



Connected and Automated Vehicles

A Roadmap for New Hampshire

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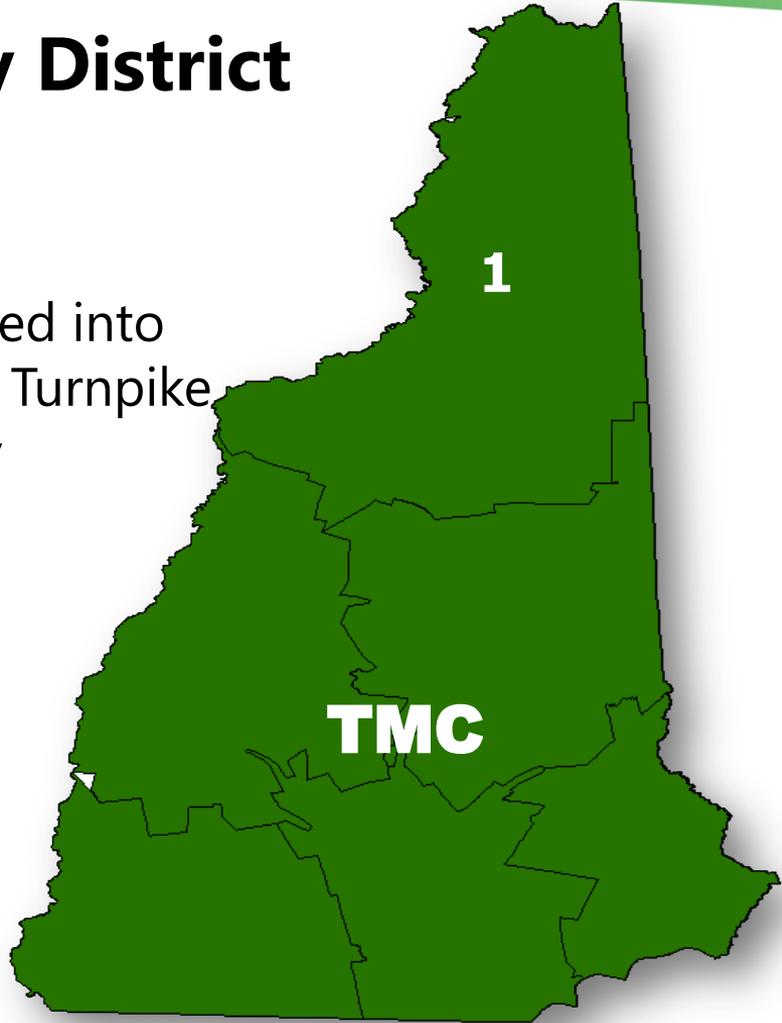


Agenda

- TSMO
- Levels of Autonomy
- Policy and Legislation
- NHDOT Focus Areas
- The Future – ITS and CAV

NH DOT Coverage Areas by District

The State of New Hampshire is divided into six Districts and the New Hampshire Turnpike System comprising of approximately 9,266 lane miles.



What is TSMO

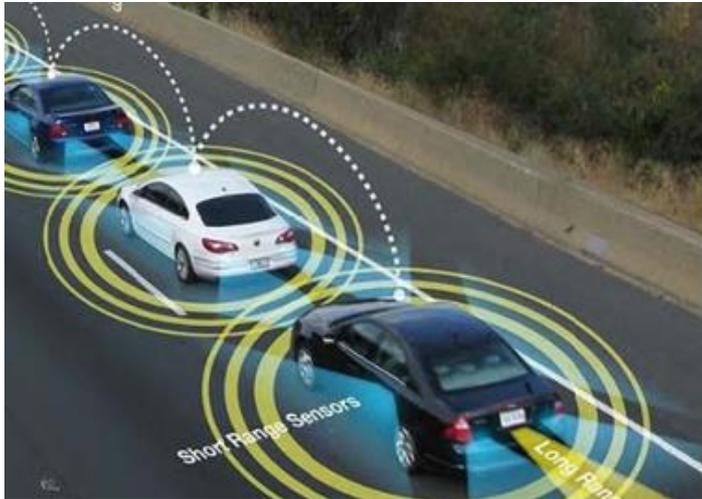
- Transportation System Management & Operations (TSMO) is an integrated approach to **optimize the performance of existing infrastructure** by implementing multimodal, intermodal, and often cross jurisdictional systems & services.
- TSMO is not routine road maintenance like resurfacing or guardrail replacement.
- TSMO strategies **improve system efficiency, enhance public safety and security, reduce traffic delays of road users, and improve access to traveler information.**

Automated Vehicles



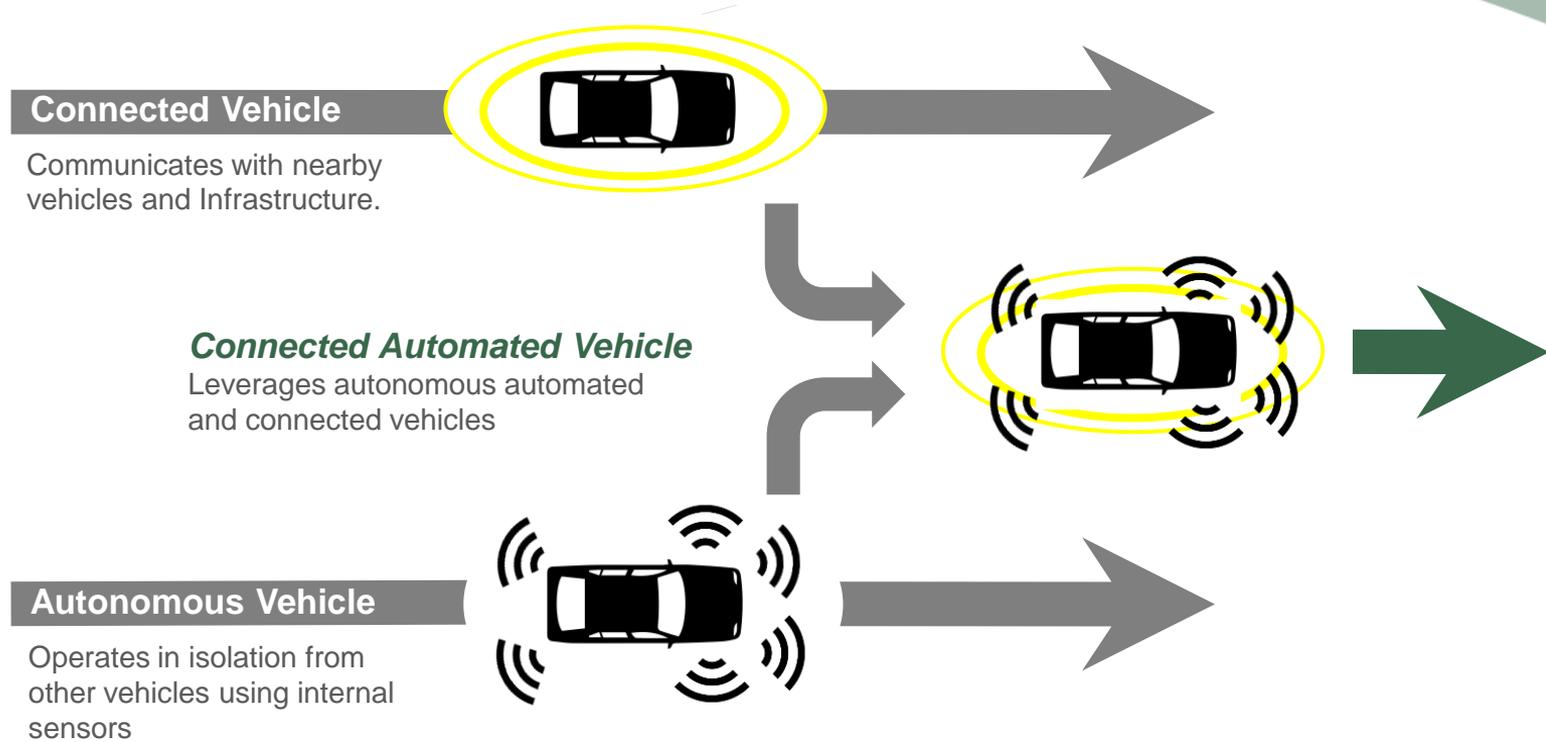
- **Automated Vehicles (AVs)** are vehicles in which at least one element of vehicle control occurs without direct driver input.
- AVs work by gathering information from various sensors.
 - Cameras
 - Radar
 - Light detection and ranging (LiDAR)
- AVs may combine sensor data with other inputs such as detailed map data.

Connected Vehicles



- Connectivity provides the ability for a vehicle or driver to receive and use broadcasted information about traffic, travel, roadway condition, and other information.
- Enhances the safety and efficiency of AVs by providing greater situational awareness and efficiency.

Connected and Autonomous Vehicles



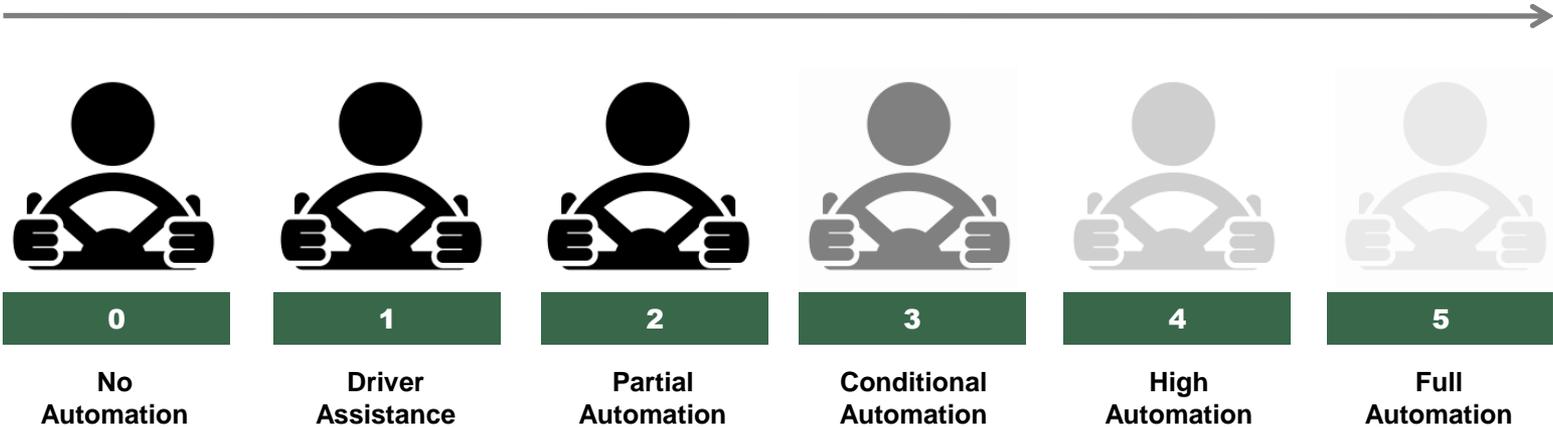
Levels of Autonomy

Society of Automotive Engineers (SAE)



Levels of Autonomy

SAE AUTOMATION LEVELS



SAE Levels of Autonomy

SAE Level	Description	System Capability	Driver Involvement	Example
0	No Automation	None	The human at the wheel steers, brakes, accelerates, and negotiates traffic.	Regular cruise control. The ability to maintain a speed that the driver sets is not autonomous.
1	Driver Assistance	Under certain conditions, the car controls either the steering or the vehicle speed, but not both simultaneously.	The driver performs all other aspects of driving and has full responsibility for monitoring the road and taking over if the assistance system fails to act appropriately.	Adaptive cruise control.
2	Partial Automation	The car can steer, accelerate, and brake in certain circumstances.	Tactical maneuvers such as responding to traffic signals or changing lanes largely fall to the driver, as does scanning for hazards.	Audi Traffic Jam Assist, Cadillac Super Cruise, Mercedes-Benz Driver Assistance Systems, Tesla Autopilot, Volvo Pilot Assist.

SAE Levels of Autonomy

SAE Level	Description	System Capability	Driver Involvement	Example
3	Conditional Automation	In the right conditions, the car can manage most aspects of driving, including monitoring the environment. The system prompts the driver to intervene when it encounters a scenario it can't navigate.	The driver must be available to take over at any time.	Audi Traffic Jam Pilot
4	High Automation	The car can operate without human input or oversight but only under select conditions defined by factors such as road type or geographic area.	In a shared car restricted to a defined area, there may not be any. But in a privately owned Level 4 car, the driver might manage all driving duties on surface streets then become a passenger as the car enters a highway.	None
5	Full Automation	The driverless car can operate on any road and in any conditions a human driver could negotiate.	Entering a destination.	None

Policy and Legislation



New Hampshire HB 314

- Would allow car manufacturers to test automated vehicles on New Hampshire roads by January 2019 (Applies to “Level 5” vehicles only)
- Anyone with a self-driving vehicle, a \$10 million insurance plan and \$500 for a state licensing fee could apply with the DOT to test the vehicle on NH roads.
- Applicants would be required to produce certification that the vehicle had been previously tested under controlled conditions that would simulate the testing environment in New Hampshire.
- They would need to demonstrate a plan for how the vehicle would interact with law enforcement

NE Transportation Consortium

- The New England Transportation Consortium (NETC), a cooperative effort of the Departments of Transportation and the Land Grant Universities of the six New England States (CT, NH, ME, MA, RI and VT) has recently begun an initiative to identifying issues related to the testing and deployment of connected and automated vehicles extending beyond state lines.
- As a first step, an initial research task is being started to identify multi-state issues. New Hampshire DOT will be participating in this project and can provide lessons learned from the evolving NHDOT ITS Program.



New Hampshire DOT

CAV Focus Area



Policy and Planning

Federal Guidance

- Identify a lead agency to coordinate CAV activity.
- Create a CAV committee that is launched by the designated lead agency.
- Develop an internal process for entities to test CAVs within the state.
- Coordinate training with public safety officials on vehicle technology and operations.
- Consider multi-state coordination of applicable activities.

NH Focus

- Within New Hampshire, the DOT serves as the lead agency of CAV activities.
- With much of the current V2I focus on communications, traffic signals, and various sensor technologies, the TSMO Bureau is representing NHDOT.

Performance Measures

Federal Guidance

- Transportation agencies may want to consider how the effects of AV and CV technologies can contribute to broad agency goals.



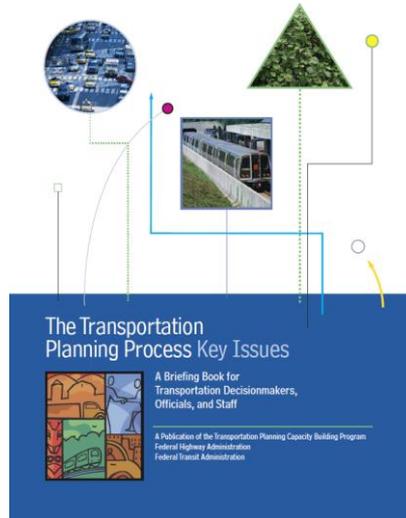
NH Focus

- To facilitate the alignment of transportation agency goals with AV and CV technologies, NHDOT is evaluating additional performance measures that support specific safety, congestion, mobility, and environmental goals that may be supported by CAV.

Long Range Transportation Plans

Federal Guidance

- With freeway, arterial, and urban environments all affected by potential future CAV scenarios, transportation planners should consider developing long range transportation planning tools that take automated vehicle systems into consideration.



NH Focus

- Both increases in capacity and changes to traveler behavior due to automated vehicles are being assessed for NHDOT long range transportation plans.
- If levels of automation continue at the current pace, infrastructure investments will be assessed considering the likely impacts of CAV systems as an additional variable within the model.

Infrastructure

Federal Guidance

- Standards related to infrastructure design considering CAV requirements are continuing to evolve.



NH Focus

- NHDOT is monitoring the guidance being issued by FHWA, NHTSA and others related to CAV deployment and evaluating any recommended changes.
- Early adoption will likely ease any transition before widespread deployment.

Traffic Control Strategies

Federal Guidance

- The Signal Phase and Timing (SPaT) Challenge is a first step for states to consider the deployment of V2I technology at signalized intersections.

The Connected Vehicle Intersection



NH Focus

- NHDOT is supporting the efforts in Dover, NH to implement various signal controller platforms to test V2I strategies.
- NH is also participating with neighboring states in a regional approach to CAV planning and deployment through the NE Compass software platform.

Data Management and Cybersecurity

Federal Guidance

- While V2V data will come primarily from the vehicle manufacturers, V2I data will primarily be mined from traffic operation centers.
- Data collection, processing and dissemination of transportation system data will need to be processed outside of the vehicle architecture.



NH Focus

- The NHDOT ITS Program has considered these issues in all ATMS applications to date.
- We are continually evaluating the implications of these issues on the design of our communications networks, networking equipment configuration, field device security, and operations best practices.

The Future – ITS and CAV



Possible CAV Use Cases



- Light Duty Vehicles (Personal or Shared)
- Shuttles
- Buses
- Light Rail
- Freight



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