WSDOT efforts to prepare for connected and autonomous vehicles

Washington State Transportation Commission

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What is a Connected Autonomous Vehicle?

**Connected Vehicle**
Communicates with nearby vehicles and infrastructure; Not automated

**Connected Automated Vehicle**
Leverages autonomous automated and connected vehicles

**Autonomous Vehicle**
Operates in isolation from other vehicles using internal sensors
What should the focus be?

The 20th century way

How many people can this street serve per hour?

Up to 29,600
What should the focus be?

Are we focused on:

Replacing the human driver with a robot?

Or

Enhancing the lives of the people we serve?
What should the focus be?

“...It’s clear that the mobility model we have today simply will not work tomorrow.

We are going to build smart cars, but we also need to build smart roads, smart parking, smart public transportation systems, and more.”

Bill Ford
So when will Autonomous Vehicles arrive?

Where we are Today
So when will Autonomous Vehicles arrive?

Prediction: Greater than 10 years for significant penetration of SAE Level 4 & 5
So when will Autonomous Vehicles arrive?

• There are > 2,600 companies testing 2 to 3 vehicles each (SAE Level 4 or 5) somewhere in the world right now.
• Every single one of these vehicles was retrofitted.
• There could be a marketable retrofit kit available within 2-3 years

Source: Insurance Thought Leader, Guy Fraker: Tracking AV Startup companies world wide
So when will Autonomous Vehicles arrive?

However... Tesla claims their current models are SAE Level 5 ready today from a hardware standpoint, what they are missing is the software and algorithms to fully utilize all the hardware. They also need favorable, ideally consistent nationwide, enabling legislation at some point in the future....

Many current Tesla owners will be able to go to Level 5 with an over the air firmware upgrade at some point in the future....
Some of the benefits...

**Safety:** 34,000 deaths each year, 94% likely correctable

**Mobility:** “It Depends” VMT could go down 60% or up 200%, It depends on who owns the vehicles, private or shared mobility.

**Infrastructure Sustainability:** At full penetration of SAE Level 5 what is really needed beyond the pavement?

**Inclusion:** Reclaimed mobility, independence and quality of life for those that can no longer drive themselves

**Time:** Reclaimed ability to work, play, sleep, eat, text while you travel

**Environment:** Vehicles will likely be 100% electric and with shared mobility reduce VMT.
Some of the challenges...

1. **Insurance** – How do you assign responsibility?
2. **Legislation** – Regulating too far too fast could hinder innovation
3. **Cybersecurity**
4. **Funding** for transportation system investments – Will AV’s usher in a replacement for the gas tax? VMT based Road User Charge
5. **Public Acceptance**
6. **Technological requirements** are uncertain
7. **Pilot Testing** restrictions – Controlled facilities or public roads?
8. **Education** – Assessing the trusted sources for information
9. **Technical Capability and Capacity** of the current workforce
10. How do you plan for something that’s **not fully understood**?
11. Too Many **Unknowns**
Some of the challenges...

Public Acceptance

How long would it take a fleet of 100 autonomous vehicles driving 24 / 7 / 365 at 25mph to demonstrate reliability?

<table>
<thead>
<tr>
<th>Statistical Question</th>
<th>Benchmark Failure Rate</th>
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<tbody>
<tr>
<td>(1) without failure to demonstrate with 95% confidence that their failure rate is at most...</td>
<td>(A) 1.09 fatalities per 100 million miles?</td>
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<td>275 million miles (12.5 years)</td>
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<td>(2) to demonstrate with 95% confidence their failure rate to within 20% of the true rate of...</td>
<td>(B) 77 reported injuries per 100 million miles?</td>
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<tr>
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<td>8.8 billion miles (400 years)</td>
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<tr>
<td>(3) to demonstrate with 95% confidence and 80% power that their failure rate is 20% better than the human driver failure rate of...</td>
<td>(C) 190 reported crashes per 100 million miles?</td>
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<td>11 billion miles (500 years)</td>
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In order to have 95% confidence that AV’s are 20% safer than Human Drivers: 1 Fatality per 100 million vehicle miles AV’s would need to drive 11 billion miles which in this case would take 500 years.

Department of Licensing Autonomous Vehicles: Self Certification Testing in WA State

Autonomous vehicles: Self-certification for testing in Washington state

Who needs to self-certify?
Companies conducting, testing, and operating autonomous vehicles on the roads of Washington state.

How to self-certify
Before beginning a pilot program, submit a Self-certification form confirming that you are compliant with the following:

Testing with human operators present
- Only a trained employee, contractor, or other person authorized by the company developing the autonomous technology can operate or monitor the vehicles.
- Vehicles must be monitored, and an operator must have the ability to direct the vehicle’s movement if assistance is required.
- Anyone operating an autonomous vehicle needs a valid U.S. driver license.
- Proof of insurance is required by RCW 46.30.020 (leg.wa.gov).

Testing without human operators present
- Vehicles must be equipped with an automated driving system that performs all driving tasks on a part or full-time basis within their operational design limits. Vehicles must also be able to make it to a safe condition in the event of a system failure.
- Vehicles must comply with Washington state motor vehicle laws (leg.wa.gov) relevant to the vehicle’s operational design limits.
- Proof of insurance is required by RCW 46.30.020 (leg.wa.gov).

Self-certified companies
- Simple Solutions
- TORC Robotics

Related information
- Autonomous Vehicle Testing & Technology in Washington State and Autonomous Vehicle Work Group
**How is WSDOT preparing?**

<table>
<thead>
<tr>
<th><strong>Internal CAV Task Force</strong></th>
<th>- Learn, Monitor, Engage, Educate, Advise, Make recommendations to be enacted within the next 5 years</th>
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<tbody>
<tr>
<td><strong>External Engagement</strong></td>
<td>- Conferences, Technical Training, Pooled Funds, Peer Exchanges, Policy Forums, Governor's AV Workgroup, TRB, Review State and Federal Legislation, Multijurisdictional Coordination</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>- Weekly News Clips, News Media</td>
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</table>
| **Near Term Products** | - Preparing a CAV Readiness Roadmap with preliminary recommendations  
- Preparing a plan to improve Pavement Markings and Signing |
Internal CAV Task Force

• Started in May 2017, Monthly Meetings
• Serves as a consolidated clearinghouse to communicate, coordinate, evaluate and pursue CAV related issues
• Provide insight, guidance and direction within WSDOT
• Participate regionally and nationally
• Recommend research, pilots, changes to policies, procedures, standards, operations, organizational structure, funding levels that will enable CAV
Successfully Tested Vehicle 2 Infrastructure (V2I) technology on I-5 to replicate the functionality of Active Traffic Management through in-vehicle messaging using DSRC connected vehicle technology.
Winter Operations Pilot

Informing the public: “Snow Plow Operations Ahead”

Data Integrators and Vehicle Manufactures

Data Processing and Integration

Fleet Data → Alerts

Information Delivery Channels

APPs

Travel Information Map

API

Roadside Data

Social Media & Party Data

Data Integrators

Vehicle Manufactures
University Research (UW & WSU)

1. Preparing for Connected Vehicle Opportunities – UW
   • Provide guidance on what CAV issues / technologies we should pursue as a State DOT in relation to Smart Cities.

2. Enhancing Roadway Safety and Operations – UW
   • Collecting and sharing information between pedestrians, bicycles, transit vehicles and traffic signals to enhance safety and operations through DSRC

   • What locations would benefit from CV equipment first and how should we adjust traffic signal timing?
Traffic Signal Pilot Project

Communicating traffic signal information to vehicles through the cloud
Traffic Signal Pilot Project

- 2 Locations along US 2 North of the City of Spokane
- 2 Locations along US 2 West of the City of Spokane
- 10 Locations along SR 522 North of Lake Washington through the Cities of Lake Forest Park and Kenmore
- 6 Locations along SR 305 from the Bainbridge Island Ferry Terminal to the City of Poulsbo
- 4 Locations along SR 500, between I-5 and I-205, through the City of Vancouver

AASHTO SPaT – Initial locations planned for DSRC CV Technology Deployment
Work Zone Safety Pilot

- Pilot Truck and Autonomous Attenuator Vehicle
- 2018 Pilot with Other States
- Considering Low Speed Striping Operations
Incorporating CAVs into the Long Range Planning Process

Text Suggested during Public Comment Period:
Connected and Autonomous Vehicles (CAV), Electric Vehicles and Shared Mobility are all technological developments that will have significant implications on our transportation system. While FHWA predicts CAVs will significantly increase safety and reduce crashes, researchers and analysts do not agree on whether these developments will drastically increase or decrease vehicle miles traveled (VMT). Anticipating and planning for the interaction of these developments may not be easy, but planners should take a number of possibilities into consideration.

For example, if shared mobility and CAVs develop and quickly become dominant vehicles, do plans consider the impacts on an increase in parking demand, or a substantial decrease in parking demand? What will the demand be for park and rides in a CAV dominant scenario? How will plans consider the changes in associated land use? How can CAVs be an extension to a robust transit system to serve the first mile Last Mile needs? At the end of the day, any long-range planning process needs a thorough exploration of the potential impacts to the transportation system given a wide array of potential outcomes.
Developing Educational Information

Connected and Autonomous Vehicles

SAFETY
CAVs have tremendous potential to improve roadway safety by eliminating driver errors, which are the major contributing factor in roughly 94% of all fatal vehicle crashes.

CONGESTION REDUCTION
By communicating with vehicles and infrastructure around them, CAVs have potential to reduce highway congestion and commute times while decreasing the need for more lanes.

INCREASED MOBILITY
Autonomous vehicles could improve mobility for the elderly and people with disabilities who can’t currently drive a traditional vehicle.

VEHICLE AUTOMATION LEVELS

0 1 2 3 4 5

No Automation | Driver Assistance | Partial Automation | Conditional Automation | High Automation | Full Automation

Driver performs all driving tasks. | Driver controls vehicle, but some driving assistant features are included. | Vehicle has combined automated functions, such as steering and acceleration, but driver must remain engaged with driving and monitor environment at all times. | Driver necessary but not required to constantly monitor the environment. DRIVER MUST BE READY TO TAKE CONTROL WITH NO NOTICE. | Vehicle can perform all driving functions under certain conditions. Driver may have option to control vehicle. | Vehicle can perform all driving functions under any condition. Driver may have the option to control the vehicle.

WSDOT AND CONNECTED AUTONOMOUS VEHICLES

WSDOT is committed to preparing for CAV technology and is researching infrastructure needs, planning considerations for future projects and impacts to existing roadways and technology.

WSDOT CAV Task Force
WSDOT’s internal CAV Task Force is investigating the challenges and opportunities CAVs bring to Washington roadways – and how to best prepare roadways and infrastructure for the new technology.

The task force has hired a consultant to review other states’ efforts in this field and produce a roadmap with recommended next steps for WSDOT initial readiness. Some CAV challenges to resolve include:

- Difficult to plan for still-evolving technology
- May require more frequent striping and sign maintenance to allow CAVs to “see” road markings
- Best way to include CAV in all future project planning
- More education and pilot testing needed about CAVs to achieve widespread public acceptance
- Effect of CAVs on traffic modeling and predictions
- CAV impacts to existing and future smart technology infrastructure

Pilot projects
WSDOT is conducting pilot projects using CAV technology including:

Winter Operations Pilot – Using various connected vehicle technologies, WSDOT will share real-time road conditions from snow plows, etc., to give motorists direct information (via apps or vehicle safety systems) of road conditions and adverse weather. Could also provide info about nearby roadway work.

Traffic signals – Test how existing WSDOT signal systems can communicate with CAVs to improve intersection safety and timing as well as overall traffic operations. Will also test how WSDOT systems can communicate the presence of pedestrians and bicyclists to avoid potential collisions.

Automated Work Zone Vehicles – Test how autonomous vehicles could improve work zone safety. An autonomous attenuator vehicle – placed before a work zone to absorb the impact of any motorist crashes – would no longer need a driver, who is still at risk during an impact.

State Level
WSDOT staff are on the Governor’s Autonomous Vehicles Work Group, engaged in a broad range of CAV issues. The work group also includes:

- Governor’s Office
- Commerce Department
- Department of Licensing
- Washington State Patrol
- Washington Traffic Safety Commission
- Governor’s Office for Regulatory Innovation and Assistance
- Other Public and Private Advisors

MORE INFORMATION
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Preparing to improve roadway
Signing and Striping

“Good for human drivers today …… Prepares for AV’s tomorrow”

Preparing a plan for how to approach an increased programmatic biennial investment in signing and striping
What else could we pursue?

1. Look at cities and counties that are focused around **pick-up drop-off zone policies**. Allowing people to be picked up and dropped off anywhere may negatively impact congestion.

2. Support **legislation that supports continued DSRC deployment and protects the 5.9 GHz public safety band** for interference-free operations.

3. Consider **opportunities to leverage public roadway right of way assets** in support of CV deployments. (e.g. Delaware recently passed legislation to allow telecom companies to construct cell towers on state R/W in exchange for the installation of CV supporting technologies)

4. Explore the potential to **expand the scope** of use for the funds that are generated from the current **$150 Electric Vehicle car tab fee**.

5. Improve real-time **communication of ongoing work zone operations**

6. Improve real-time **communication of construction activities**
What else could we pursue?

Autonomous Shuttle Pilot?

1st Mile / Last Mile Connection to Transit through partnerships with rideshare companies?
What else could we pursue?

Continue automated pedestrian and bicycle detection pilots with the addition of automated braking and connection to traffic signals operations.
What else could we pursue?

Truck platooning pilots?

May require some changes to state statutes?
What else could we pursue?

Prepare for the next Federal Grant Opportunity
What else could we pursue?

Consider a new or existing local forum / summit / conference that could help consolidate and coordinate the discussion in WA State.
How are we / should we invest compared to other State DOTs?

CURRENT LEVEL OF ENGAGEMENT

As technology advances, state and regional agencies are increasingly engaging in policy and planning to respond to the challenges and opportunities presented by Connected and Autonomous Vehicles (CAV). This snapshot summarizes high level results from a 2017 survey. For more information contact Matt Hardy of AASHTO.

How would you best describe your agency’s level of engagement in policy and planning for connected and autonomous vehicles?

“Autonomous vehicles will significantly affect our transportation system. It seems to be too early to tell whether it will advance existing objectives or just reshape dynamics.”

“We are aware of possible impacts of CAV but to date, we haven’t included it in any of our processes.”

“We have reoriented staff, hired global leaders, started private sector and military partnerships and we are developing a strategic plan.

“Agency executives are supportive and engaging other partners in the CAV dialogue at our agency.”

Not Engaged 6%
Passively Engaged 38%
Actively Engaged 34%
Early Adopter 6%
Leader 15%

Acrobat Document
**WSDOT Investment Level**

**What should the target be?**

**Level A** Status Quo: Existing WSDOT CAV Task Force member

Divisions commit to 20% of an FTE

Listening, Learning, Some Advising, Passive Regional and National Engagement, some partnership / pilot funding (Federal Research Funds)

**Level B** Identify $450k from existing 17-19 resources

Seat at the table to support partnership initiatives and pilot deployments

- $50k – National Academies / TRB Forum – Preparing for AV and Shared Mobility
- $100k – Connected Vehicle Pooled Fund

Funding to support Governor’s AV Working Group – Technical Advisory Body

- $100k – Consultant Contract to create an Initial WSDOT CAV Readiness Roadmap for the next 5 years

Funding to Support Pilots:

- $100k – Work Zone Safety – Autonomous Truck Mounted Attenuator (TMA) Pilot
- $100k – AASHTO SPaT Challenge – Connecting Traffic Signal Operations to Vehicles

**Level C** Additional funding beyond existing resources

- $900k – 2-3 Dedicated FTEs to implement WSDOT CAV Readiness Roadmap
- $150k – Maintain partnership level commitments regional and nationally
- $2M – Match funds to support federal grant and partnership opportunities
**Something to think about...**

Is the ideal autonomous car one that will let you do what you want when you want right up until the point until you have an incident then the technology takes over?

**Toyota thinks so...**
- They are developing a system called “Guardian.” The goal is to make a human driven car un-crashable.
  - Toyota Level 4 cars will be sold with the Guardian System
  - Full Level 4 in a geofenced area
  - Full self-control with “guardian backup” in areas where humans still desire to drive the car.
THANK YOU

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