

Connected and Automated Vehicle Implications for Planning and Operations

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Technology Implications

- What changes will we see over the next 20 years and what impact will those changes have on our planning assumptions?
- What changes to our operational strategies and investments should we begin to make now to prepare for those changes?





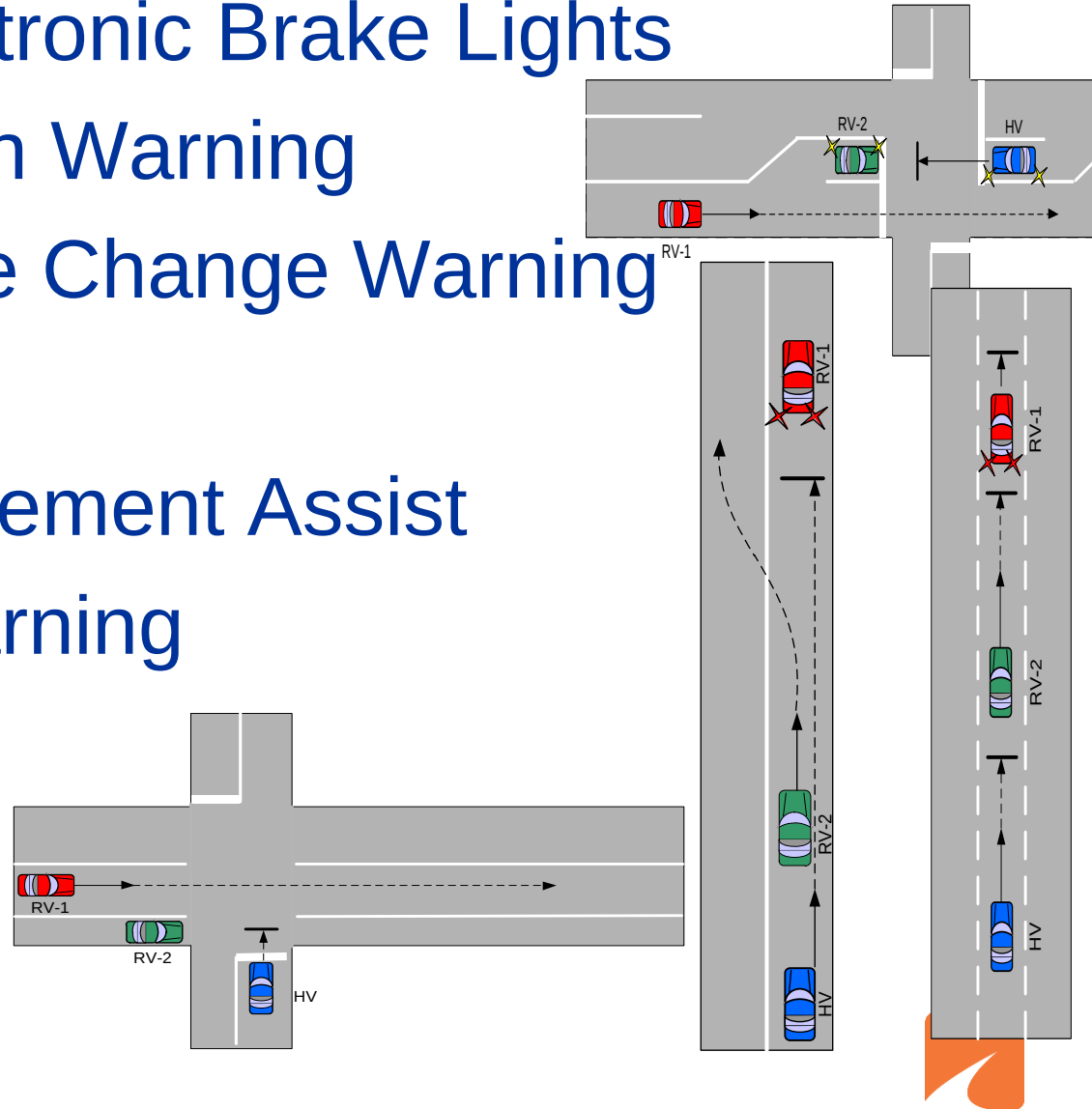
“Connected” Car?

- **V2V:** Bi-directional information sharing between vehicles
- **V2I:** Bi-directional information sharing between a vehicle and the roadway
- **V2X:** Bi-directional information sharing between a vehicle and X (pedestrians, cyclists, trains, etc.)



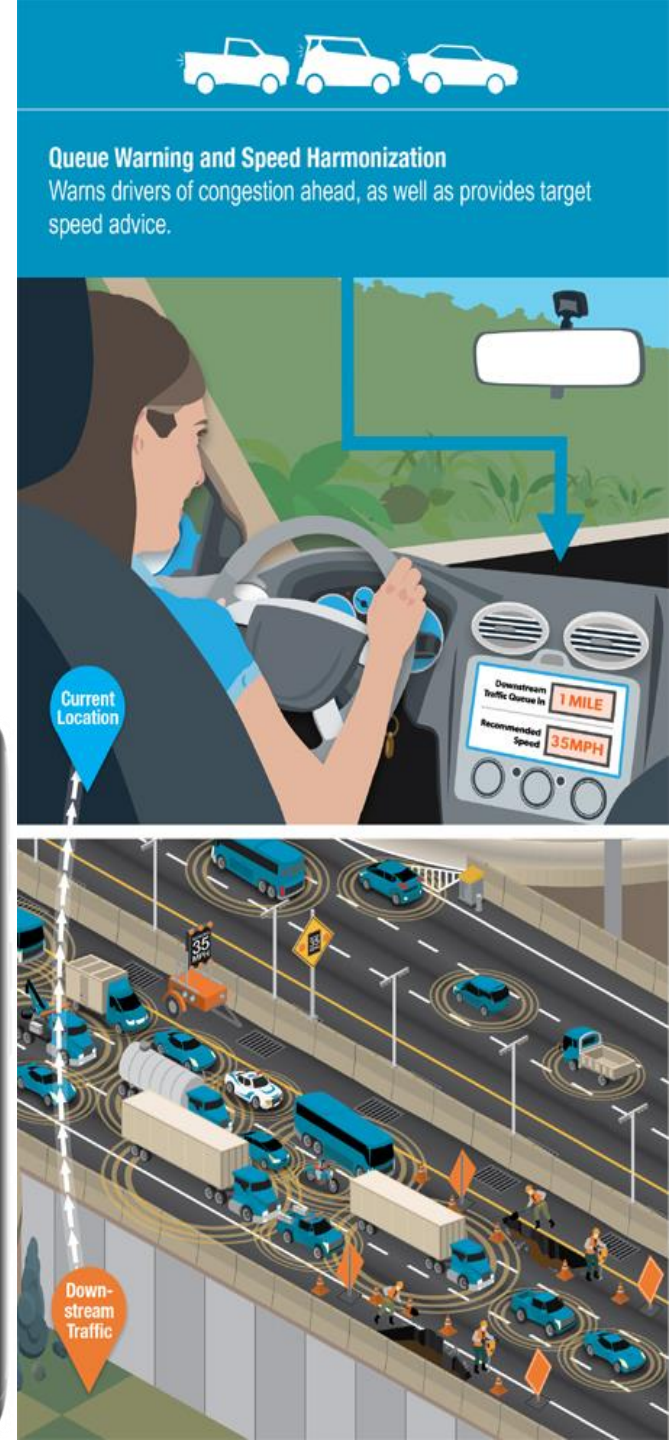
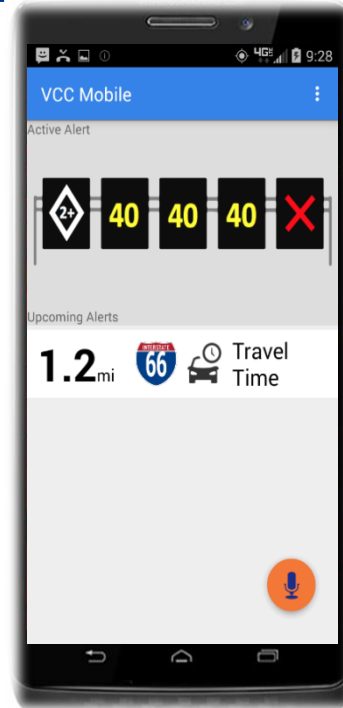
Example V2V Safety Applications

- Emergency Electronic Brake Lights
- Forward Collision Warning
- Blind Spot / Lane Change Warning
- Left Turn Assist
- Intersection Movement Assist
- Do Not Pass Warning
- Etc., Etc.



Example V2I Applications

- Queue Detection and Warning
- Red Light Violation Warning
- Merge Assistance
- Emergency Vehicle Preemption
- Transit Signal Priority
- Eco Traffic Signal Timing
- Dynamic Driver Messaging
- ATM Integration

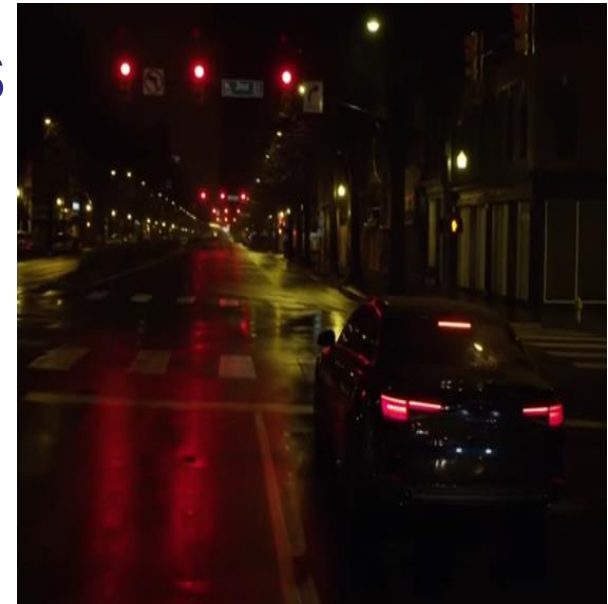


Queue Warning and Speed Harmonization

Warns drivers of congestion ahead, as well as provides target speed advice.

Early Implementation Example

- Audi PRIME traffic light feature
- Interface to centralized signal control system in several cities
- Counts down Red to Green phase change
- Uses cellular communications



Implications of Connected Vehicle Deployment

- Safety
 - V2V alone may address up to 81% of crashes involving unimpaired drivers (27K fatalities, 1.8M injuries, 7.3M property damage)²
 - V2I alone may address up to 19% of crashes involving unimpaired drivers²
- Mobility
 - Improved traffic flow and reduce delays (27%)¹
 - Increased awareness of and access to multi-modal choices
 - More direct, actionable information for drivers (re-routing, incidents, weather, etc.)
- Environmental
 - Combined Eco-Signal apps may reduce CO2 and fuel consumption (11%)¹
 - Signal and freeway lane management combined reduce fuel consumption (22%)¹

1 - Estimated Benefits of Connected Vehicle Applications: Dynamic Mobility Applications, AERIS, V2I Safety, and Road Weather Management, <http://ntl.bts.gov/lib/56000/56200/56238/FHWA-JPO-16-255.pdf>

2 – Harding, J., Powell, G., R., Yoon, R., Fikentscher, J., Doyle, C., Sade, D., Lukuc, M., Simons, J., & Wang, J. (2014, August). Vehicle-to-vehicle communications: Readiness of V2V technology for application. (Report No. DOT HS 812 014). Washington, DC: National Highway Traffic Safety Administration.



SAE Levels of Automation

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the <i>driving mode</i> -specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the <i>driving mode</i> -specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	System	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the dynamic driving task with the expectation that the <i>human driver</i> will respond appropriately to a <i>request to intervene</i>	System	System	Human driver	Some driving modes
4	High Automation	the <i>driving mode</i> -specific performance by an automated driving system of all aspects of the <i>dynamic driving task</i> , even if a <i>human driver</i> does not respond appropriately to a <i>request to intervene</i>	System	System	System	Some driving modes
5	Full Automation	the full-time performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> under all roadway and environmental conditions that can be managed by a <i>human driver</i>	System	System	System	All driving modes



Difficult AV Challenges



Implications of Automated Deployment

- Implications depend on type of automation and level of adoption
 - Safety Implications
 - Roadway Capacity
 - Travel Demand
 - Auto-ownership
 - Mobility as a service



GHSA offers the following **five pieces of advice for states as they grapple with the issue of AVs:**

1

Be informed.

2

Be a player
in your state.

3

Understand
the role
of states.

4

Don't rush
into passing
laws or
establishing
regulations.

5

Be flexible –
this is a
new game.

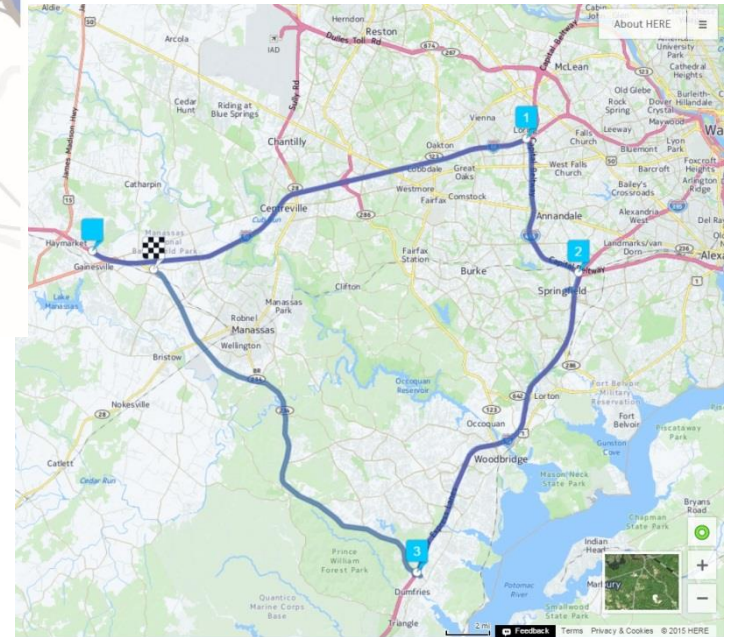
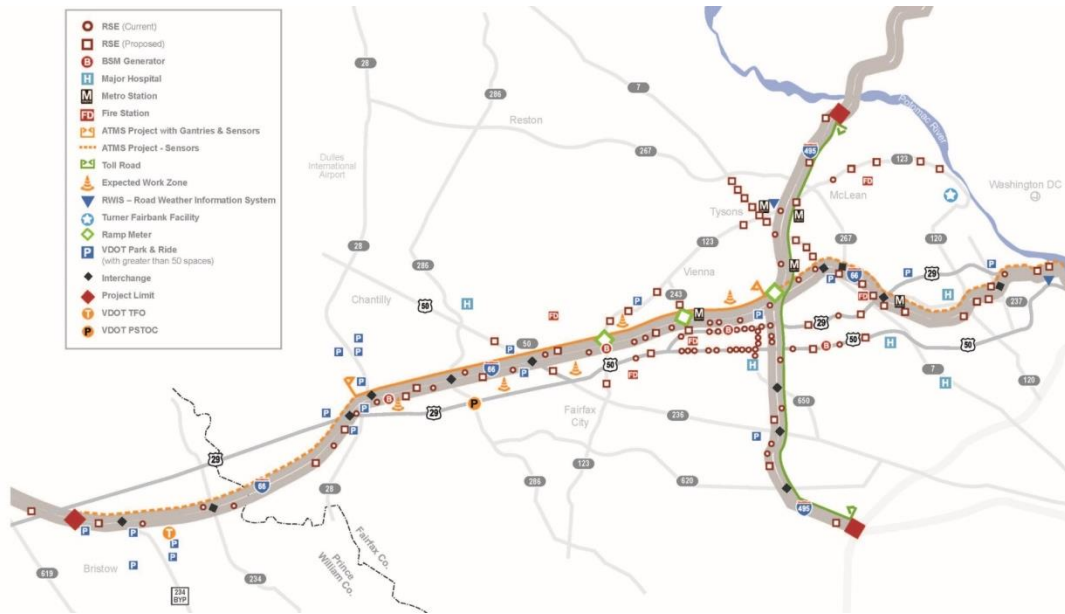


So what is VDOT doing?

- Taking an evolutionary approach
- Focusing on implementation from the beginning
- Targeting existing challenges with new, technology-based solutions
- Supporting private development with minimal regulation



Virginia Connected and Automated Corridors



Recent Activities

Virginia.gov Agencies | Governor



SMARTERROADS

Welcome to SmarterRoads, VDOT's new data portal.

SmarterRoads makes VDOT's transportation data available to approved users online. This cloud-based portal will provide raw data pertaining to road conditions, incidents, work zones, multi-modal transportation and road signs to the connected and automated vehicle industry, third-party enterprise and the public. Data sets range from real-time sensor streams updated every minute, to road statistic shape files updated annually. Browse available data sets, then [create a free account](#) to get started.



Partially Automated Truck Platooning Demonstration



You are cordially invited to join the Federal Highway Administration (FHWA) for the Partially Automated Truck Platooning Demonstration based on a Cooperative Adaptive Cruise Control (CACC) System, which enables heavy trucks to more closely follow each other through the automated control of speed and spacing. The Federal Motor Carrier Safety Administration (FMCSA) will also conduct demonstrations of truck inspections and safety screening tools.

Dates: Friday, September 14, 2017
September 15, 2017
11:00 am - 2:15 pm
(Runs every 30 minutes)

Location: EC Lawrence Soccer Fields
Parking Lots
5200 Sully Rd
Centreville, VA 20120

REGISTRATION:

Registration is required. Register at www.fhwa.gov/automatedtruckplatooning or email andy.palanisamy.ctr@dot.gov. Event details will follow shortly.

Truck Platooning Demonstration rides is limited; full capacity is anticipated. Please arrive on time for individually scheduled demonstrations to ensure participation.

Federal Highway
Administration



U.S. Department of Transportation
Federal Motor Carrier Safety Administration



For more information:
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