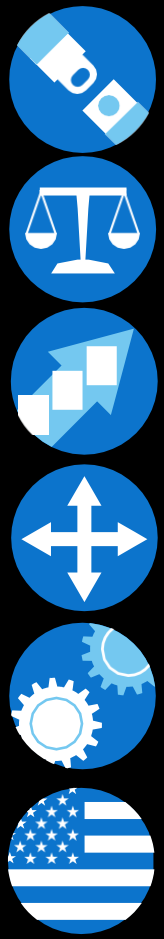
WSDOT NWR SPaT Challenge

WSDOT-NW Region
Regional Traffic Operations
Innovations and Partnership Conference,
Dec 2018

Washington State Department of Transportation

Preparing for the Future of Transportation
US DoT - Automated Vehicles 3.0



We will prioritize safety.

We will remain technology neutral.

We will modernize regulations.

We will encourage a consistent regulatory and operational environment.

We will prepare proactively for automation.

We will protect and enhance the freedoms enjoyed by Americans.

Source US-DoT

Early Eras of Safety

1950 – 2000
Safety/Convenience Features:

Cruise Control
Seat Belts
Antilock Brakes

2000 – 2010
Advanced Safety Features:
Electronic Stability Control
Blind Spot Detection
Forward Collision Warning
Lane Departure Warning

Source NHTSA

New Eras of Safety

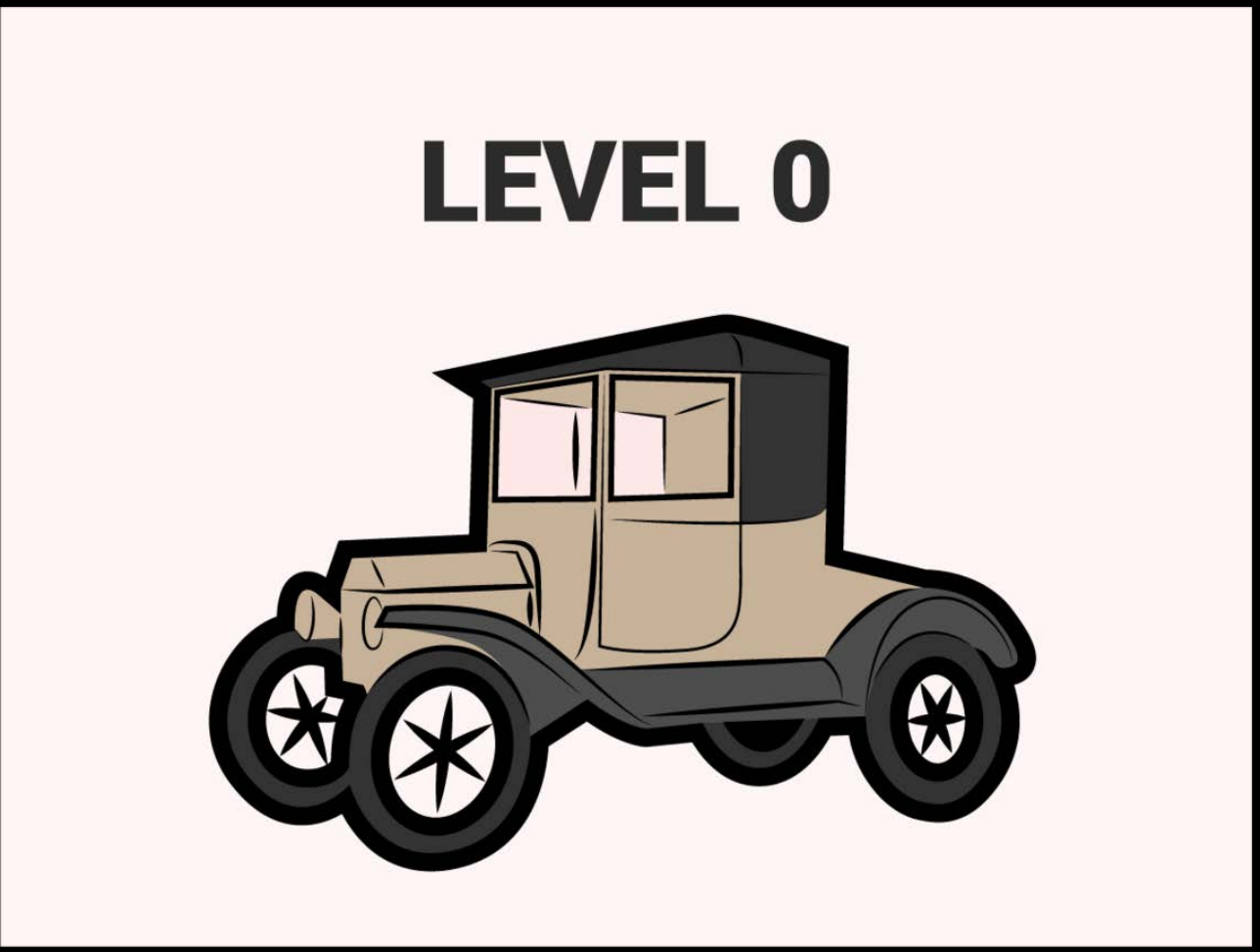
2010 – 2016
Advanced Driver Assistance Features:
Rearview Video Systems
Automatic Emergency Braking
Pedestrian Automatic Emergency Braking
Rear Automatic Emergency Braking
Rear Cross Traffic Alert
Lane Centering Assist

2016 – 2025
Partially Automated Safety Features:
Lane keeping assist
Adaptive cruise control
Traffic jam assist
Self-park

2025+
Fully Automated Safety Features:
Highway autopilot

Source NHTSA

Level 0: Feet On, Hands On, Eyes On!



0

No Automation

Zero autonomy; the driver performs all driving tasks.

Source NHTSA

Level 1: Hands On, Eyes On!

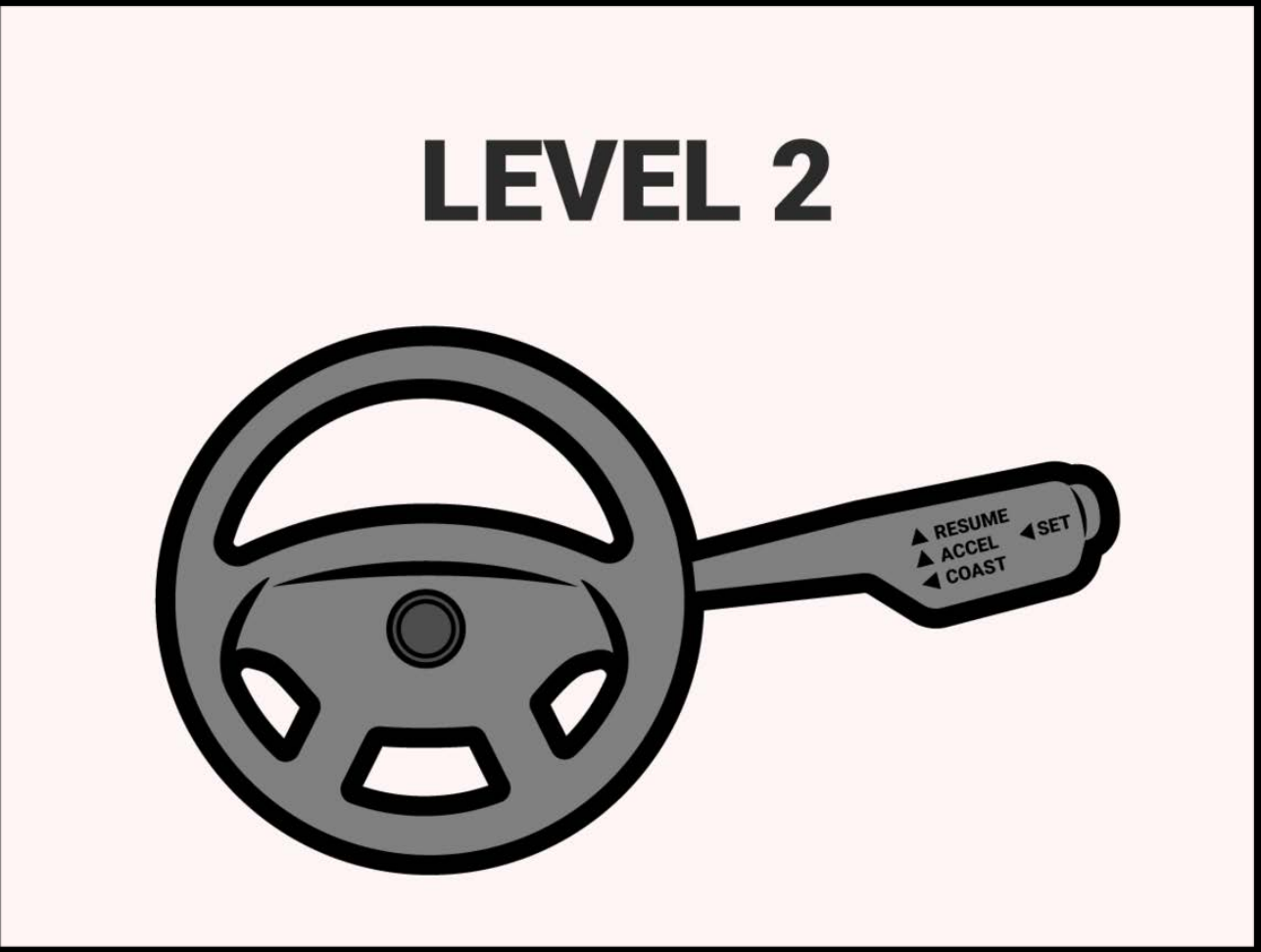
1

Driver Assistance

Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.

Source NHTSA

Level 2: Hands Off/On, Eyes On!



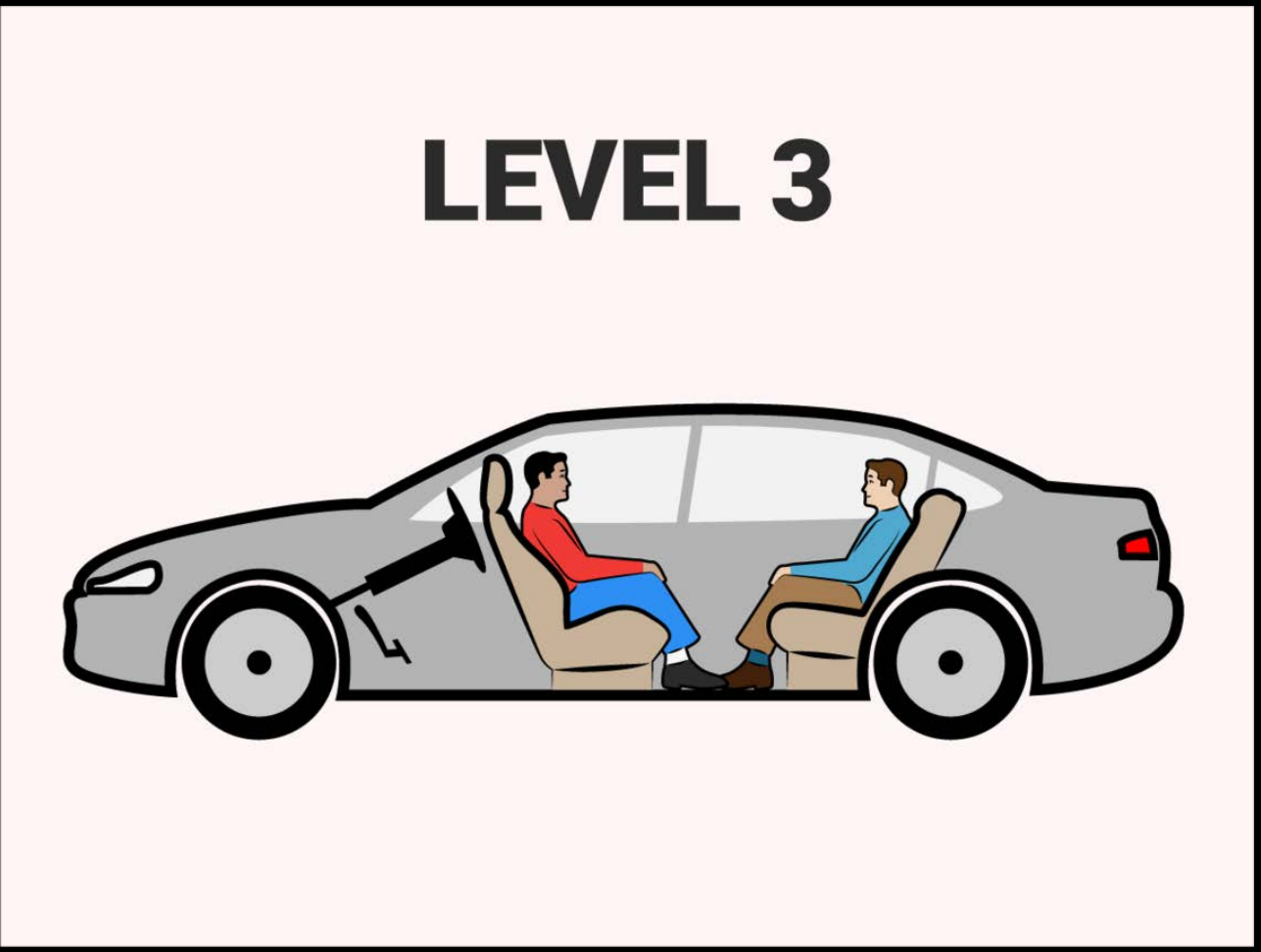
2

Partial Automation

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.

Source NHTSA

Level 3: Eyes Off, Minds On!



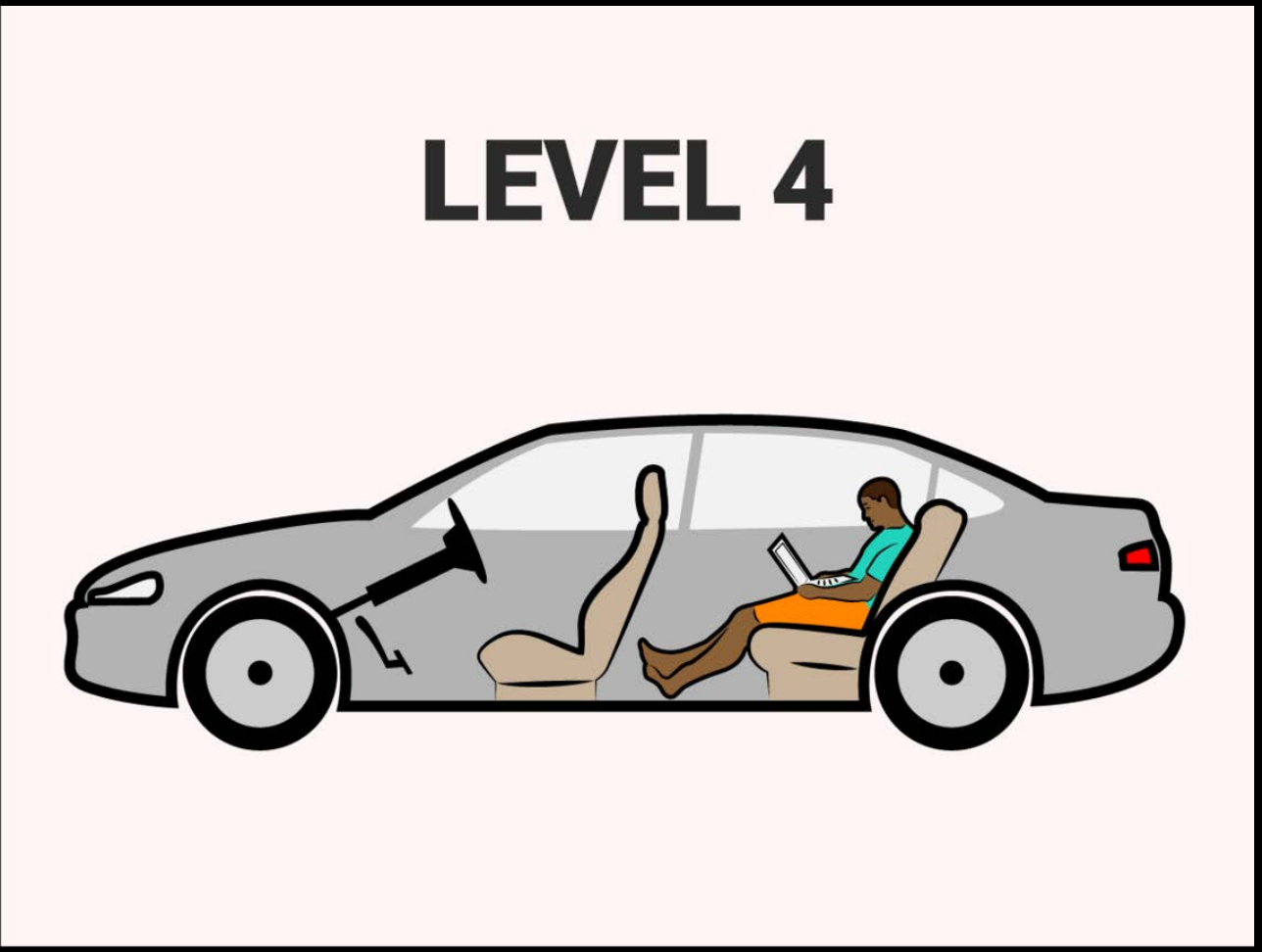
3

Conditional Automation

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.

Source NHTSA

Level 4: Eyes Off, Minds On/Off!



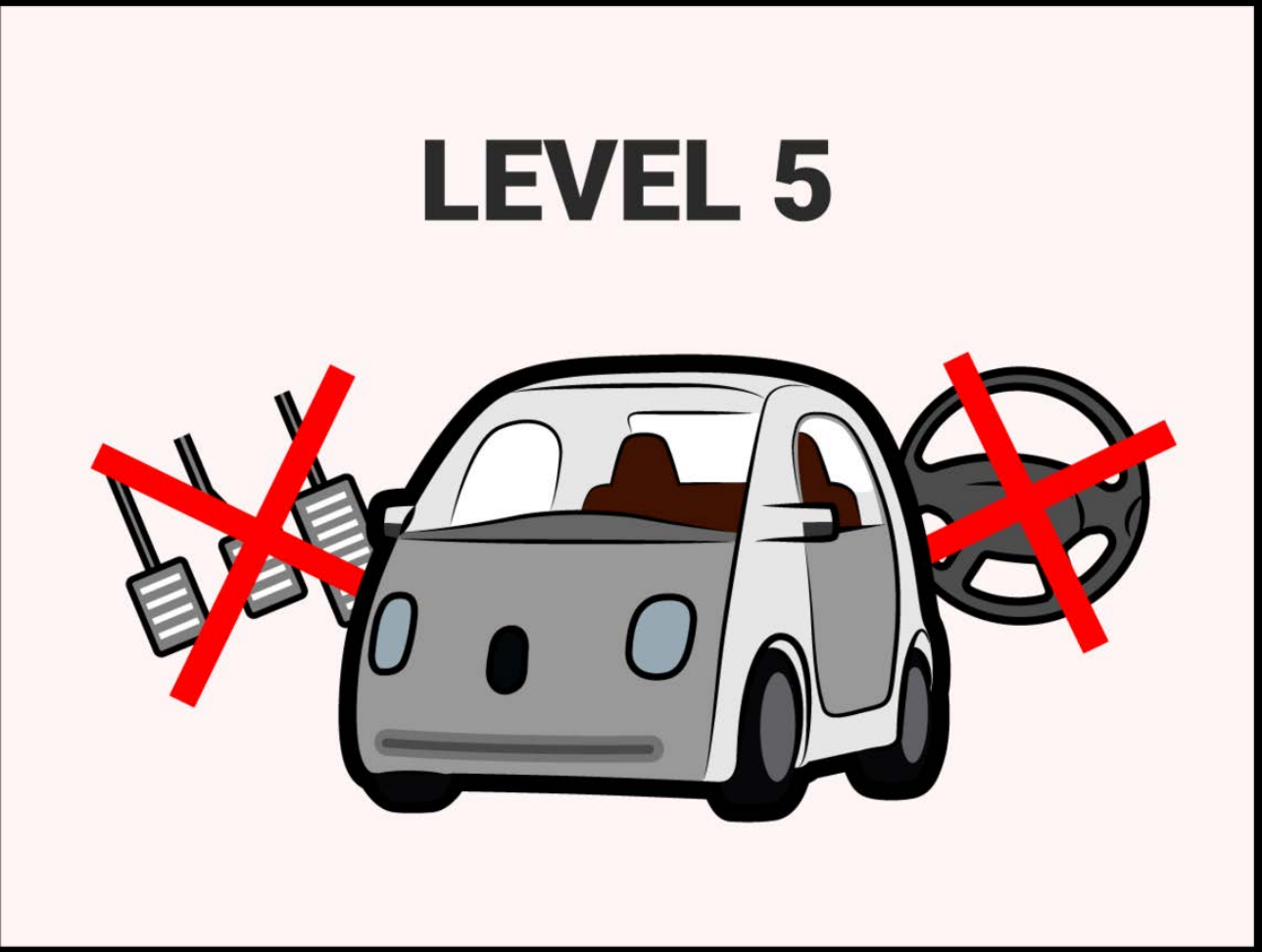
4

High Automation

The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.

Source NHTSA

Level 5: No Driver!



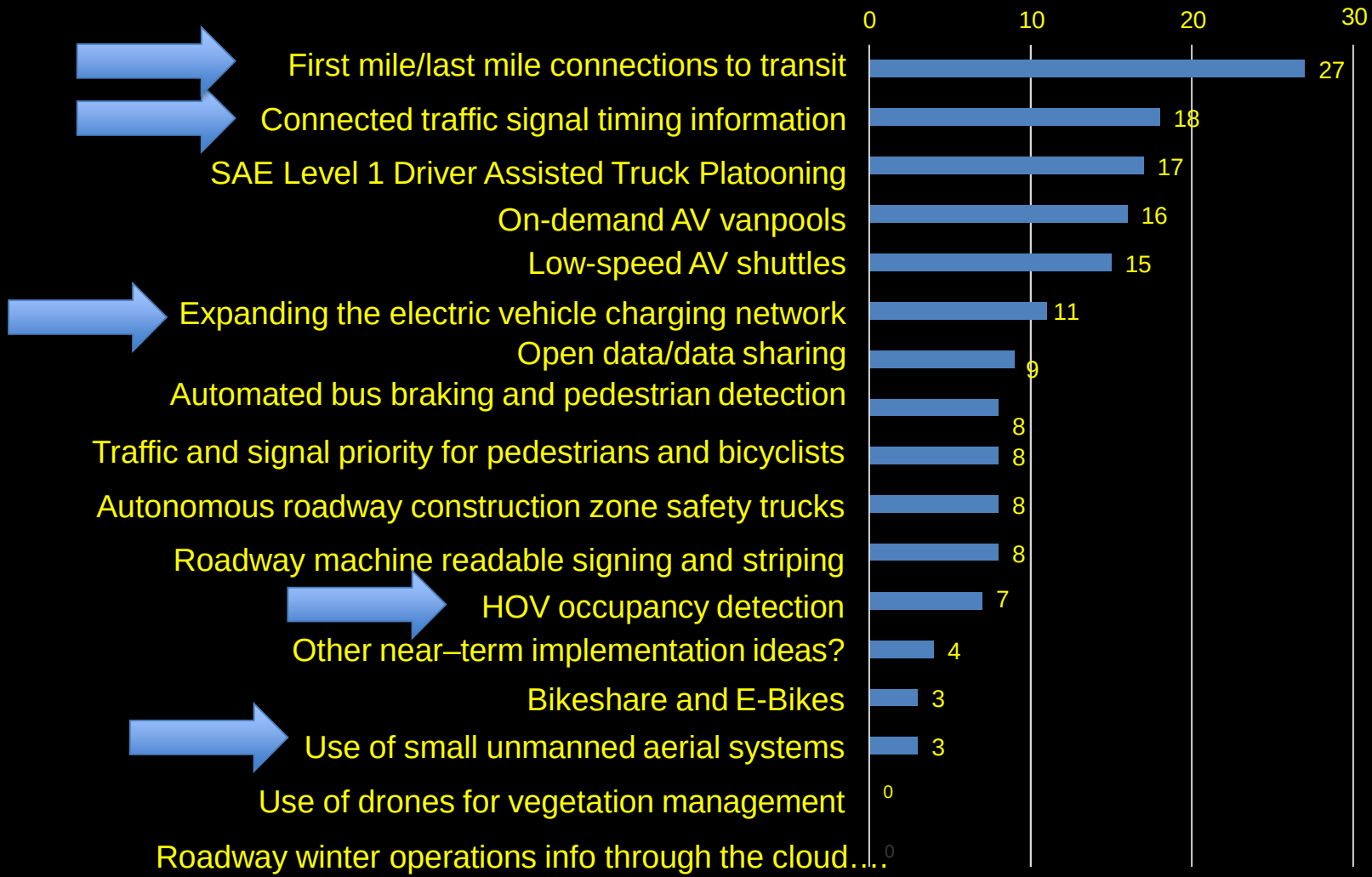
5

Full Automation

The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

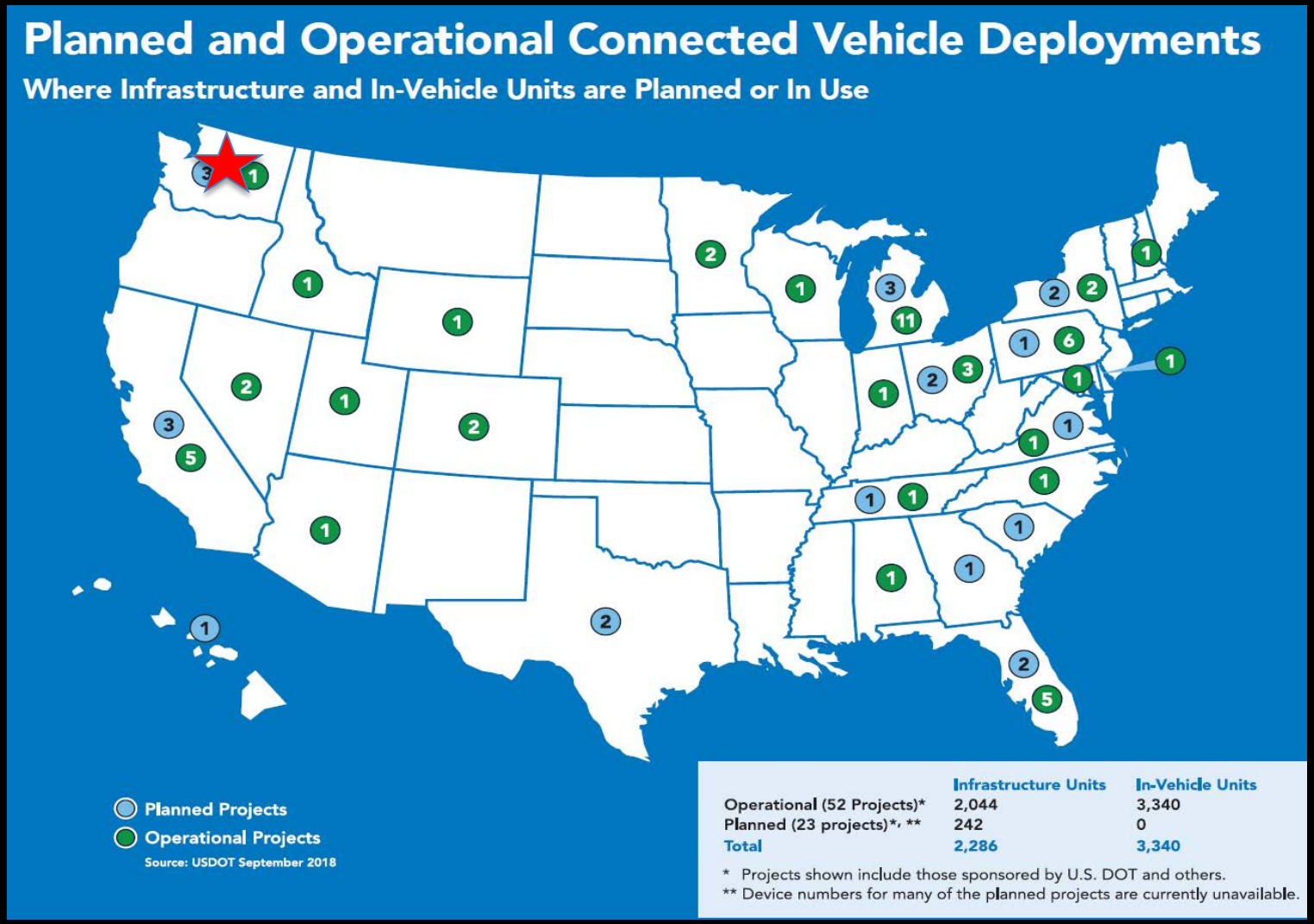
Source NHTSA

WSDOT- Pilots & Deployments Priority



Source: Sec. Millar Presentation to CAT

We are on the Map



SPaT Challenge

What is the AASHTO Challenge?

- To challenge state and local transportation infrastructure owners and operators (IOOs) to achieve deployment of Dedicated Short Range Communications (DSRC) infrastructure with SPaT (and MAP) broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each state by January 2020

Goals and Objectives?

- To show a commitment to OEMs and applications developers;
- To support deployment of V2I/PID applications that build on SPaT at intersections;
- To improve safety and mobility for traveling public
- To improve pedestrian safety
- To provide better access for active transportation and vulnerable users
- To provide smart transit & freight signal priority;
- To provide Eco-Driver assistance

We have to start small . . . and scale up!

Source NOCoE

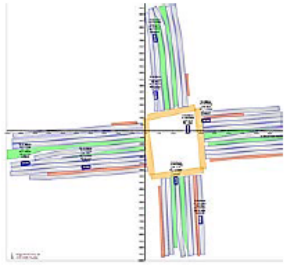
Variable Schemes – Communication:

- The DSRC operates in the 5850 – 5925 MHz band (the 5.9 GHz band), and coexists as a primary use along with other Federal users authorized by the National Telecommunications and Information Administration (NTIA), as well as with a number of commercial satellite operators.
- In actual case a fully ‘driverless’ car would need to be driverless in all geographies, and hence would require full road network coverage with 100% reliability to be a viable proposition.
  - While connected and autonomous vehicle systems would not require high bandwidth, providing data with a command response time close to zero would be crucial for their safe operation, and thus such applications clearly require the 1 millisecond delay time provided in the 5G specification.

Variable Schemes – Message Creator:

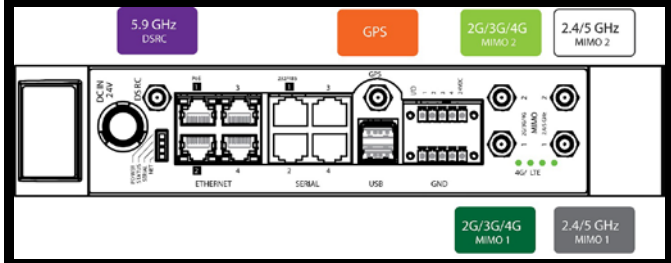
- ❑ **ATC or Hub?**
- **Intelight Vs Miovision**

Connected Vehicle
Infrastructure Equipment
Road Side Equipment (RSE)



MAP Data
Digital Description of Roadway
(D. Kelley, 2012)

Intelight ATC



Miovision HUB

Vehicle

+

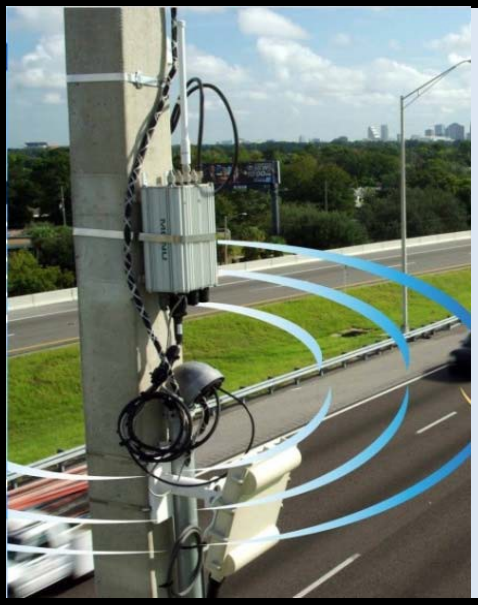
Connected Vehicle
Equipment

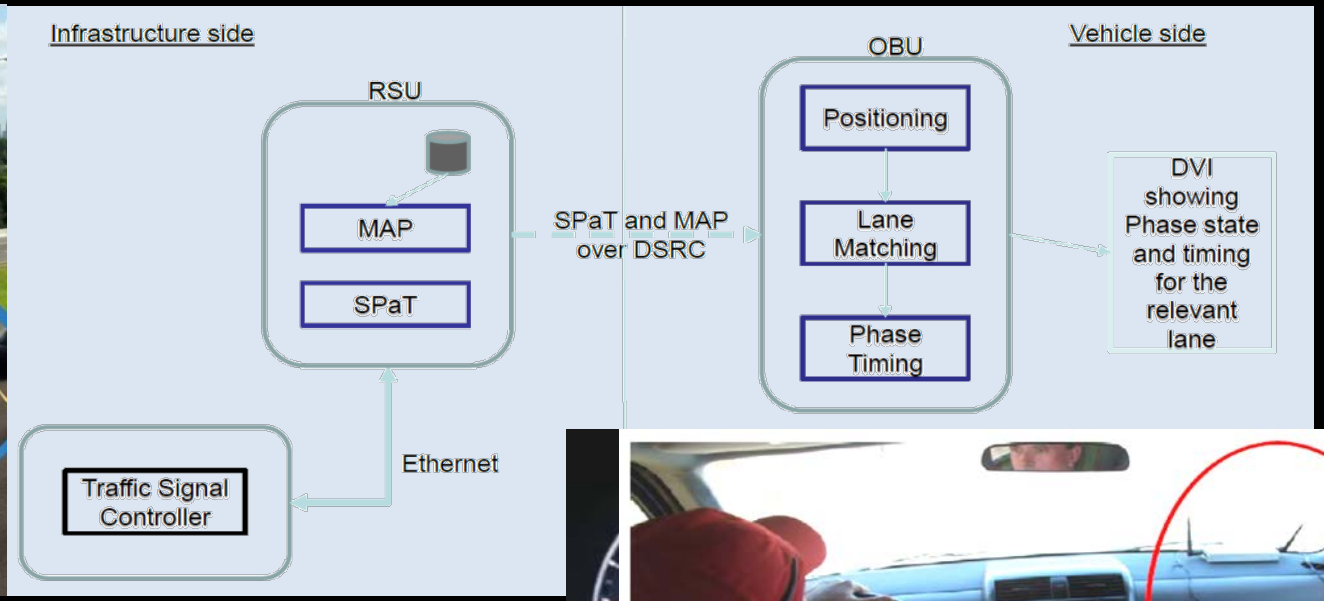
On Board Unit (OBU)
After Market Safety Device (ASD)

Variable Schemes – Message Delivery:

- Cloud Vs Local?
  - **A local based communication uses DSRC radio or 5G protocol to communicate between Vehicle and Infrastructure (two ways).**
    - This allows sending requests from Veh, Active Transportation Users or commercial vehicle and transit fleets to controller.
    - Allows localized information related to the intersection to the vehicle and Ped/Bike or Transit bus.
  - **A cloud base uses Central server information and broadcasts messages via cellphone carriers similar to any smartphone.**
    - Currently this does not allow a direct communication from user to infrastructure: vehicle or ATU cannot request calls or priorityfrom controller;

Road Side & On Board Units (RSU, OBU)





Until OBUs are in place,

how do we know?

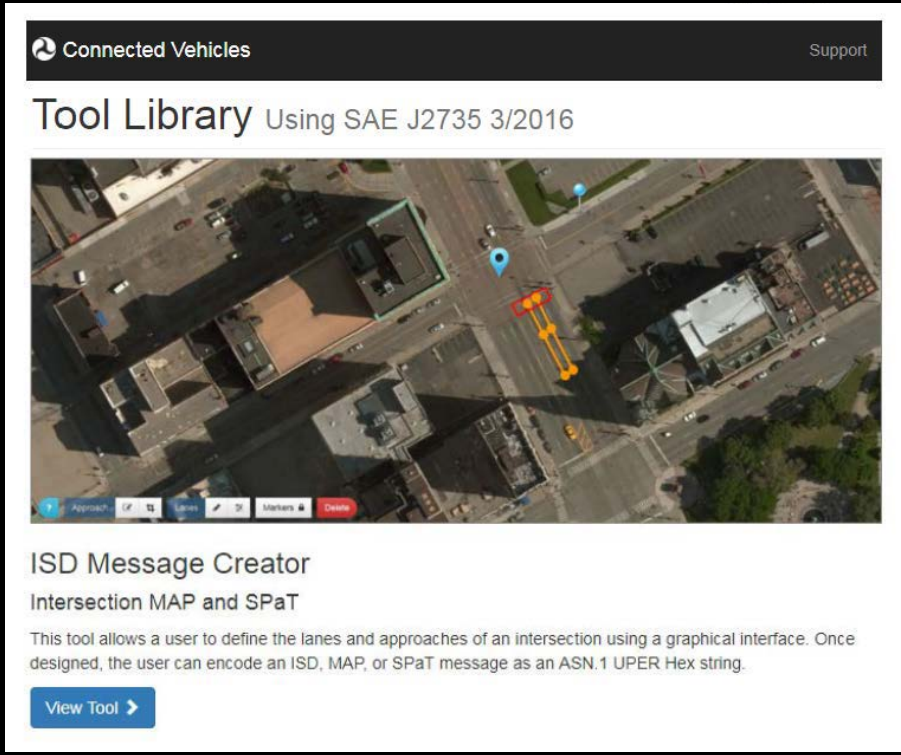
- That MAP and SPaT is actually being broadcast?
- How far from the RSU can it be received?
- Can RSU receive Basic Safety Message (BSM)?
- What other applications could be deployed with OBU and RSU?
  - E.g. EV Priority/Preemption, Transit Priority, Freight Priority, P.M. Observation,…

Source NOCoE

SAE J2735-2016 Messages

- A Signal Phase and Timing (SPaT) message defines the current and future steps of the intersection traffic signal phases; Current state of all lanes at intersection are provided, as well as any active pre-emption or priority.

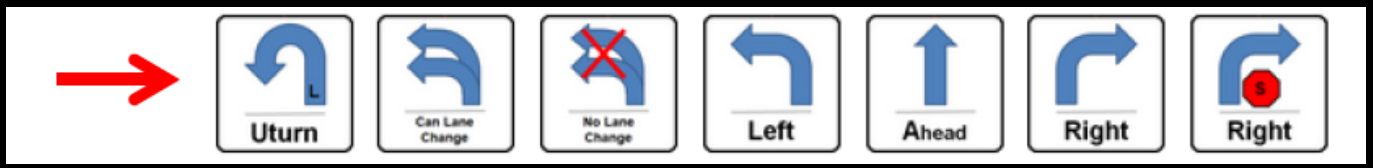
- Compliant messages for broadcast
  - SPaT– Signal Phase and Timing
  - MAP – Intersection Geometry
  - BSM – Basic Safety Message
  - SRM – Signal Request Message
  - SSM – Signal Status Message
  - TIM –Traveler Information Message
  - RTCM - The Radio Technical Commission for Maritime Services, Position Correction



SAE International, the Society of Automotive Engineers, is a U.S.-based, globally active professional association and standards developing organization for engineering professionals in various industries. Principal emphasis is placed on transport industries such as automotive, aerospace, and commercial vehicles.

Messages Summary

- **A typical MAP message is Static**
  - One Intersection with
    - Many Lanes (each with a LaneID, and **GroupIDs**, and where it connects to)
  - A MAP message contains all relevant lane details: width, length, use(Veh., Bike, Crosswalk, Parking, Median, etc.)
- **The SPaT message is Dynamic**
  - Signal, Phasing & Timing
  - All time of day details (which lane description is to be used at a given time of day)
    - Reversible Lanes
    - Time of Day Parking Lanes
    - Left Turn, Right on Red and other Crossing lanes that vary with time



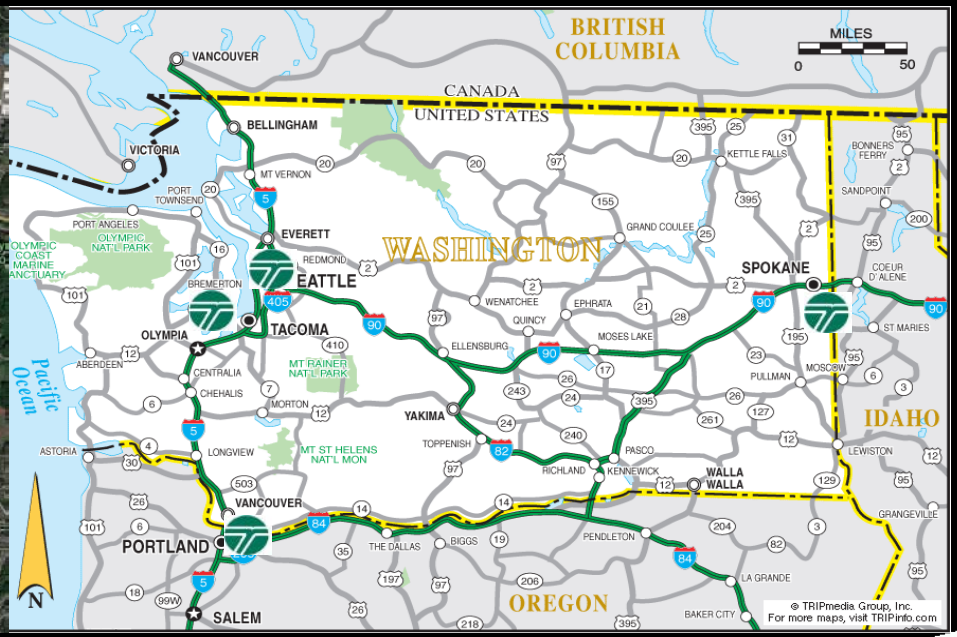
Source NOCoE

Project Objective:

- One of the main objectives of our project is to establish an infrastructure bed that allows fruition of innovations and ideas which utilize the communications between infrastructure and connected vehicles and other users (i2X).
- In our opinion that is how the government should hand over the concept to Academy and private entrepreneurs in order for industry to advance.

WSDOT Accepts the SPaT Challenge

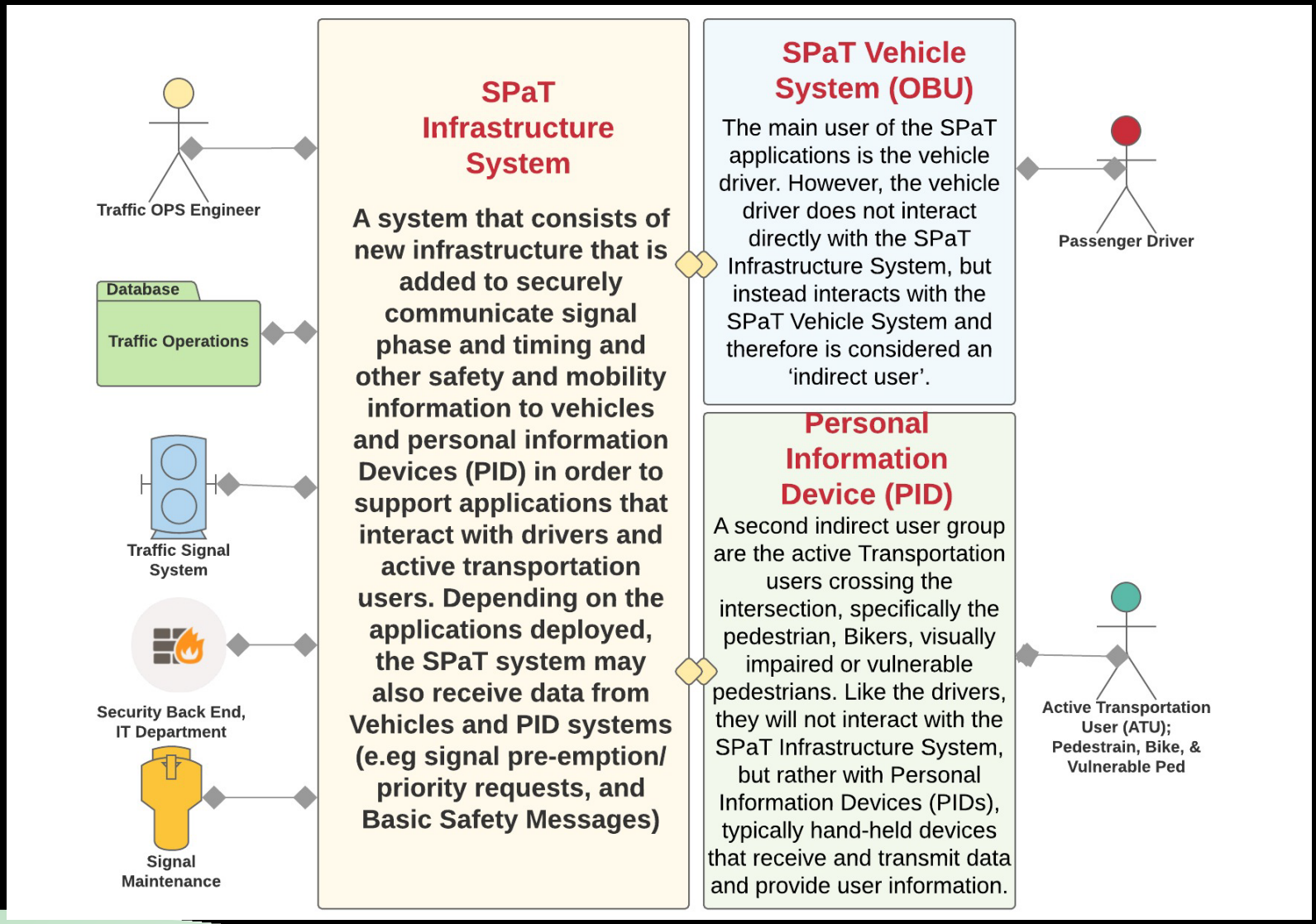
- ER- Three Locations along SR 27, Spokane Valley, (DSRC, SPaT)
- NWR- Ten Locations along SR 522 North of Lake Washington through the Cities of Lake Forest Park and Kenmore, (DSRC, SPaT)
- OR- Six Locations along SR 305 from the Bainbridge Island Ferry Terminal to the City of Poulsbo, (MioVision, ATSPM)
- SWR- Four Locations along SR 500, between I-5 and I-205, through the City of Vancouver. (MioVision, SPaT)



SR 522 Project

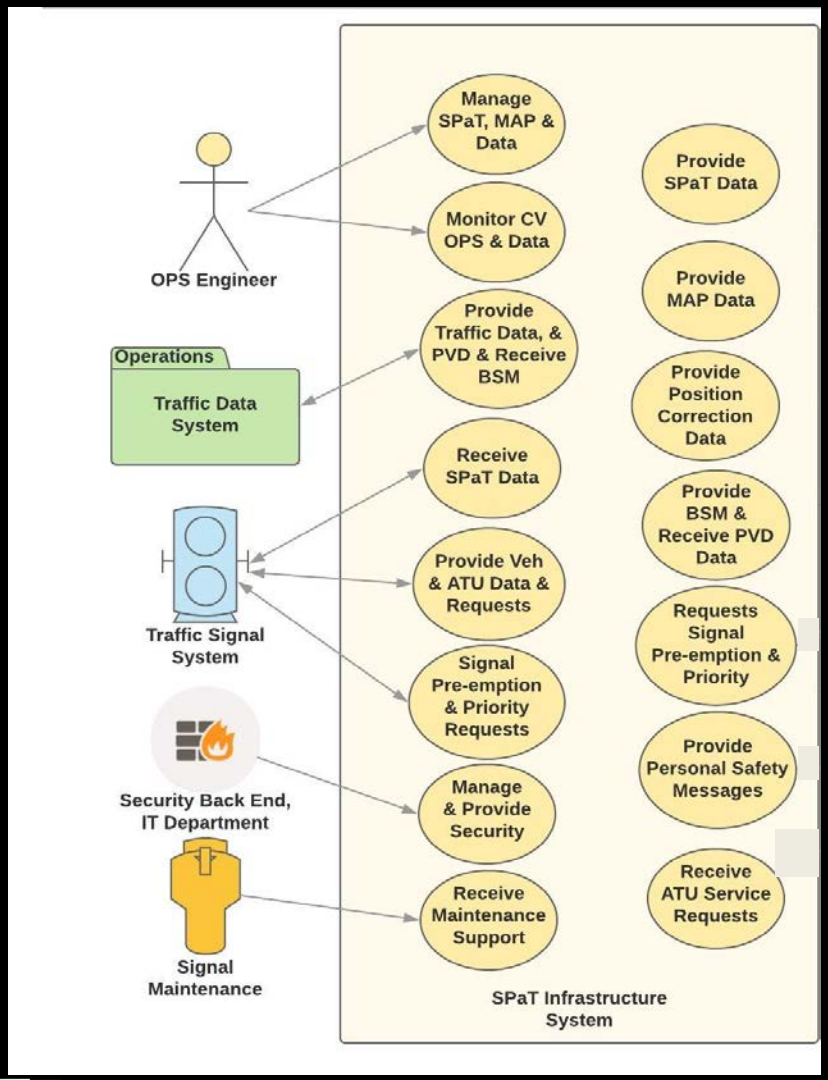
- 10 Intersections along Lake City – Bothell Way NE (SR 522)
  - Heavy commuter traffic
  - With recreational active users @ Burke Gilman Trail

Stakeholders



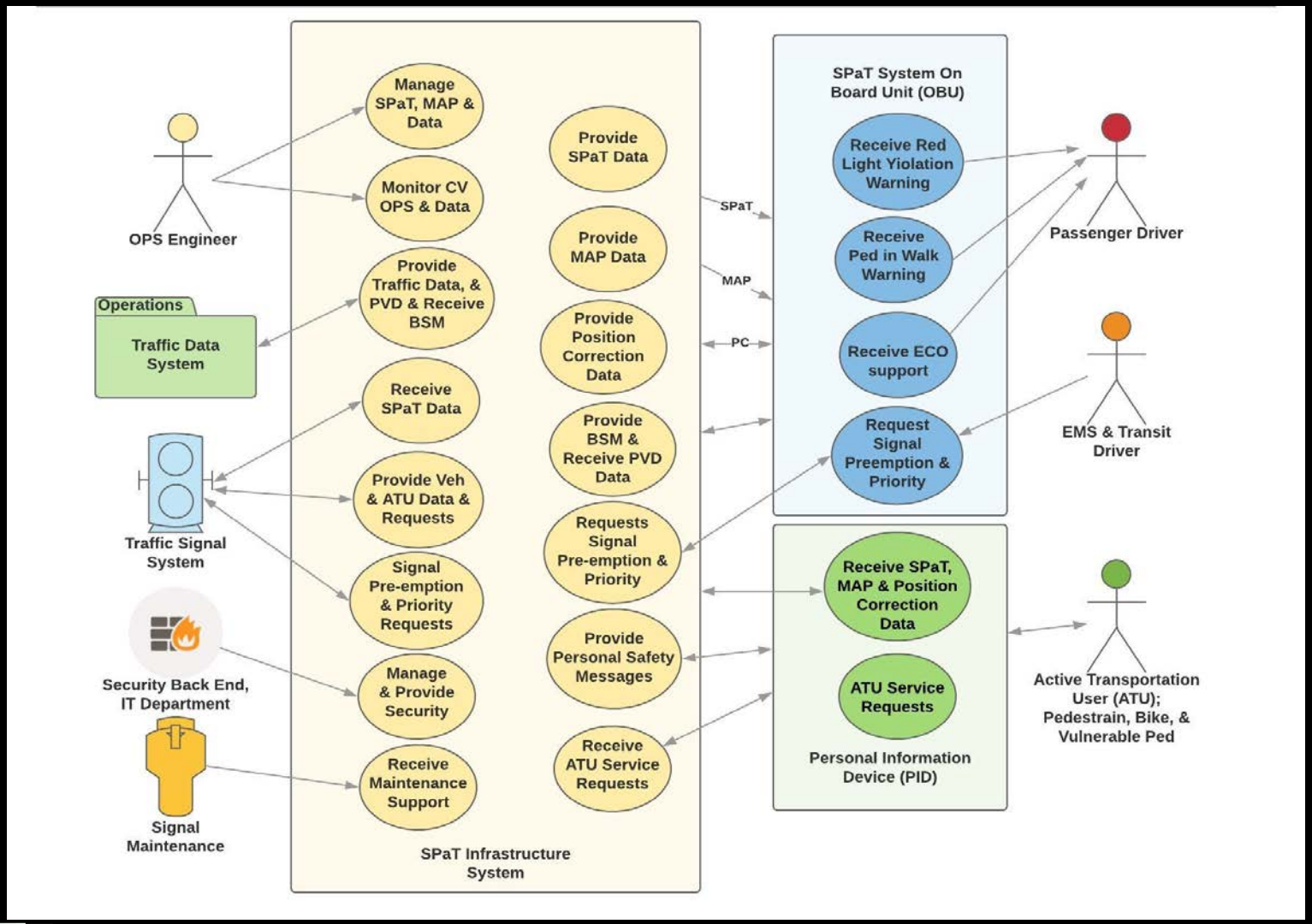
Use Case Diagram

Direct Users



Use Case Diagram

Direct Users



Indirect Users

Vulnerable User Needs

Talk with us if you are a mobile App developer!

Vision Impaired Call

Difficulty placing a call for a walk indication

Difficulty placing a call for a crossing indication and may be vulnerable to drivers who do not see them in Bike lane on the right.

Bikes

Deaf-Blind User

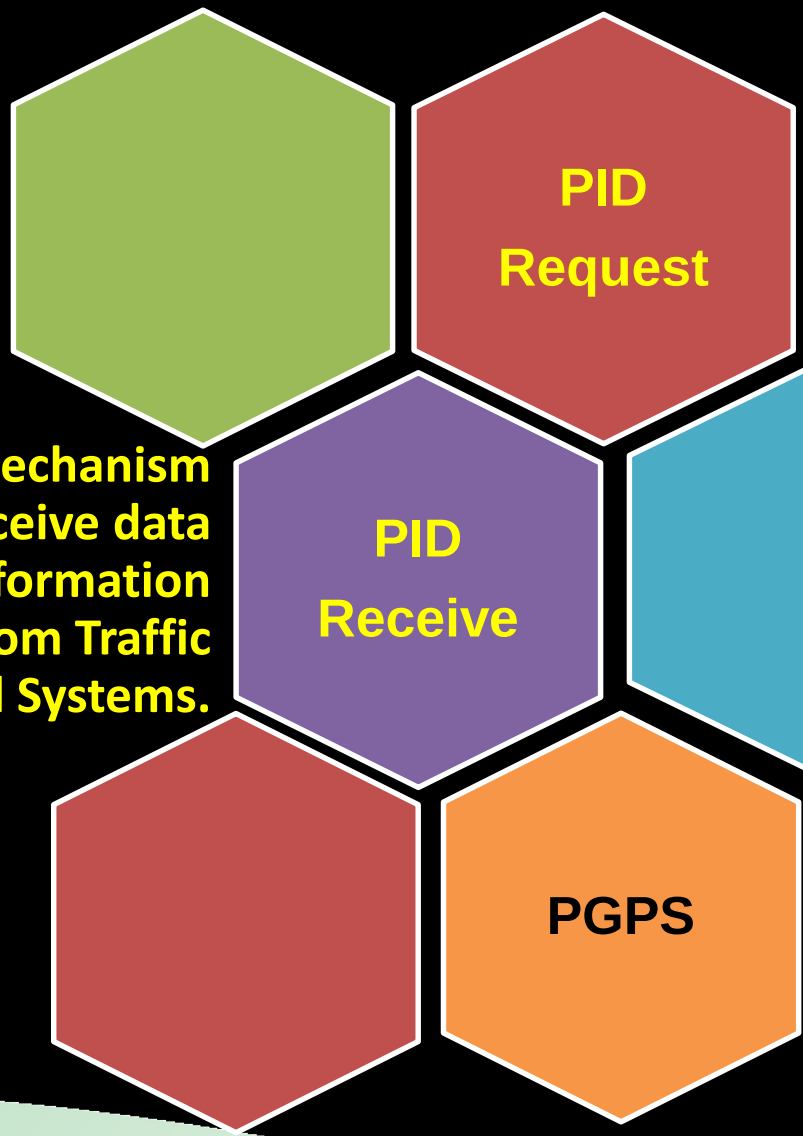
Difficulty discerning the current state of the walk/don't walk indications

Vision Impaired Walk

Peds.

During a permitted crossing time may still be vulnerable to drivers who do not see them in crosswalk

Personal Information Device Needs



There is no mechanism for PIDs to send messages directly to Traffic Signal Systems to request a pedestrian crossing.

There is no mechanism for PIDs to receive data or status information directly from Traffic Signal Systems.

In order to accurately assess if pedestrians are outside the designated crosswalk, or Bikes are approaching on the right lane, their position must be accurately determined.

Vehicle System Needs

A mobile App compatible with Apple CarPlay or Android Auto needed to overcome the low rate of vehicles with SPaT data compatibility.

Limited SPaT Capable Veh.

SPaT Veh.

Providing Red Light Violation Warning (RLVW), Pedestrian in Crosswalk, Bike in Bike lane, and Eco Arrival / Departure (Eco A/D), applications requires information from the SPaT Infrastructure System.

Arterial Traffic Signal Performance Measures and arterial traveler information would benefit from increased information about vehicles.

Traffic Data

EMS & Transit Driver

The driver of a commercial Freight, transit or emergency vehicle approaching a traffic signal does not know if the signal will be green when the vehicle reaches the intersection.

Security Needs

Federal Cyber Security Model

Eliminate Intruders

Risk of unauthorized systems imitating vehicles and sending data to the roadside equipment.

Risk of unauthorized systems imitating the infrastructure and sending inappropriate data to vehicles.

Back End Security

Privacy Concerns

Risk of any infiltration into the user data should be eliminated by adopting protocols for Human Research Protections as OHRP recommendations.

IT Security

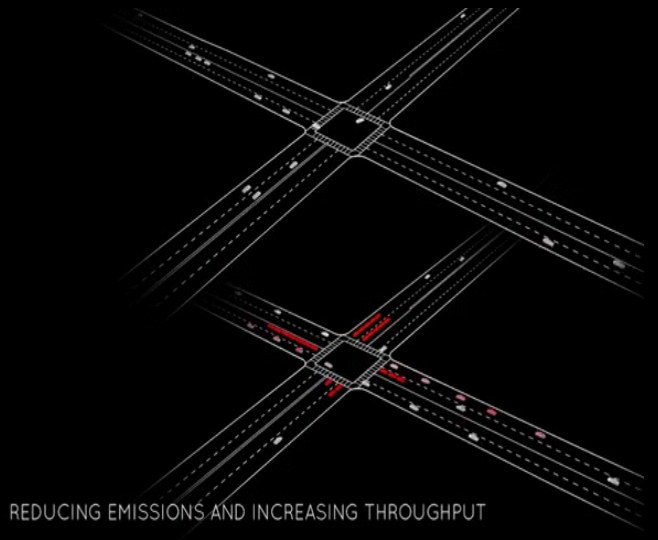
The agency must protect the signal controller, network, and central system that interfaces with the SPaT Infrastructure System from unwanted access or malicious intents.

Current Project Partners

- WSDOT Northwest Region Traffic Operations,
- WSDOT HQ Traffic Research,
- WSDOT Cooperative Connected Automated Mobility.
- Intelight ITS company—Hardware sponsor and integrator.
- University of Washington – Star Lab (UW) is partnering in developing an application for PID users
- Washington State University at Pullman (WSU) is partnering in research and testing of the system.

Future Trends

- **Market Penetration in 10 Yrs:**
  - 32.4% no advance changes
  - 40% advanced features
  - 16.5% Partial Automation
  - 11.1% Fully AV
- **Impacts of CV/AV on Traffic Signals (MMiTSC)**
  - Use of BSM, MAP, SPaT
  - Performance Observation, including ATSPM
    - Travel Time, Delay, Stop, AoG, Queue Length
    - Mode: Veh., Transit, Freight, Ped. Bike
  - Controls: Ph Call, Ph Extend, Dilemma Zone, Coordination
  - Priority control: EMS, Transit, Truck, Ped & Bike



A Similar Project Downunder

- **AIMES, University of Melbourn**

Questions?

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