40 – 60%	50 – 80%

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Public Concerns About AV

Would Drive AV

Enthusiastic About

AV OK without Driver

Share Road with AVs

AVs Safer than Human



USDOT AV Principles

- Safety first priority
- Technology neutral



- Modernize regulations (remove barriers)
- Consistent regulation and operation
- Prepare proactively
- Protect and enhance freedom

Benefits of Automated Vehicles

- Safety
- Congestion
- Energy & Pollution
- Mobility
- Land Use
- Economic Vitality



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USDOT Roles



- NHTSA—Federal Motor Vehicle Safety Standards
- FMCSA—Commercial Vehicle Operation, Drivers, Maintenance
- FTA—Transit Agency Safety Plans
- FHWA—Manual on Uniform Traffic Control Devices, Technology Standards

State Policy Considerations

AV Stance

"Cutting edge" or "wait and see"?

Permissive or regulatory?

Vehicle Registration
 Identify AV Level?

- Driver Licensing
 - Operator training
 - Driver education
 - License testing
 - o Examiner training
 - License needed for
 Level 4 5?

State Policy Considerations

- Enforcement
 - Traffic laws
 - Communicating to AV, occupants
 - Crash response
 - Crash investigation, use of vehicle data

- Commercial Vehicles
 - Screening
 - o Inspection
 - Hours of service
 - Safety responsibility
 - o Platooning
- Insurance
 - Financial responsibility

State Policy Considerations

• Highway Infrastructure
• Safety

- Design (lanes, signing, pavement markings...
- o Maintenance
- o Roadside electronics
- Communication backhaul
- Workforce skills

- Vehicle capability
- Distraction
- o Driver Impairment
- o Peds & bikes
- Data Systems Privacy Cybersecurity

State AV "Best Practices"

- Create AV Task Force
- Review, revise statutes & rules
- Define AV testing requirements
- Define AV deployment requirements
- Educate AV owners and road users
- Incorporate AV info into state data systems

Review insurance requirements

Useful Online Resources

- Preparing for the Future of Transportation Automated Vehicles 3.0 (USDOT)
- Preparing for Automated Vehicles: Traffic Safety Issues for States (GHSA)
- Jurisdictional Guidelines for the Safe Testing and Deployment of Highly Automated Vehicles (AAMVA)
- Strategies to Advance Automated and Connected Vehicles: Briefing Document (NCHRP)
- Autonomous Vehicle Pilots Across America (NLC)

Questions?

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Thank You!!