# Infrastructure and Systems Subcommittee

## Preparing the Transportation Infrastructure and Systems for Connected and Automated Vehicles

Roger Millar, Secretary of Transportation
Kickoff Meeting: Infrastructure and Systems Subcommittee
Washington State Department of Transportation
October 2nd, 2018, 9:00-12:00pm

**Version: 10-1-18, 12pm**

WASHINGTON STATE
AUTONOMOUS VEHICLE
WORK GROUP

# Washington State Autonomous Vehicle Workgroup
## Infrastructure and Systems Subcommittee

**Legislative Focus Areas**
➢ Roadway infrastructure
➢ Traffic management
➢ Transit service & vehicles
   / Public Transportation
➢ Advertising
➢ Right of way
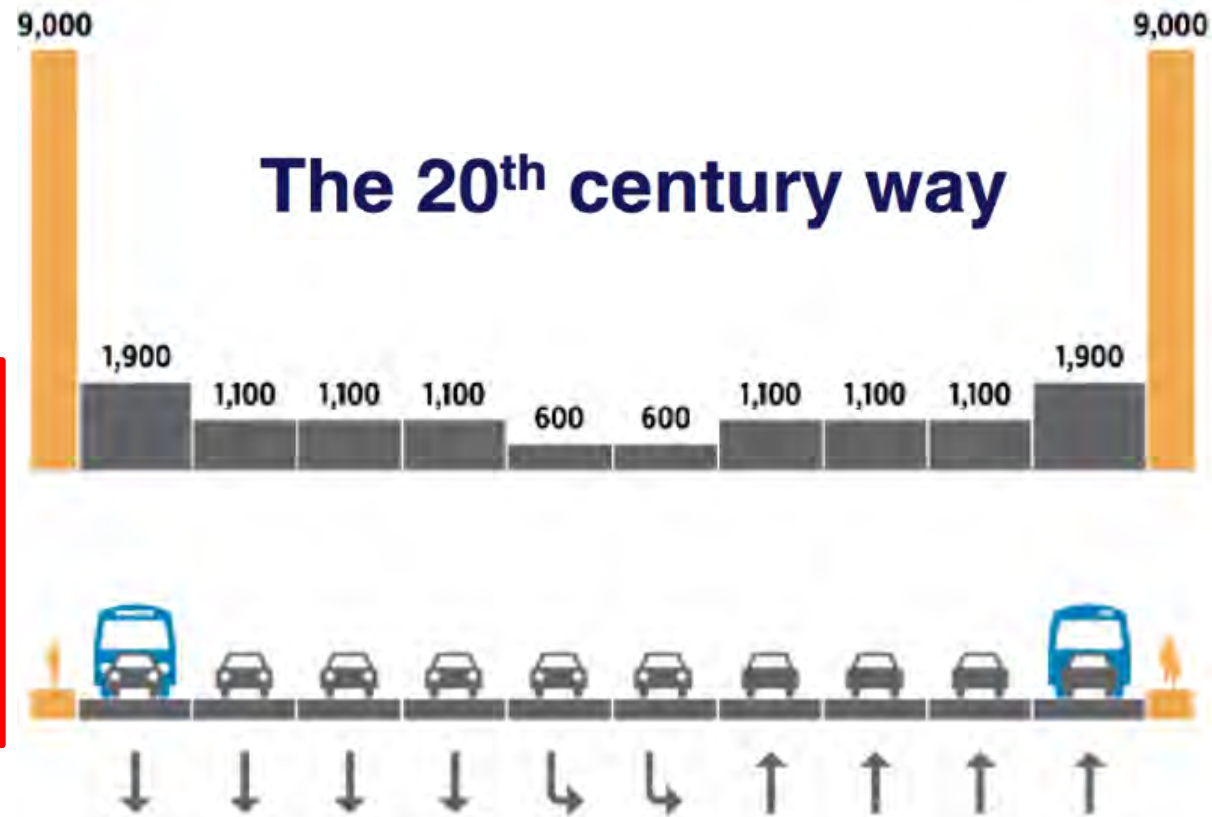➢ Multimodal transportation
➢ Mobility as a service

**Approach**
➢ This forum is for **open discussion** and will serve as **a sounding** board to inform recommendations to the Washington State AV Work Group Executive Committee

➢ The staff support for this subcommittee will take input received from subcommittee working group members with the **goal of developing a 2019 action plan for discussion at the December 17th meeting**.

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# Cooperative Automated Transportation

# Do our old standards meet today's demands?



Photo credit: Perkins + Will, Nelson\Wygaard & Lyft

# A new way to look at our transportation system

**If we manage the asphalt and concrete, we can move more people**



**How many people can this street serve per hour?**

Up to **77,000**

Source: NACTO Transit Street Design Guide

11,000 / 9,000

3,750

4,400 — Potential for 4x increase with shared AVs and incentives to fill seats

1,100 — Personal car ownership only

17,500 17,500

4,400 4,400

1,100 1,100

3,750

11,000 / 9,000

*Photo credit: Perkins + Will, Nelson\Wygaard & Lyft*
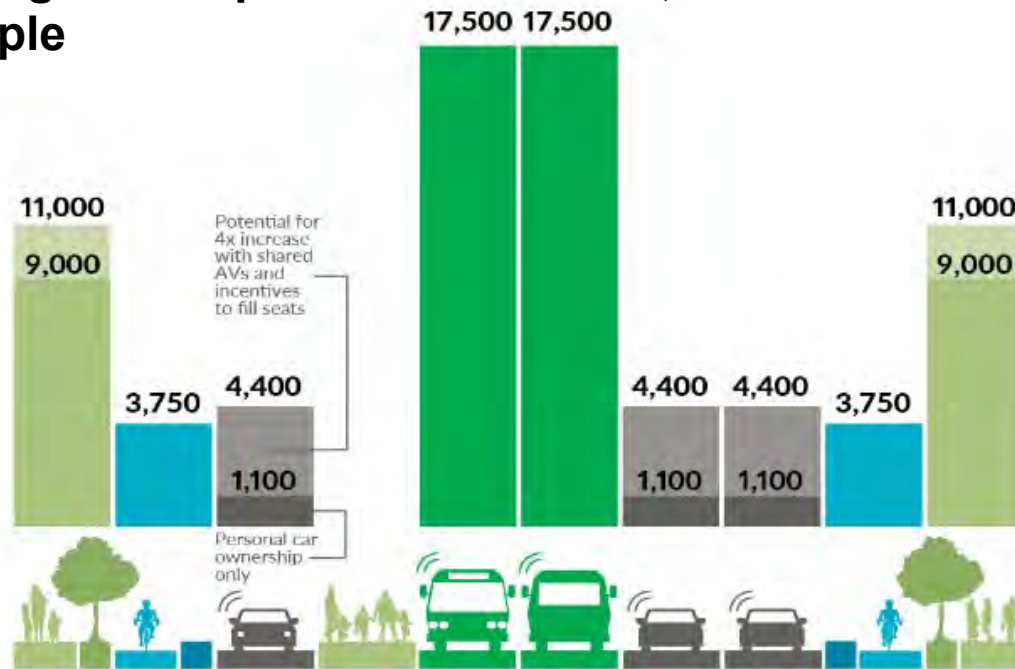
**Are we focused on:**

**Replacing the human driver with a robot?**

**or**

**Enhancing the lives of the people we serve?**

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# Preparing for "Autonomous" or Connected and Automated Vehicles requires a broader perspective

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# Cooperative Automated Transportation (CAT)

**Cooperative:** Deploying technology to encourage all modes of transportation to work in concert to provide travelers a safe, sustainable, and integrated multimodal transportation system.

**Automated:** By automating some or all of the functions of or access to various vehicle types (automobile, van, plane, truck, bus, rail, ferry, bicycle, scooter, etc.), traffic management systems, integrated multimodal trip planning and pavement systems along with other functions of the transportation system will greatly improve our collective ability to leverage our limited funding to get the most capacity and safety out of the entire multimodal transportation system.

*"Autonomous" implies independence, when in reality all of the parts of the transportation system are interdependent."*

**Transportation:** The entire transportation system working together (vehicles, infrastructure, modes, services, etc.) to provide safe, reliable and cost-effective transportation options to make our communities more livable, improve economic vitality, and improve the safety of our entire multimodal transportation system.

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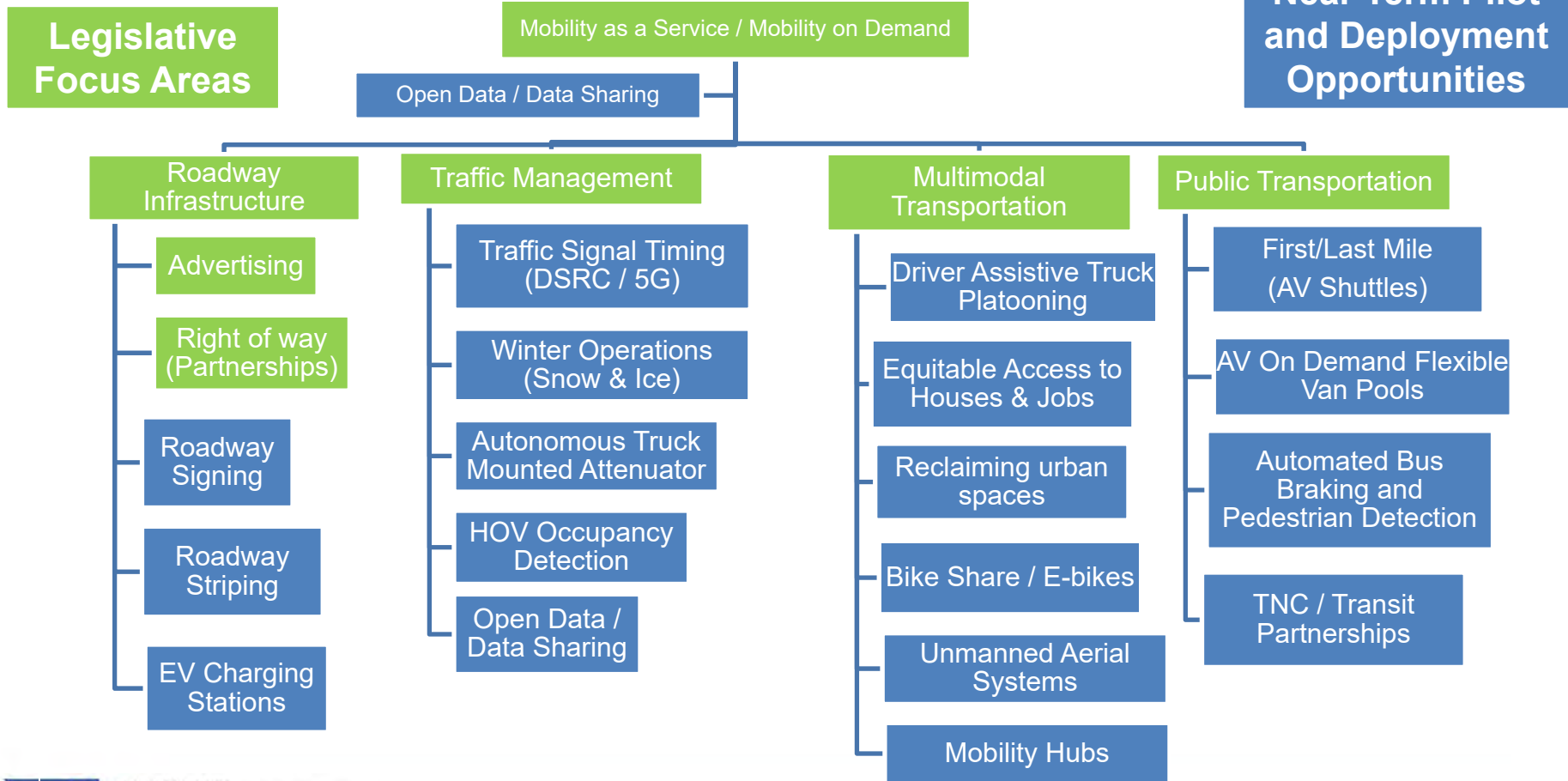WORK GROUP

# WSDOT's Vision for CAT

**Vision**

We envision a future where automated, connected, electrified, and **shared mobility** contributes toward a **safe** and efficient transportation system that **emphasizes public transit and active transportation** and promotes **livable (walkable / bikeable), economically vibrant communities** with affordable housing and convenient access to jobs and other activity centers.

# WSDOT's Draft CAT Policy Goals

- Organizing for innovation

- Shared mobility

- Economic vitality and livability

- Infrastructure and Context Sensitive street design

- Land use

- Equity

- Safety

- Environment

# Cooperative Automated Transportation (CAT)

**Legislative Focus Areas**

**Near Term Pilot and Deployment Opportunities**

Mobility as a Service / Mobility on Demand

Open Data / Data Sharing

## Roadway Infrastructure
- Advertising
- Right of way (Partnerships)
- Roadway Signing
- Roadway Striping
- EV Charging Stations

## Traffic Management
- Traffic Signal Timing (DSRC / 5G)
- Winter Operations (Snow & Ice)
- Autonomous Truck Mounted Attenuator
- HOV Occupancy Detection
- Open Data / Data Sharing

## Multimodal Transportation
- Driver Assistive Truck Platooning
- Equitable Access to Houses & Jobs
- Reclaiming urban spaces
- Bike Share / E-bikes
- Unmanned Aerial Systems
- Mobility Hubs

## Public Transportation
- First/Last Mile (AV Shuttles)
- AV On Demand Flexible Van Pools
- Automated Bus Braking and Pedestrian Detection
- TNC / Transit Partnerships

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# Open Group Discussion

1. Do we have the right people around the table? Who is missing?
   - Review working group and interested persons roster

2. Are any organizations and/or interest groups <u>over</u> **OR** <u>under</u> represented?

# What does CAT look like?

# A Connected Automated Vehicle is one component of CAT

**Connected Vehicle**

Communicates with nearby vehicles and infrastructure; Not automated
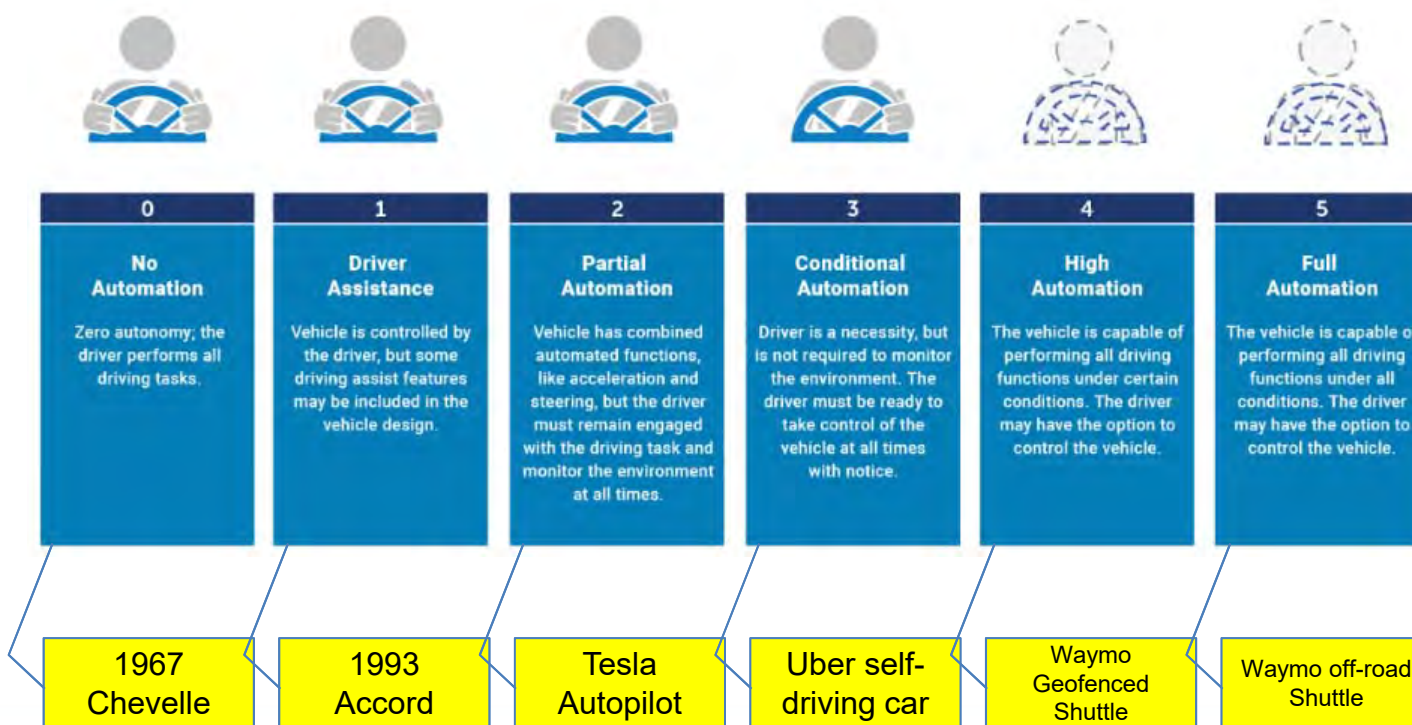
*Connected Automated Vehicle*
Leverages autonomous automated and connected vehicles

**Autonomous Vehicle**

Operates in isolation from other vehicles using internal sensors

# Connected Automated Vehicle Level of Automation

SAE: Society of Automotive Engineers



| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **No Automation** | **Driver Assistance** | **Partial Automation** | **Conditional Automation** | **High Automation** | **Full Automation** |
| Zero autonomy; the driver performs all driving tasks. | Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design. | 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. | 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. | The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle. | The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle. |
| 1967 Chevelle | 1993 Accord | Tesla Autopilot | Uber self-driving car | Waymo Geofenced Shuttle | Waymo off-road Shuttle |

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# Mobility as a Service / Mobility on Demand



MOBILITY AS A SERVICE FRAMEWORK

- Integrated, seamless payment and trip planning
- Bundling of services
- On demand, dynamic services
- City Mapper- integrated trip planning
- Lyft- integrating bus and scooter
- Go Monrovia (Los Angeles) subsidized PPP
- Whim (Finland)- integrated all mobility options and bundled with monthly subscriptions

Image from Ministry of Transport and Communication, Finland

# Automated



- Commercial availability of Level 2 technologies

- Truck platooning and AV freight

- AV proving grounds

- AV shuttle deployments

- Drones, delivery robots

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# Connected



Source: U.S. Department of Transportation

- CV Pilot Program
- SPaT Challenge
- Communications technology debate (DSRC vs. cellular/ C-V2X)
- Smart Cities and data

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# Electric

- EV in the AV ecosystem
- EV infrastructure (fixed and inductive charging)
- Electrification initiatives and incentives
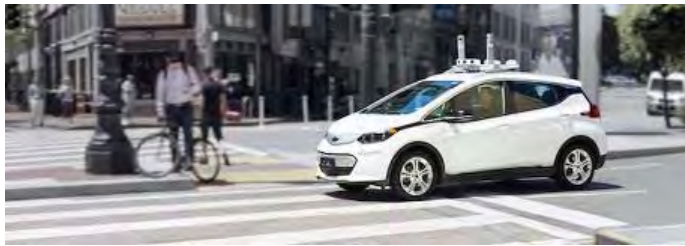
# Shared



- Planned launches of AV taxi services
- Transit / TNC partnerships
- Carpool / vanpool programs
- Bikeshare/ scooters/ personal car share, etc.

# Driver-Assistive Truck Platooning

➤ As of September 2018, **17 states have made allowance for commercial deployment of driver-assistive truck platooning**. Sixteen have passed legislation (Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Michigan, Mississippi, Nevada, North Carolina, Oregon, South Carolina, Tennessee, Texas, Utah, and Wisconsin), and one has acted administratively (Ohio).

➤ **Four other states** (Arizona, Colorado, Florida, and New Mexico) allow limited commercial deployments of truck platooning.

➤ **Three states** (California, New York, and Virginia) allow for testing of truck platooning, with others expressing interest.

➤ **Illinois and Pennsylvania** currently have legislation pending which would allow full commercial deployment of truck platooning.

# Future uses for Public R/W

- Leveraging the Public Right of Way Asset
  - Telecom Partnerships
    (Long Term Lease Agreements)
    - 5G small cell deployment
    - Fiber optic trunk lines to facilitate Smart City Applications

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# CAT in Action in Washington

# Multimodal Transportation

- **Incorporating CAT Policy Goals into a guiding policy framework** that will serve as reference point for short and long term planning
- Encouraging partnership
- Reclaiming urban spaces
- Equitable access to jobs and housing
- Sustainable transportation system

# Public Transportation

- **Pierce Transit** has been piloting:
  - Automated pedestrian detection which has reduced pedestrian-related crashes
  - Use of subsidized transportation network company (TNC) trips first and last mile connections to and from transit centers and bus stops
- **WSDOT** is exploring
  - Rural micro-transit
  - First/last mile connections
  - Potential Grant Program



*Photo credit: Seattle Med...*



*Photo credit: WSDOT*



*Photo credit: Pierce Transit*

**lyft**

Providing first and last mile service connections for transit users

**PierceTransit**

This is a pilot project to provide first and last mile connections to and from transit centers and bus stops.

ORIGIN    TRANSIT CENTER    DESTINATION



*Photo credit: Pierce Transit*

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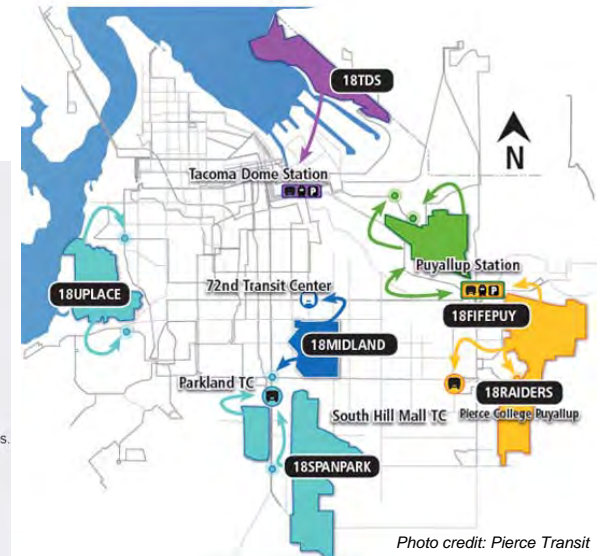
# Multimodal Connection Hub

- Separated transit interchange concept

- Preparing for Transit Connectivity



Local bus stop

BRT stop

BRT stop

We are considering shared mobility and autonomous vehicle drop-off/pickup locations in future projects
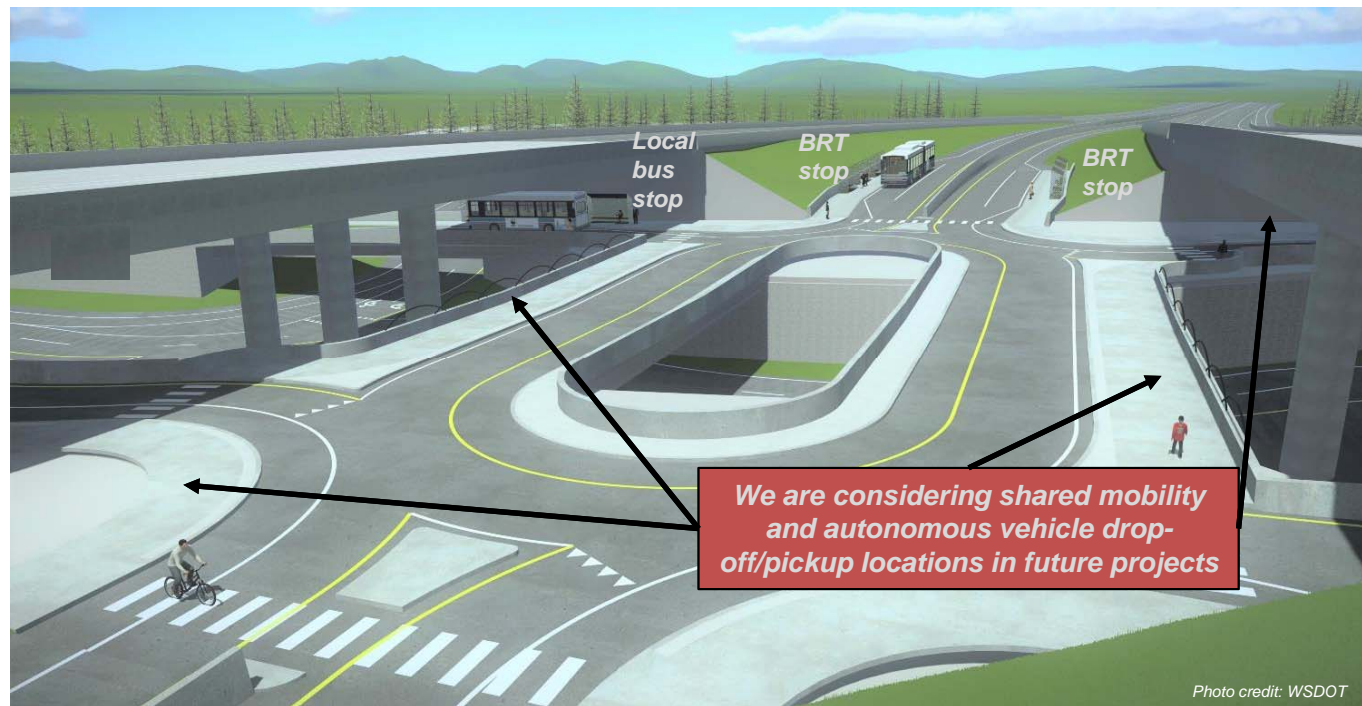
*Photo credit: WSDOT*

# Autonomous Truck Mounted Attenuator (ATMA)
## Work Zone Safety

Low-speed striping operations



Photo credit: WSDOT

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# Winter Roadway Operations
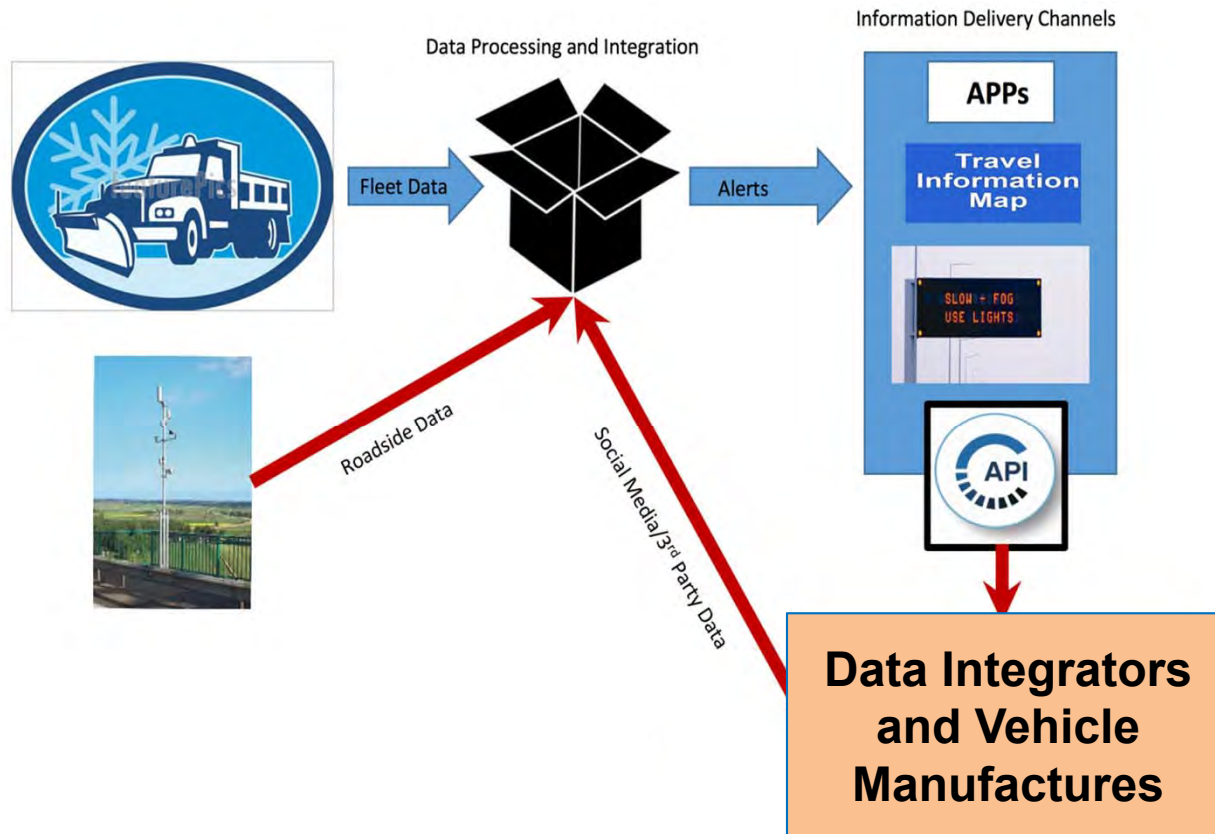


Informing the public: "Snow Plow Operations Ahead"

# Machine Readable Signing and Striping

"Good for human
drivers today …

Prepares for
Automated
Vehicles
tomorrow"
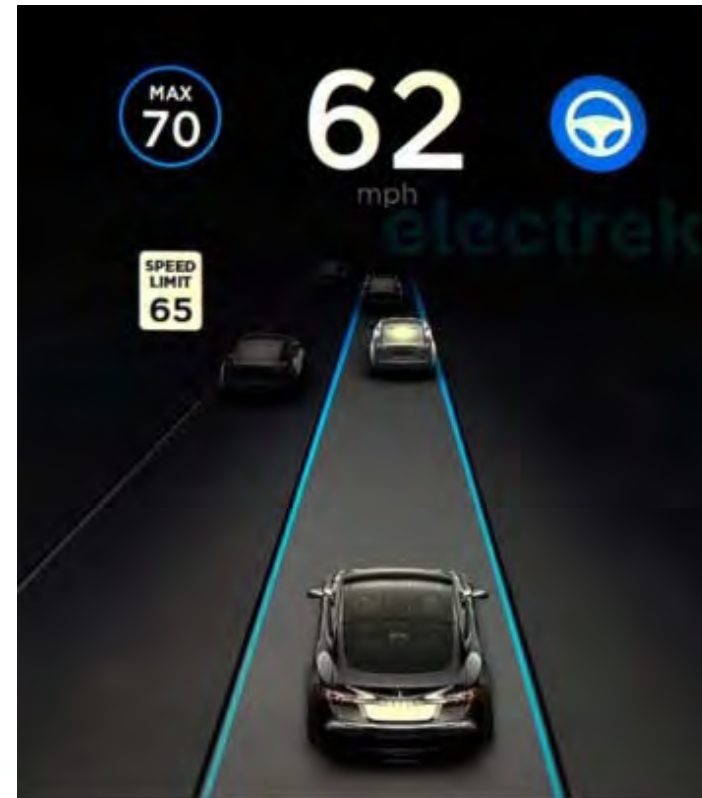
# Traffic Signal Operations

**Communicating with the transportation infrastructure**





Communicate via **centralized system**

**AASHTO Signal Phase and Timing (SPaT) Challenge**

– **4 locations across WA**
  - **23 intersections**



Photo credit: GM

**DSRC:** Dedicated short range communications the vehicle to the traffic signal

# EV Charging Infrastructure

- Uses a portion of the annual electric vehicle registration fee to provide matching grants

- $1 million in state funding used to encourage private sector investment for 15 new locations totaling $2.5 million

- $100M would complete the gap map with charging station(s) every 70 miles



WSDOT Electric Vehicle Highway Corridor Charging Gap Map
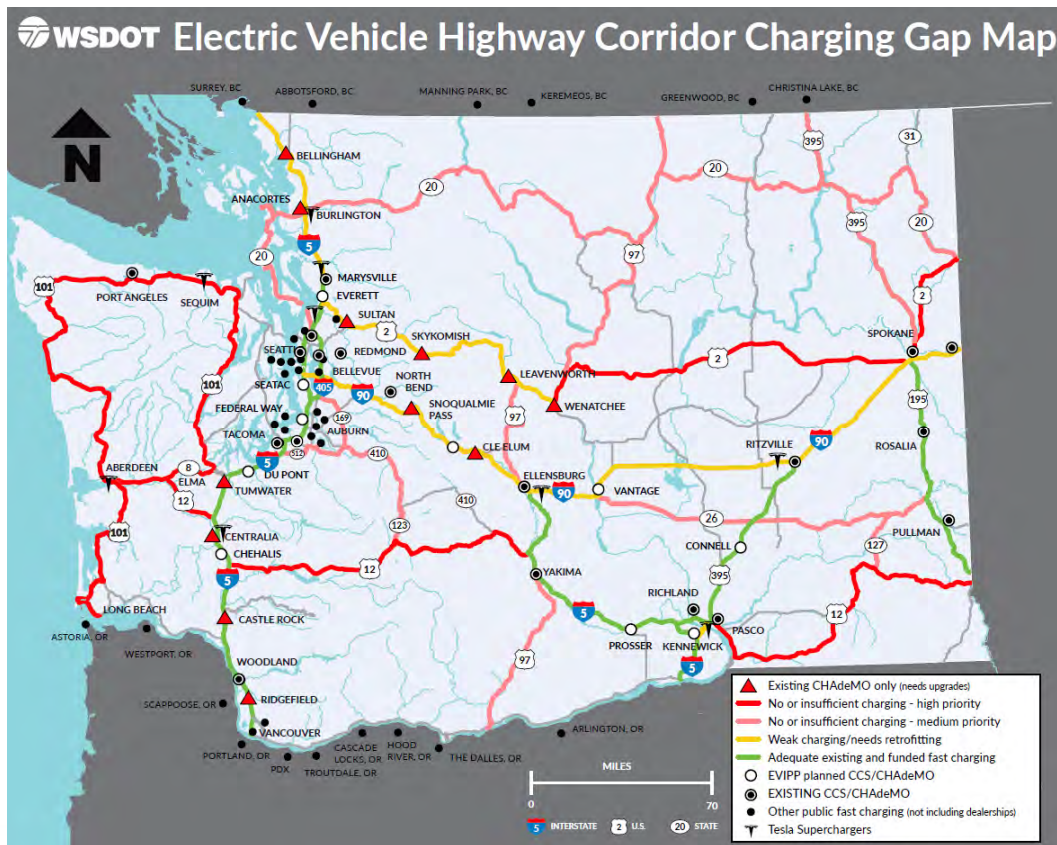
# National Framework Overview

# Automobile history



Easter Parades in New York City

Year 1900: One Motor Vehicle    Year 1913: One Horse & Carriage

# So when will "Autonomous" Vehicles arrive?
## Ten competitors have publically projected market dates between 2019 and 2022 for SAE Level 4 Vehicles

# National Efforts

# Federal Legislation

- House (H 3388 SELF DRIVE Act) passed the full House and awaits Senate action

- Senate Bill (S 1885 AV START Act) passed the Committee on Commerce, Science, and Transportation, but hasn't been brought to full vote of Senate yet

- Open issues include whether or not to include trucks, the pre-emption language, and the FMVSS exemption numbers

- Work continues behind the scenes to get the holds released and determine whether this bill stands alone or gets incorporated into an upcoming bill.

- Once it eventually passes the Senate, then a conference committee will be named to work out differences.
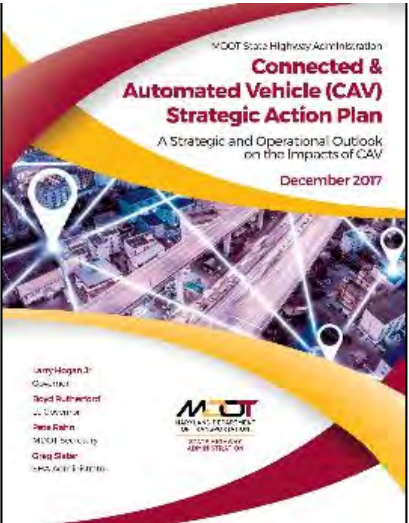
# Federal Guidance

- 2016 – Federal Automated Vehicles Policy

- 2017 – Automated Driving Systems: A Vision for Safety 2.0

  - The first two versions provided manufacturers with guidance on how the technology would be regulated by NHTSA and advised states on best practices for regulating them in their jurisdictions.

- 2018/19 – version 3.0 will reportedly go beyond by incorporating other modes

  - We expect truck, bus, motorcycles, and more

# Policy and Legislation

**States with Autonomous Vehicles Enacted Legislation and Executive Orders**
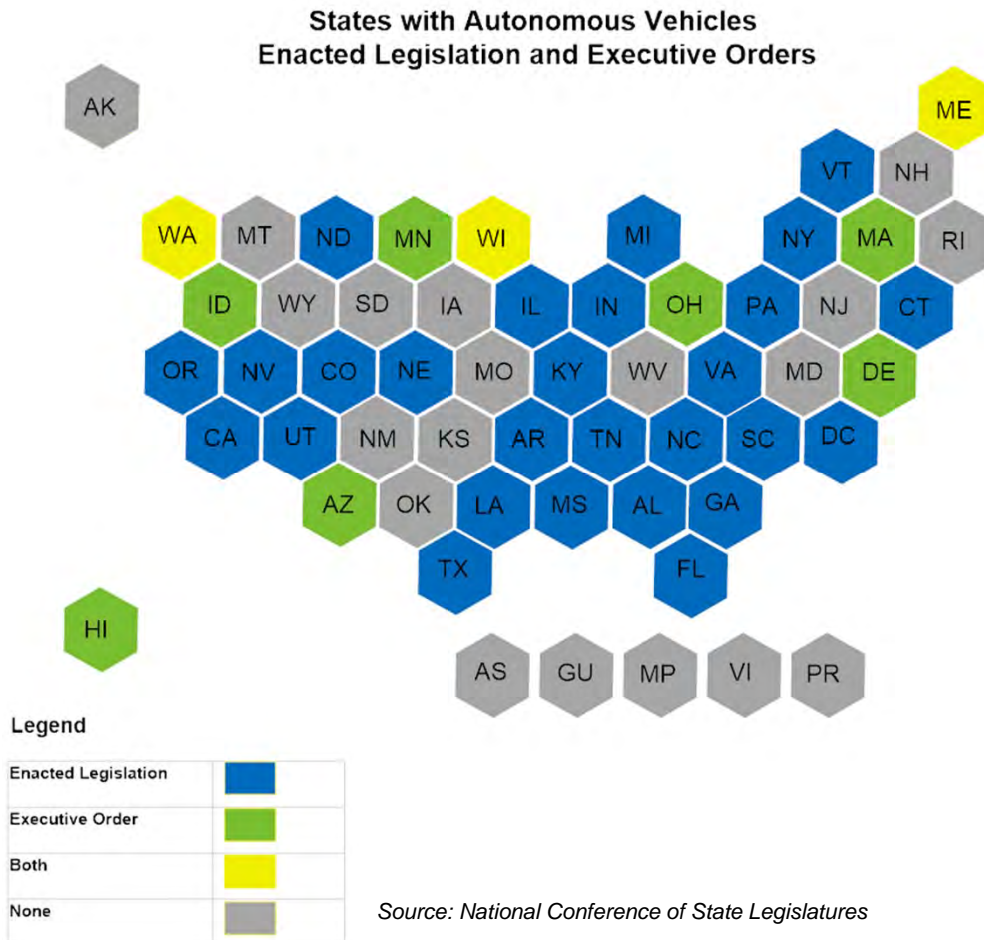
- State legislation and executive actions
- Emerging policy issues (parking, curb space, enforcement)

Legend

| | |
|---|---|
| Enacted Legislation | (blue) |
| Executive Order | (green) |
| Both | (yellow) |
| None | (gray) |

*Source: National Conference of State Legislatures*

# Strategy, Guidance and Organization

- Strategic planning for CAV/New Mobility
- Best practices and guidance documents through national organizations
- Establishment of CAV-specific offices within organizations
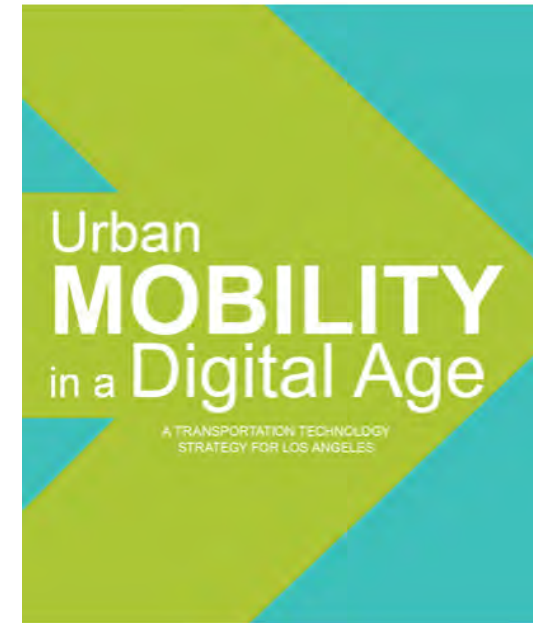- Multi-agency work groups

# Policy Framework Efforts



**San Francisco**



**Los Angeles**

- Guiding Principles
- Data Standards
- Metrics
- Policies
- Pilots

# AASHTO CAT Policy, Legislative and Regulatory Work Group
## Work Plan Priorities through June 2019

**Activity #1:** Create a clearinghouse for sharing CAT policy frameworks completed or under development

**Activity #2:** Identify funding opportunities and financing models to enable near-term CAT investments

**Activity #3:** Identify model regulations that enable near-term pilots and deployments

### Top Priorities
1.) Guidelines for AV testing on public roads
2.) Truck platooning – driver assisted (SAE Level 1)
3.) HOV lane enforcement

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# Washington State Framework Overview

# How is Washington state preparing?

JAY INSLEE
Governor

STATE OF WASHINGTON
OFFICE OF THE GOVERNOR
P.O. Box 40002 • Olympia, Washington 98504-0002 • (360) 902-4111 • www.governor.wa.gov

EXECUTIVE ORDER 17-02

AUTONOMOUS VEHICLE TESTING & TECHNOLOGY
IN WASHINGTON STATE
AND AUTONOMOUS VEHICLE WORK GROUP

GOVERNOR INSLEE'S ANNOUNCEMENT

"Washington state is already a leader in autonomous vehicle technology. We are an early-adopter that welcomes innovation and the safe testing and operation of AVs," Inslee said. "AVs could help save countless lives, reclaim time spent in traffic, improve mobility and be an important tool in our efforts to combat climate change."
—Governor Jay Inslee

In 2016, Governor Inslee worked with Google executives to recruit their self-driving car program to Washington state. That program (now known as Waymo) has successfully tested AVs throughout the City of Kirkland without incident. Over twenty AV technology companies — both established companies and start-ups — have developed a presence in Washington state. On June 7, 2017, Governor Inslee signed an executive order to further support the safe testing and operation of autonomous vehicles.

Governor's Autonomous Vehicle Work Group

➢ June 7, 2017 Executive Order 17-02 formed Governor's AV Work Group

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➢ March 22, 2018 SHB 2970 Transportation Commission facilitated AV Work Group

SHB 2970  AUTONOMOUS VEHICLE WORK GRP          3/22/18
LEGISLATIVE BUILDING, OLYMPIA
FOR MORE INFORMATION VISIT GOVERNOR.WA.GOV
GOVERNOR JAY INSLEE BILL SIGNING CEREMONY

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# Governor's Executive Order 17-02

# Key Provisions

**Executed June 7, 2017**

- Pilot programs are enabled throughout the state in partnership with entities that are developing AV technology equipment and such pilots may or may not have a human present in the vehicle.

- Entities conducting AV <u>testing with a human present</u> in the vehicle must self-certify to DOL they are compliant with all requirements including: possessing a valid drivers license; providing proof of financial responsibility as required by RCW 46.30.020; the operator must have ability to direct the vehicle's movement if assistance is needed; etc.

- Entities conducting AV <u>testing without a human present</u> in the vehicle must self-certify to DOL they are compliant with all requirements including: vehicles being equipped with automated driving systems that perform all aspects of driving on a part or full-time basis and must be able to bring the vehicle to a safe condition in the event of a system failure; providing proof of financial responsibility as required by RCW 46.30.020; etc.

- Entities may implement pilot programs immediately after providing notification to DOL.

- Establishes an interagency work group to advance the objectives of the Exec. Order and examine emerging automated transportation technology in other modes, including freight, aviation, transit, passenger rail, marine vessels and ferries, as well as points of convergence with connected, shared and electric vehicles.

- Work group includes representatives from the: Governor's Office, Dept. of Transportation, Dept. of Commerce, Dept. of Licensing, Wash. State Patrol, and the Traffic Safety Commission.

# SHB 2970

**Legislative Intent** *(SHB 2970 (Sec. 3), Ch. 180, Laws of 2018)*:

*"The legislature finds that establishing an autonomous vehicle work group, to be convened by the transportation commission, will facilitate state efforts to address the emergence of autonomous vehicle technology. It is the intent of the legislature for the transportation commission to develop recommendations for policy, laws, and rules for the operation of autonomous vehicles, with input from the autonomous vehicle work group, that enable Washington state to address the public policy changes necessitated by the emergence of this technology in an informed, thorough, and deliberate manner."*

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# SHB 2970
# Key Provisions

- The AV Work Group is to develop policy recommendations to address the operation of autonomous vehicles on public roadways.

- Executive branch agencies are identified who must participate.

- Requires four House and four Senate members – two from each caucus of each house.

- The Transportation Commission may invite additional participation as needed.

- The Work Group must:
    - Follow developments in AV technology, AV deployment, and federal, state and local policies that relate to AV operations.
    - The scope of this work must include commercial and passenger autonomous vehicles.
    - Explore approaches to modifying state policy, rules and laws to further public safety and prepare for AV technology deployment in the state.
    - Disseminate information

- The Transportation Commission must develop and update recommendations annually based upon input from the work group and report them to the Legislature and Governor.

- Recommendations may include changes to state law and rules.

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# Washington State Autonomous Vehicle Workgroup

- Roadway infrastructure
- Traffic management
- Transit service & vehicles
- Advertising
- Right of way
- Multi-modal transportation
- Mobility as a service

- Governor
- Insurance Commissioner
- Department of Licensing
- Department of Transportation
- Washington State Patrol
- Traffic Safety
- Commission
- State Chief Information Officer
- WSTC Chair
- Four members from Senate
- Four members from House

WASHINGTON STATE AUTONOMOUS VEHICLE WORK GROUP

www.wstc.wa.gov/Meetings/AVAgenda/AutonomousVehicleWorkGroup.html

## Subcommittees

| Licensing | Infrastructure and Systems | Liability | Safety | System Tech and Data Security |

WASHINGTON STATE AUTONOMOUS VEHICLE WORK GROUP

# WSDOT Organizational Efforts External Engagement

**Secretary of Transportation**

**Assistant Secretary Multimodal Development & Delivery**

**External Workgroups**

**Governor's Autonomous Vehicle Work Group**

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**WSDOT**

**CAT Workgroup**

- Active Transportation
- Traffic Operations
- Research
- Aviation
- Project Development
- Multimodal Planning
- Public Transportation
- Freight
- Tolling
- Innovative Partnerships
- Maintenance

**AASHTO CAT Coalition**

Policy, Legislative, and Regulatory Workgroup

ITS AMERICA

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# Engagement Opportunities

# On-road testing and deployment in Washington



**Department of Licensing Autonomous Vehicles: Self-certification testing in Washington state**

### **Self-Certified Companies**
1. Dooblai LLC
2. May Mobility
3. Navya Inc.
4. NVIDIA Corporation
5. Simple Solutions
6. TORC Robotics
7. Waymo LLC

# Policy Framework Efforts

Seattle

- Vision
- Values
- Principles for Mobility
- Next Steps

# Summary of other Washington State AV Work Group subcommittee progress

# Washington State AV Work Group subcommittees progress report

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                    │       Subcommittees         │
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| Licensing | Infrastructure and Systems | Liability | Safety | System Tech and Data Security |
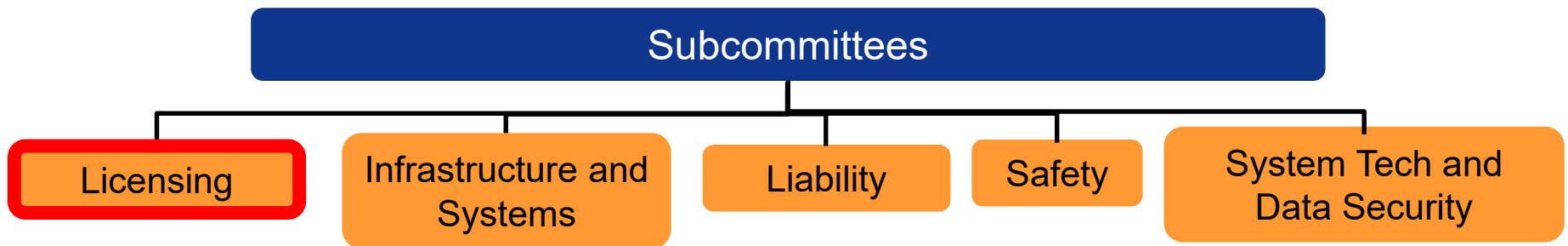
- One meeting held to date
- Approved subcommittee charter
- Established goals for the coming year
- Next meeting scheduled for October 5th

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# Washington State AV Work Group subcommittees progress report
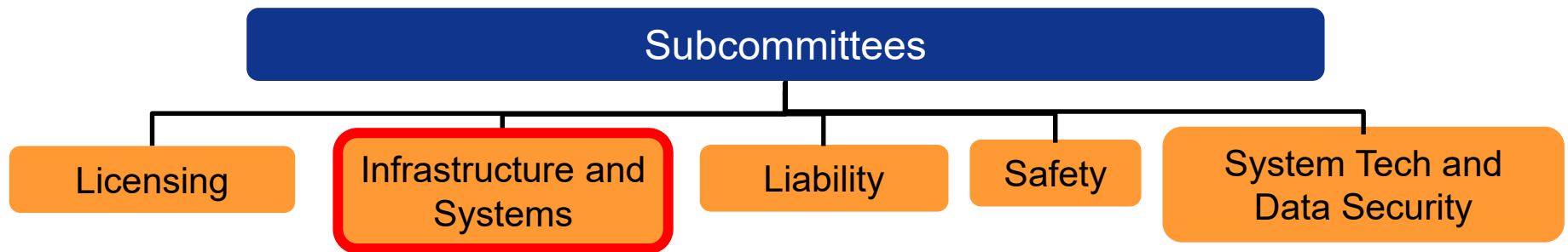


- Progress report will be developed for the October 24th Executive Committee Meeting based on the pre meeting survey, todays discussion and other input from working members.

# Washington State AV Work Group subcommittees progress report

Subcommittees

- Licensing
- Infrastructure and Systems
- Liability
- Safety
- System Tech and Data Security
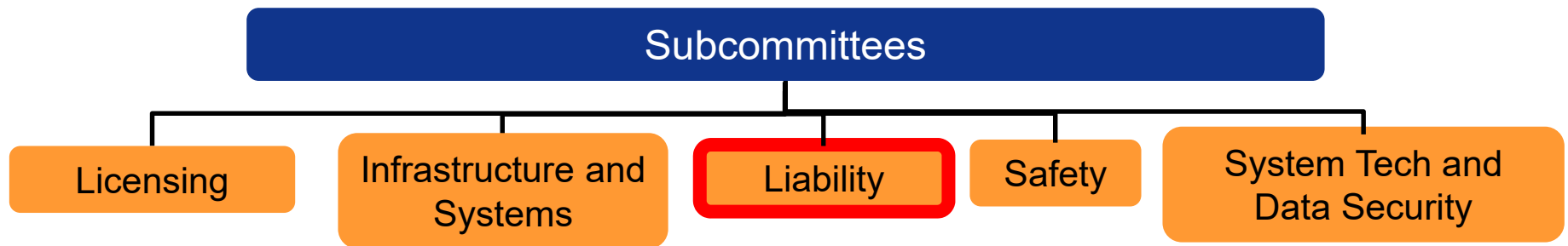
- One meeting held to date
- Developed decision-making and voting process
- Created a list of issues to be tackled by the subcommittee

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# Washington State AV Work Group subcommittees progress report

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                        │         Subcommittees        │
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   │ Licensing│  │ Infrastructure  │  │ Liability│  │  Safety  │  │ System Tech and │
   │          │  │   and Systems   │  │          │  │          │  │  Data Security  │
   └──────────┘  └─────────────────┘  └──────────┘  └──────────┘  └─────────────────┘
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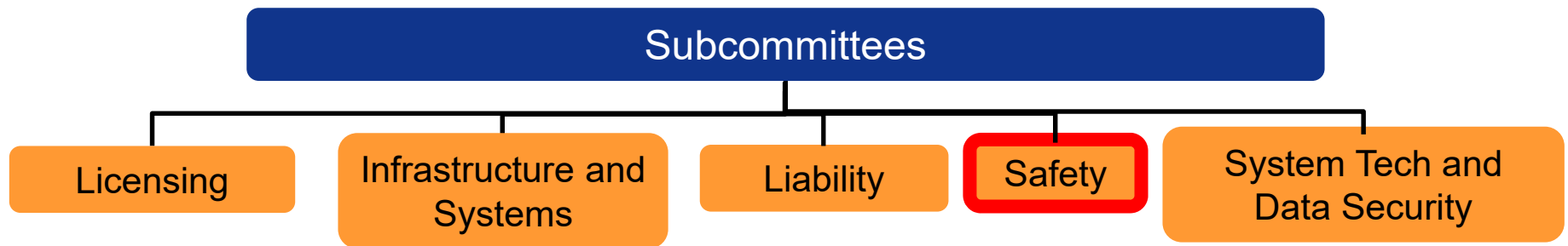
- Three meetings held to date
- Conducted AV 101 education
- Discussed key topics including educating the public, understanding "black box" data, health impact assessment, and AV certification

# Washington State AV Work Group subcommittees progress report

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                    │      Subcommittees      │
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| Licensing | Infrastructure and Systems | Liability | Safety | System Tech and Data Security |
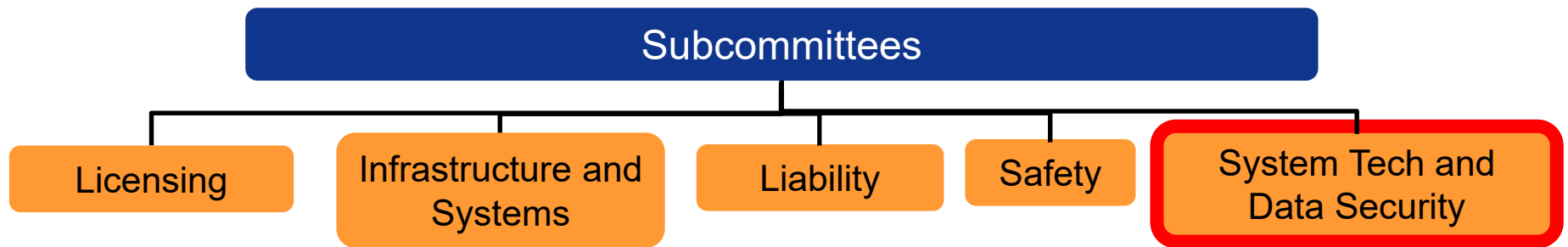
- One meeting held to date
- Conducted overview of key provisions of the legislation
- Initiated scope discussion and identification of subcommittee membership

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# Identifying a **2019** Action Plan

# Working Groups Member Survey

**Questions**

Have you been involved in either policy or implementation work related to Autonomous/Automated Vehicle (AV) and Connected Vehicles (CV) technology?

Involved in CAV Work



12
30
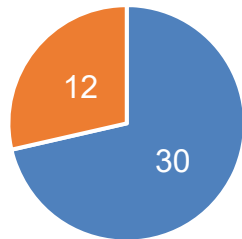
53 invitations 42 Responded

■ Yes ■ No

How would you categorize your understanding of the Autonomous/Automated Vehicle (AV) and Connected Vehicles (CV) subject area on a scale from 1 to 100?

➢ Average score of 64

➢ 14 responses of 80 or higher

1 = Need a detailed primer
100 = Could instruct a CV / AV 101 course

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# Enabling Policy & Program Survey

Series 1

# Enabling Policy & Program Survey

## Other Ideas Submitted in the Survey

1. **Need for Regulatory Framework**
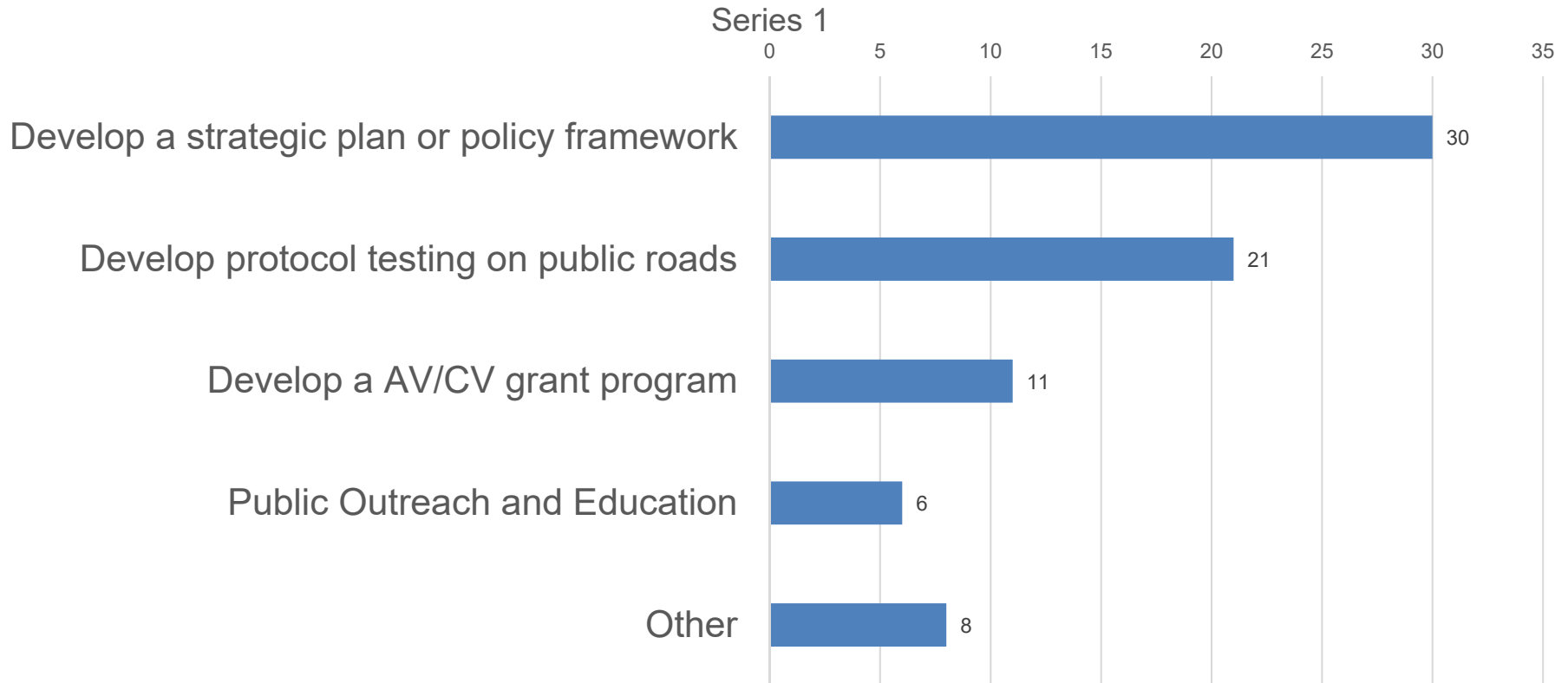   a) Develop a program for Cities and Counties to coordinate with the State in **establishing local regulatory frameworks for AV/CV testing, pilots, and deployment**
   b) Support for local jurisdictions, **consistent regulatory framework**
   c) Protocols and requirements not just for testing of AV technology but also applications of AV technology.
      ▪ (Examples: zero occupancy tax, Sliding scale VMT etc to ensure that AVs improve transportation without adding # of vehicles, VMT and worsening congestion and energy use)
   d) **Safety requirements and infrastructure needs** to prioritize safety.
   e) **Equity implications** of AV technology
   f) **Open Data / Data Sharing / Cyber Security / Data Privacy**
      • Understanding what will happen to the data created by Autonomous Vehicles - will it be given to public agencies for study or use / will it stay within private AV companies / what are the legal, privacy, and protection implications for citizens?
   g) Will infrastructure need to adapt to AV technology or will AV technology be perfected to adapt to the infrastructure?
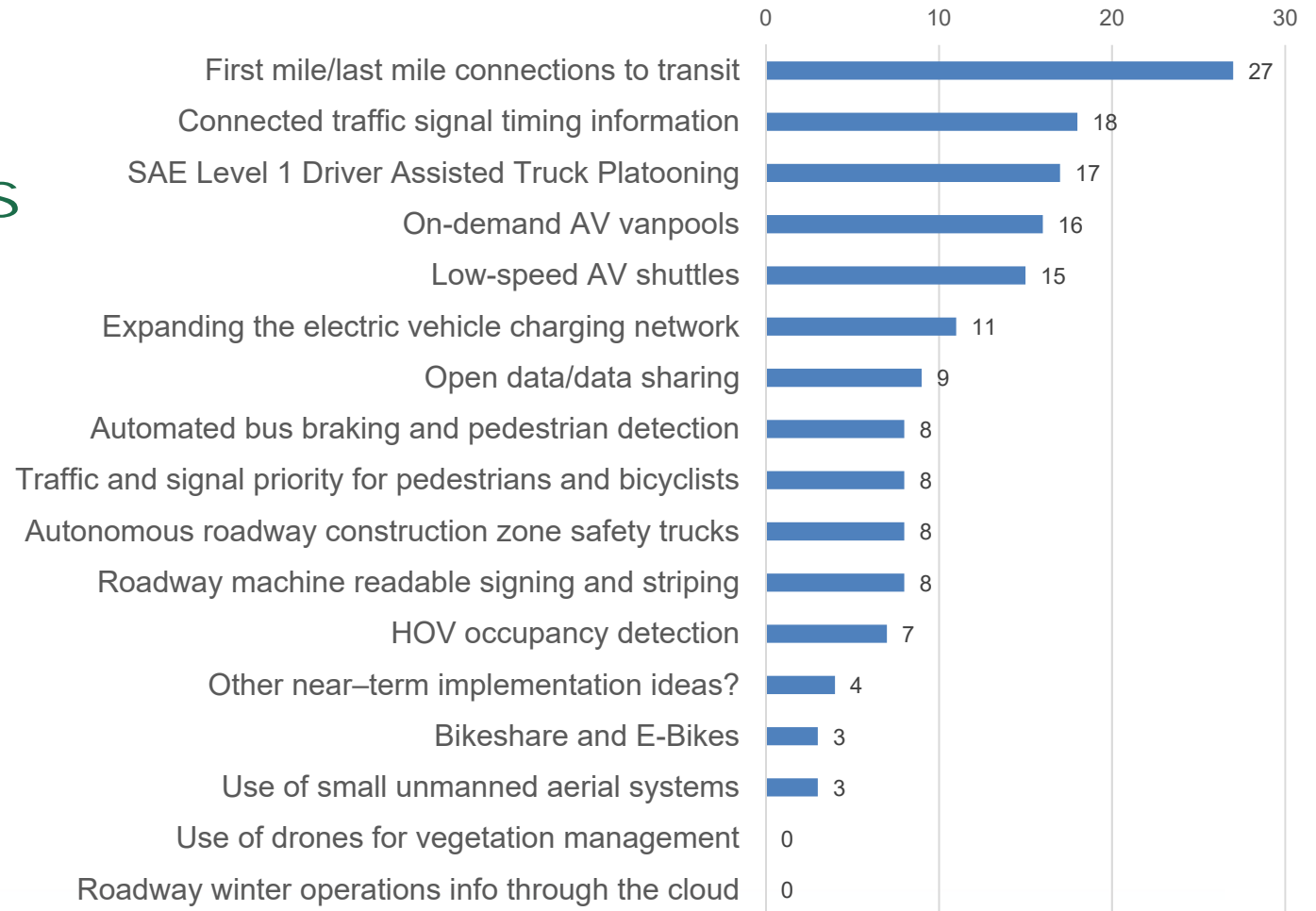
2. **Need Funding for Transportation Infrastructure & Systems**
   a) Road Pricing
3. **Commute Trip Reduction Act**
   a) Cross-reference above with changes to state Commute Trip Reduction Act and include in corridor planning strategies

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# Near Term Pilots & Deployments Survey



First mile/last mile connections to transit — 27
Connected traffic signal timing information — 18
SAE Level 1 Driver Assisted Truck Platooning — 17
On-demand AV vanpools — 16
Low-speed AV shuttles — 15
Expanding the electric vehicle charging network — 11
Open data/data sharing — 9
Automated bus braking and pedestrian detection — 8
Traffic and signal priority for pedestrians and bicyclists — 8
Autonomous roadway construction zone safety trucks — 8
Roadway machine readable signing and striping — 8
HOV occupancy detection — 7
Other near–term implementation ideas? — 4
Bikeshare and E-Bikes — 3
Use of small unmanned aerial systems — 3
Use of drones for vegetation management — 0
Roadway winter operations info through the cloud — 0

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# Near Term Pilots and Deployments Survey

**Other Ideas Submitted in the Survey**

1. Data privacy and security
2. Bus platooning to create a "true" BRT (rail on surface) for buses as well as AV buses
3. Campus bus automation

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# What "Other" ideas have we missed?

Facilitated Group Discussion

1.) <u>Enabling policies and programs</u>

➤    Additional items?

2.) <u>Near term demonstrations pilots and deployments</u>

➤    Additional items?

# Open Discussion / Working Group

➢ Given everything we have presented and discussed

1. Does this resonate with how your organization is preparing?

2. Do we have the right people around the table?

3. Are any organizations and/or interest groups <u>over</u> **OR** <u>under</u> represented?

# Next Steps / Closing Remarks

➢ Prepare a subcommittee progress report for the WA State AV WG Executive Committee meeting on October 24th

➢ Prepare a draft 2019 Action Plan for subcommittee input prior to the next meeting on December 17th

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