Advancing Intelligent Transportation in New York State

CTG
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Introduction

Intelligent transportation initiatives have been underway in New York State for some time now, but as connected and autonomous vehicles (CAVs) are increasingly tested throughout the United States, state leaders recognized the importance of preparing for and informing statewide decision making.

This project, focused on CAVs that will have the potential to change the way society, including the full range of goods and services, move from place to place. CAVs will affect all segments of society.

Governments, however, have a unique and critically important role in ensuring that full-scale deployment of passenger, commercial, and transit CAVs is done in a way that ensures public safety and provides equal access to opportunity.

It is critical for governments to understand the advantages CAVs will have on roadways and the public, private, and nonprofit organizations who are already working in concert to provide mobility.

As a consequence, governments throughout the world are investing in efforts to understand the potential impact of deployment of such intelligent transportation systems and to ensure that they are fully prepared.

In New York State, several transportation-related agencies are already working together on initiatives focused on building new understanding of the implications of CAVs deployment:

- The New York State Department of Motor Vehicle (NYSDMV) and New York State Police (NYSP) are developing and implementing an autonomous vehicle demonstration and testing permit process.
- The New York State Energy Research and Development Authority (NYSERDA), in conjunction with the NYS DOT, conducted a commercial vehicle platooning study to gauge the viability of electronically connected tandem commercial vehicles in New York State.
- The New York State Thruway Authority (NYSTA) is deploying one of the most advanced bridges in the country, the Governor Mario M Cuomo Bridge.
- The New York State Department of Transportation (NYSDOT) is piloting several infrastructure-based connected vehicle technologies.

To build on such efforts, and to ensure a coordinated approach to CAVs in NYS, the NYSTA and NYSDOT convened a small group of leaders of transportation-related agencies to identify a set of critical questions related to full-scale deployment of CAV in New York State. (See Appendix A for project participants.)

This effort, led by CTG UAlbany, a research institute at the University at Albany, was designed to gather NYS leaders to discuss and prioritize critical questions to prepare for deployment of intelligent transportation in NYS's unique environment while also exploring potential roles and responsibilities of NYS government agencies.

Project Sponsor and Leads

- This project was sponsored by the New York State Thruway Authority (NYSTA) and the New York State Department of Transportation (NYSDOT)
- Project Leaders were Kim McKinney, Chief Information Officer for NYSTA and Meghan Cook, Program Director at CTG UAlbany.

Introduction

During facilitated meetings, workshops and knowledge sharing sessions, participants identified and prioritized 70 questions.

The highest priority question posed was, "What should NYS' CAV leadership structure look like?"

This question was the focus of a number of discussions among participants and resulted in the development of a recommendation for establishing such a structure in NYS to oversee the development of clear and consistent policies as well as specific understanding of relevant roles and responsibilities on intelligent transportation, specifically the deployment of connected and autonomous vehicles.

The 70 questions, participants agreed, should provide the initial agenda for the recommended NYS Leadership group on Intelligent Transportation.

Answers to these questions, according to participants, are instrumental in informing efforts to prepare for CAVs deployment in NYS.

This report presents a short summary of the potential benefits from CAVs deployment, followed by the list of the highest priority questions and a short discussion of the full set of questions in terms of the seven categories into which they were organized; laws, regulations, and policies, administration, operations, and management, physical and information technology infrastructure, data environment, cybersecurity, outreach and awareness, and workforce and labor relations.

The report closes with the single recommendation from the agency leaders; establish a NYS Leadership group on Intelligent Transportation.

The appendices provide additional information about project participants, CAVs definitions, the full list of critical questions, and a CAVs reading list.

Advancing Intelligent Transportation in New York State

- 19 Participants
- 8 NYS transportation-related agencies
- 8 Meetings, Workshops, & Knowledge Sharing Sessions
- Presentations: ITS America, CTG UAlbany, and Albany Law School

Advantages of CAVs

Increased traffic safety, reduced fuel consumption, and increased mobility for specific populations are three categories of potential benefits of particular relevance to the discussions among the NYS intelligent transportation leadership.

While CAVs are being tested, it is important to note that fully autonomous vehicles are only available in limited locations.

Currently, vehicles with partial automation, levels 0-2, are available in some commercially available models, but vehicles with higher automation, levels 3-5, are not being sold in mass markets (see Appendix B for CAVs definitions).

The National Highway Traffic Safety Administration (NHTSA) estimates that 94 percent of the accidents on U.S. roadways are due to human error from inattention to intoxication and speeding to sleepiness.

It has been reported that CAVs safety advantages over human operated vehicles will include their ability to constantly scan the road; accurately navigate via a combination of onboard sensors and GPS data; and consistently comply with traffic regulations designed to promote safety.

CAVs are also expected to improve capacity on roadways and combined with electric vehicle technologies, ride-sharing and innovative approaches to public transportation, there is a potential to have a positive impact on roadway capacity, energy usage, and the time spent by riders in automobiles.

Finally, specific populations, including the elderly, the disabled, and other communities underserved by traditional personal and public transportation systems, may also realize the benefits of CAVs as they will have more options for mobility.

Intelligent transportation systems, specifically CAVs, have the potential to change the way society moves from place to place.

While the full potential of CAVs deployment is not known, a number of studies are being recognized as the most comprehensive considerations of that potential.

Key findings from these studies are presented in the four categories of impact considered to be most significant; increased traffic safety, reduced energy consumption, and increased mobility for specific populations.

Increased Traffic Safety

The promise of safety improvements are primarily described as a reduction in human error on roadways.

According to estimates by the National Safety Council in 2017, 40,100 people died on U.S. roadways.

The National Highway Traffic Safety Administration (NHTSA) estimates that 94 percent of the accidents on U.S. roadways are due to human error from inattention to intoxication and speeding to sleepiness.

Despite limited deployment, it has been reported that CAVs safety advantages over human operated vehicles will include their ability to track aspects of the environment by constantly scanning the road for other vehicles, bicyclists, pedestrians, and potential hazards; accurately navigating via a combination of on-board sensors and GPS data; and consistently complying with traffic regulations designed to promote safety.

As a result, CAVs are expected to perceive the road ahead in far more detail than a human driver or automated sensors alone.

Advantages of CAVs

CAVs could have a tremendous advance in safe transportation.

Additionally, they will have the potential to provide an unprecedented level of transparency when incidents occur.

CAVs will not rely on the recollection of a human driver or eyewitnesses in case of accidents.

CAVs capabilities such as adaptive cruise control, traffic/hazard avoidance navigation, and traffic signal synchronization, have demonstrated great potential.

The vehicles will collect data about the conditions before, during, and after an incident that first responders and others can use for investigative purposes.

Reduced Fuel Consumption

CAVs are also expected to improve capacity on roadways and combined with electric vehicle technologies, ride-sharing and innovative approaches to public transportation, there is a potential to have a positive impact on roadway capacity, energy usage, and the time spent by riders in automobiles.

A recent report by the Intelligent Transportation Society of America (ITS America) projects that so-called intelligent transportation systems (ITS) could achieve a two to four percent improvement in both fuel consumption and emissions over ten years for CAVs with those systems over traditionally operated vehicles with similar capabilities.**

There are also other potential areas of improved efficiency such as platooning of freight vehicles and reducing the amount of vehicles needed individual commutes, and available space for parking.

Platooning, allowing vehicles to operate closer together and at higher speed than is safe for a human driver, could increase capacity of roadways.

With millions of companies moving goods over the roadways every day, even a small increase in efficiency could by platooning could realize an energy efficiency.

The U.S. Census Bureau estimates the average one-way American commute time is 26.1 minutes.***

In more distant suburbs and exurban areas, that average time can be 45 minutes or more.

The availability of "on call" shared CAVs would reduce the need for individual vehicles and reduce the real estate for parking.

CAVs could also reduce that time through more efficient use of roadways, and allowing the vehicle occupants to direct most, if not all, of their attention to purposes other than driving.

More efficient vehicles and the overall potential reduction of vehicles on roadways has the potential to impact the overall energy usage in a positive way.

Increased Mobility

Specific populations, including the elderly, the disabled, and other communities under-served by traditional personal and public transportation systems, may also realize the benefits of CAVs.

** - https://www.scientificamerican.com/article/self-driving-cars-could-cut-greenhouse-gas-pollution/
*** - https://www.census.gov/search-results.html?stateGeo=none&q=commute+time+to+work&searchtype=web

Advantages of CAVs

A report by the Center for the Study of the Presidency and Congress contends that there is a potential to redefine transportation accessibility and as a result have a positive impact on economic opportunity and productivity.****

CAVs could allow underserved communities to access better transportation options and have more personalized transportation choices.

Because driving may not be a feasible option for some populations due to the cost of full-time car ownership, the cost of learning to drive, difficulties with licensing, or to health, disability, or age factors, there can be an impact.

Access to CAVs could provide another transportation option and have the potential to influence their ability for employment and education.

CAVs have the potential to reshape transportation models that currently emphasize car ownership as the foundation of full personal transportation freedom and flexibility.

CAVs could empower those simply unable to drive such as the elderly, those too young to drive, the blind, the disabled, and others and give them the same options.

**** - http://www.thepresidency.org/sites/default/files/The%20Autonomous%20Vehicle%20Revolution%E2%80%94Fostering%20Innovation%20with%20Smart%20Regulation.pdf

Questions for Informing CAVs Deployment in NYS

In order to develop a shared understanding of the broad range of considerations required for passenger, commercial, and transit CAVs deployment in NYS, agency leaders identified, discussed and prioritized a set of questions they consider critical to informing the preparation for CAVs deployment in NYS.

The questions were grouped into seven categories that included laws regulations and policies, physical and information technology infrastructure, administration operations and management, outreach and awareness, workforce and labor relations, cybersecurity, and data environment.

Among the 70 questions identified, six questions (from five categories) were considered the most critical to informing and advancing NYS's efforts to prepare for CAVs deployment.

Seven Categories of Questions

1. Laws, Regulations and Policies
2. Physical and Information Technology Infrastructure
3. Administration, Operations, and Management
4. Outreach and Awareness
5. Workforce and Labor Relations
6. Cybersecurity
7. Data Environment

Priority Questions

1. What should the NYS' CAVs leadership structure look like?
2. What are the must-have physical and structural investments for CAVs in NYS (i.e. striping, signs and cones)?
3. What are the skills, capabilities, and equipment needed for a workforce to plan, design, operate and maintain CAVs in NYS?
4. What control and responsibilities are left to the NYS if the federal preemption law is passed?
5. How can NYS' efforts to improve mass transit ensure support for CAVs deployment preparation, rather than divert funding to other initiatives?
6. What level of cybersecurity investment is necessary to ensure safe deployment of CAVs in NYS?

Questions for Informing CAVs Deployment in NYS

The 70 questions (See Appendix C) identified as necessary to inform NYS' CAVs deployment preparation efforts are organized into seven categories.

The category ***Laws, Regulations and Policies***, is the largest with 22 questions.

Questions in this category related to several policy areas including licensing and registration, safety, insurance, environmental sustainability, incentives, and standards.

The category ***Physical and Information Technology Infrastructure***, is the second largest with 11 questions.

Questions in this category related to the structural and information technology investments that would need to be made to the current transportation infrastructures, innovative funding mechanism, and considerations for bridging urban and rural areas.

The category ***Administration, Operations, Management***, consists of 10 questions.

Questions in this category include the role and mission of a leadership group in NYS, funding implications for CAVs, equitable deployment of CAVs, breakdown of administrative responsibilities, and ensuring safety.

The category ***Outreach and Awareness*** also had 10 questions.

Questions in this category included defining and carrying out education and awareness strategies for a range of stakeholders, modeling both positive and negative impacts of CAVs, and communicating the integration of CAVs into existing state economic, safety, and environmental goals.

The category ***Workforce and Labor Relations***, consists of seven questions.

Questions in this category include identifying and developing the skills and capabilities needed for a workforce to plan, design, operate, and maintain CAVs, understanding the positive and negative impacts of CAVs, the new training necessary for first responders, and the considerations for union and labor relations.

The category ***Cybersecurity*** consists of five questions.

Questions in this category include identifying the cybersecurity responsibilities of public, private and nonprofit stakeholders, understanding how the cyber investments could trigger positive impacts, identifying supply chain considerations, and determining the lead cyber agency.

The category ***Data Environment*** consists of five questions.

Questions in this category include identifying the baseline data management and stewardship policies and practices for CAVs, understanding the positive and negatives implications of data monetization, and the financial considerations for collecting, storing and managing CAVs data.

Recommending a NYS Leadership Group on Intelligent Transportation

What should NYS' CAVs leadership structure look like?

This priority question was the focus of a number of discussions among participants and resulted in the development of a recommendation for establishing a structure in NYS to oversee the development of clear and consistent policies, as well as clarity on relevant roles and responsibilities on intelligent transportation, specifically the deployment of connected and autonomous vehicles.

Participants referenced a recommendation in the report *Jurisdictional Guidance for the Safe Testing and Deployment of Highly Automated Vehicles* from the American Association of Motor Vehicle Administrators that recommends establishing an interagency committee and designating a lead agency to, "optimize collaboration among stakeholders" and, "provide the appropriate level of government oversight with flexibility to quickly modify regulations if needed."

As a result of this discussion participants agreed on a recommendation to establish a ***NYS Leadership Group on Intelligent Transportation***.

Mission

The mission of the ***NYS Leadership Group on Intelligent Transportation*** would be to oversee the development of clear and consistent policies on intelligent transportation, specifically the deployment of connected and autonomous vehicles in New York State.

The NYS CAVs Leadership Group would have oversight responsibilities for ensuring interoperability of communications structures, development of traffic and cyber safety protocols, establishing a ***Center of Excellence in Connected and Autonomous Transportation***, defining the rules of engagement with all private industry, and setting forth a consistent message and approach to intelligent transportation among NYS transportation-related agencies.

Recommended Membership

- NYS Governor's Office
- State Legislature
- Department of Motor Vehicles
- Department of Transportation
- NYS Police
- NYS Office of Information Technology Services
- Department of Financial Services
- NYS Empire State Development
- State University of New York
- NYS Port Authority
- NYS Energy Research & Development Authority
- NYS Office for the Aging
- NYS Thruway Authority
- Metropolitan Transit Authority
- Regional Transit and Planning Authorities

Proposed Agenda

The 70 questions developed throughout the workshop discussions, participants agreed, provide an initial agenda for the recommended ***NYS Leadership Group on Intelligent Transportation***.

Answers to these questions, according to the agency leaders who participated in the workshops, are instrumental in informing efforts to prepare for CAV deployment in NYS.

Appendix A: Participants

New York State Department of Motor Vehicle
Theresa Egan, Executive Deputy Commissioner
Janet Ho, Deputy Commissioner For Policy, Safety And Driver Licensing
Tim Lennon, Deputy Commissioner And Counsel

New York State Office of Information Technology Services
Robert Samson, Chief Information Officer
Mike Perrin, Chief of Staff

New York State Energy Research and Development Authority
Adam Ruder, Program Manager
Robyn Marquis, Program Manager

New York State Department of Transportation
Paul A. Karas, Acting Commissioner
Robert R. Limoges P.E, Director, Office of Traffic, Safety and Mobility
Ron Epstein, Deputy Commissioner
John Basset, Director of the Office of Traffic, Safety and Mobility

New York State Police
James Michael, Major, Traffic Services
Terence J. McDonnell, Staff Sergeant

Governor's Office/Chamber
Matthew Trapasso, Senior Policy Advisor for Transportation

University at Albany
James Dias, Vice President for Research

New York State Thruway Authority
Matthew Driscoll, Executive Director
Kim McKinney, Chief Information Officer
David Martin, Director of Application Development
Danny Lundy, Empire Fellow

Appendix B: Definitions

CAVs technologies, definitions, and concepts are becoming more widely understood but for the purposes of building a shared understanding, the following definitions were presented at the workshops.

Intelligent Transportation Systems (ITS)

ITS is the integrated application of advanced technologies including sensing, analysis, control and communications technologies to ground transportation in order to improve safety, mobility and efficiency.

ITS includes a wide range of applications that process and share information to ease congestion, improve traffic management, minimize environmental impact and increase the benefits of transportation to commercial users and the public in general.

ITS includes connected and autonomous (CAVs) and the environment/systems with which they interact.
CV and AV utilize overlapping communication technologies but are not technologically congruent.

They can develop and be implemented independently of each other. However, CV technologies and infrastructure can improve AV performance and safety.

Connected Vehicles (CV)

Connected vehicles can be a car, truck, or bus that is equipped with a wireless communication device.

A CV uses any of the available wireless communication technologies to communicate with other cars on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and other travelers, device, the grid, and the cloud [V2X].*****

The core technology components of the CV environment are safety-related systems that will likely be based on dedicated short range communications (DSRC).

Non-safety applications may be based on different types of wireless technology.

The core technology components of the CV environment are safety-related systems that will likely be based on dedicated short range communications (DSRC).

Non-safety applications may be based on different types of wireless technology.

***** - Glossary of Connected and Automated Vehicle Terms, University of Virginia Center for Transportation Studies Hyungjun Park, Zulqarnain Khattak, and Brian Smith for the Connected Vehicle Pooled Fund Study, March 2018. http://www.cts.virginia.edu/wp-content/uploads/2018/03/Glossary-of-CAV-Terms-Ver1.0-03052018-1.pdf

Appendix B: Definitions

Dedicated short-range communications (DSRC) is an open-source protocol for wireless communication.

It is similar to Wi-Fi. However, while Wi-Fi is used mainly for wireless local area networks, DSRC is intended for highly secure, high-speed wireless communication between vehicles and the infrastructure.

The key functional attributes of DSRC that make it a key communications method for safety applications are:

- Low latency: The delays involved in opening and closing a connection are very short—about 0.02 seconds
- Limited interference: DSRC is very robust in the face of radio interference and its short range (~1000 m) limits the chance of interference from distant sources. Additionally, the Federal Communications Commission (FCC) presently ensures that transportation safety applications take precedence in using DSRC over purely commercial convenience applications
- Strong performance during adverse weather conditions

The CV environment will require the deployment of a mixture of roadside, in-vehicle, network, and back office systems and technologies.

The systems needed to support CV operations can be divided into the following six broad categories.******

- **On Board Equipment (OBE) or mobile equipment.** Hardware that is located in a vehicle to collect data from the vehicle and/or provide an interface through which ITS services can be provided, (e.g. tolls, navigation, trip planning, travel information).
- **Roadside Equipment (RSE or RSU).** Hardware located at the side of the road used to exchange data with vehicles in its locality and in some instances provide an interface through which travelers can access ITS related services (e.g. Public Transport schedules).
- **Core systems.** Systems that enable the data exchange required for CV applications. Core systems exist to facilitate interactions between vehicles, field infrastructure, and back office users.
- **Support systems.** These include the Security Credential Management System (SCMSs) that allow devices and systems in the CV environment to establish trust relationships.
- **Communications systems.** Data communications infrastructure needed to provide connectivity in the CV environment. This includes DSRC and non-DSRC technologies (e.g., cellular or Wi-Fi communications) to provide V2V and V2I connectivity and network connectivity from RSEs to other system components including the appropriate firewalls and other systems components intended to protect the security and integrity of data transmission.
- **Application-specific systems.** Equipment needed to support specific CV applications that are deployed at a particular location, rather than the core systems that facilitate overall data exchange within the CV environment. An example is software systems and servers that acquire data from CVs, generate travel times from that data, and integrate those travel times into Traffic Management Channel (TMC) systems.

****** - USDOT Intelligent Transportation Systems Joint Program Office, ITS ePrimer Module 13: Connected Vehicles - https://www.pcb.its.dot.gov/eprimer/module13.aspx

Appendix B: Definitions

The US Department of Transportation (USDOT) ITS Joint Program Office (JPO) has adopted and promoted the following Connected Vehicle Applications Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) to describe the type of applications that can be deployed in the CV environment.

Application Group	Details
Commercial Vehicle Operations	Operation, safety and management of commercial vehicles.
Data Management	Support performance monitoring and other uses of historical data.
Maintenance and Construction	Track maintenance and construction vehicles and supports dissemination of these activities.
Parking Management	Monitor and manage parking spaces and provides real time information on park and ride services to support travelers' decision making.
Public Safety	Support basic public safety, call-taking and dispatch services and provides information to support dynamic routing of emergency vehicles.
Public Transportation	Monitor automated transit vehicle location, performs automated dispatch of transit services and allows travelers to request trips and request itineraries.
Support	Provide monitoring, management and control services to other applications and devices operating within CV environment.
Sustainable Travel	Monitor individual vehicle emissions and support environmentally efficient operation of traffic signals and lanes.
Traffic Management	Support infrastructure and vehicle based surveillance and the use of CV information to improve the operation of traffic systems.
Traveler Information	Disseminate traveler information for route planning and guidance.
Vehicle Safety	Leverages sensors and safety messages transmitted between CV to support and augment vehicle safety
Weather	Collect road weather data and detect environmental hazards to alert drivers.

Appendix B: Definitions

Autonomous Vehicles

Autonomous Vehicles (AV) are vehicles where operations occur without direct human driver input to control key functions such as steering, acceleration, and braking. There are various degrees of autonomy, but future systems will be principally designed so that the vehicles' passenger is not required to monitor the roadway or intervene in the operation of the vehicles in any way.

AV are seen as a continuum of increasing autonomous functionality. The Society of Automotive Engineers (SAE) has developed an AV model of five levels of increased autonomy as shown.

0

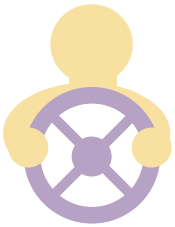
No Automation - Zero autonomy; driver performs all driving tasks

1

Driver Assistance – Adaptive Cruise Control (ACC) including stop-and-go function: Adaptive cruise control with stop and go function includes automatic distance control and, within the limits of the system, detects a preceding vehicle.

2

Partial Automation – Traffic Jam Assist: The system controls forward/backward as well as sideways movements of the vehicle in order to follow traffic flow. Level 2 can be seen as an extension of the ACC with stop-and-go functionality, with an addition of an automated lateral movement control.



3

Conditional Automation – Highway Chauffeur: Conditional automated driving on highways or highway-like roads. The Highway Chauffeur operates from entrance to exit, on all lanes, including passing movements.

4

High Automation – Highway Pilot: Automated driving on highways or highway-like roads, on all lanes, including passing movements. A driver does not have to control the vehicle and does not have to monitor the roadway but must stay vigilant to the system and be ready to take back control of the vehicle when requested by the system.

5

Full Automation – Fully automated private vehicle: The fully automated vehicle should be able to handle all driving from point A to B, without any input from the passenger. The driver can at all times override or switch off the system. No consensus exists as to when such systems will become commercially available.

Appendix C. Questions in Preparing for CAVs Deployment in NYS

Laws, Regulations, and Policies

1. What control and responsibilities are left to the state if the federal preemption law is passed?
2. Should NYS set standards for CAVs?
3. Can NYS set standards for CAVs?
4. How should the NYS laws and regulations associated with commercial vehicles, licensing drivers, and routing be modified?
5. Do the federal preemption laws apply to when the government is the owner and operator?
6. What new financial incentives need to be created?
7. What are the policy implications on state insurance laws?
8. What are the policy implications on licensing and registration?
9. What are the opportunities in each economic zone?
10. Will the automotive industry and/or the federal government set standards for CAVs?
11. What are the probability and potential implications of repealing the one-hand-on-the-wheel law?
12. What is the impact on how taxi and ridesharing operations are regulated and will it require modifications to law?
13. Do existing public safety laws need to be modified? If so, how?
14. Do the DWI/DUI laws need to be modified?
15. How should the tax incentives and credits laws modified?
16. What are the manufacturing incentives within our control that will provide positive economic impacts?
17. What are some incentives for electric CAVs will provide a positive economic impact?
18. What are some ride sharing incentives that will provide positive economic impact?
19. What legal and financial incentives for use of electric CAVs will provide the optimum environmental sustainability impact?
20. Does the state have a responsibility to promote the incorporation of environmental goals into CAVs deployment strategies?
21. What modifications to NYS laws and regulations associated with commercial vehicles, licensing drivers, and routing are need to facilitate the adoption of fuel-efficient CAVs-driven techniques such as platooning by fleet operators?
22. Are there anticipated changes with existing laws and regulations (for vehicles, people, etc.) that will engage taxi fleets and/or ridesharing companies to incorporate more electric CAVs?

Appendix C. Questions in Preparing for CAVs Deployment in NYS

Physical & Information Technology Infrastructure

23. Where are the funding implications of these investments?
24. What are the must-have physical and structural investments for CAVs? (i.e. striping, signs and cones)
25. What level of developed infrastructure would enable CAVs industry partners to invest in NYS?
26. What additions to the current technical infrastructure are necessary steps towards CAVs (i.e. DSRC)?
27. How does CAVs affect the state's current physical and technical infrastructure?
28. What are the must-have and nice-to-have physical and structural investments for CAVs?
29. Are there innovative approaches available to fund infrastructure investments (e.g., private/public partnerships)?
30. What changes in infrastructure could enhance the safe deployment of commercial CAVs?
31. How are the controlled routes of transit affected (if at all)?
32. How can NYS facilitate the development of necessary CAVs and EV technical infrastructures (e.g., charging)?
33. What are the investments needed to bridge the gap of rural and urban communities?

Administration, Operations, and Management

34. What should the CAVs leadership group and structure look like in NYS?
35. How can NYS' focus on CAVs support efforts to improve mass transit rather than divert attention and funding from it?
36. Are there changes to current transportation roles and responsibilities? (i.e. registration - vehicle and driver), road infrastructure, enforcement and safety)
37. How can we ensure that the benefits of CAVs are available to any/all?
38. What are some funding implications for new functions associated with CAVs?
39. What new skills and/or capabilities are needed to perform regulatory and control functions?
40. What CAVs deployment strategy would enable economic development given different regional needs?
41. What are the safety implications of autonomous transit?
42. How do we integrate the new investments necessary to the state's economic portfolio?
43. What administrative structures enable the state's lead CAVs agency and lead environmental sustainability agency to work together?

Appendix C. Questions in Preparing for CAVs Deployment in NYS

Data Environment

44. What are the data management policies for newly collected data from CAVs?
45. What are the privacy implications of data collected, stored, managed, and used from CAVs?
46. What are the risks and benefits associated with data monetization?
47. What CAVs-generated data can be used to support environmental sustainability efforts?
48. What are the data stewardship implications for state and local entities?

Cybersecurity

49. What level of cybersecurity investment is necessary to ensure safe deployment of CAVs?
50. What cybersecurity investments will trigger positive economic impacts with minimal to no deterrence economic development and innovation?
51. What are the information/cyber security responsibilities of various entities (state government, federal government, manufacturers, etc.) for the technical infrastructure?
52. What are the cybersecurity implications of the supply chain for connected and autonomous vehicles?
53. What agencies will lead and fund the CAVs cybersecurity efforts?

Outreach and Awareness

54. How do CAVs impact NYS' broader environmental energy goals?
55. How can NYS combine environmental sustainability and CAVs education campaigns so they are mutually supportive?
56. How do we model negative economic impacts?
57. What is the communication strategy to work with advocacy and industry partners to engage the public?
58. What are the main messages to inform the public on CAVs in NYS?
59. What are the mediums for communicating the messages?
60. What agencies are responsible for communicating which messages
61. What education is necessary for the public on how to share the roadway with commercial CAVs?
62. What approaches and messages can be effective in incentivizing CAVs-related industries and CAVs-driven economic development to NYS?
63. How do we model negative environmental impacts?

Appendix C. Questions in Preparing for CAVs Deployment in NYS

Workforce and Labor Relations

64. What are the skills, capabilities, and equipment needed for a workforce to plan, design, operate and maintain CAVs?
65. What are some of the workforce economic opportunities?
66. What are some of the impacts on workforce development?
67. What are the new skills and capabilities of the workforce that are necessary for construction, maintenance, and operations of the new infrastructure?
68. What new training is required for emergency and first responders?
69. What are the implications with unions and labor relations?
70. How can workforce use of CAVs affect environmental sustainability?

Appendix D: Reading List

The available literature on Connected and Autonomous Vehicles (CV/AV) is rapidly growing.

This list is an attempt to provide a subset of material that would be most helpful to a broad audience.

Some of the webpages cited provide a wide array of links to other material.

General Information

- Connected and Autonomous Vehicle (C/AV) Resources, Compiled by Association of Metropolitan Planning Organizations (AMPO) - http://bit.ly/2zwOEva
- Dr Charles Johnson, Readiness of the road network for connected and autonomous vehicle, RAC Foundation April 2017. - http://bit.ly/2D7NycB
- Glossary of Connected and Automated Vehicle Terms, University of Virginia Center for Transportation Studies Hyungjun Park, Zulqarnain Khattak, and Brian Smith for the Connected Vehicle Pooled Fund Study, March 2018. - https://at.virginia.edu/2RGBpj6
- National Transportation Library, USDOT Bureau of Statistics - https://rosap.ntl.bts.gov/
- Resources for Connected and Automated Vehicles, National Operation Center for Excellence - http://bit.ly/2SP1uxA
- Technology & Innovation, National Highway Traffic Safety Administration (NHTSA) - http://bit.ly/2PGZ9q0

Autonomous Vehicles (AV)

- Automated and Autonomous Driving Regulation under uncertainty, International Transport Forum, CPB, 2015. - http://bit.ly/2yWTgLI
- Autonomous Vehicles: A Public Regulatory Policy Guide - March 2018 (National Society of Professional Engineers) - http://bit.ly/2QlTpyQ
- Bill Canis, Issues in Autonomous Vehicle Deployment, Congressional Research Service, September 19, 2017 - http://bit.ly/2DppRgW
- Federal Automated Vehicles Policy 2016 - http://bit.ly/2qxTIv2
- Automated Driving Systems 2.0: A Vision for Safety 2017 - http://bit.ly/2D8l0ju
- Florida Automated Vehicles Program - http://www.automatedfl.com/
- Intelligent Transportation Society of America (ITS America) testimony to before US Congress on AV issues:
  - ITSA testimony before Senate EPW hearing on "Innovation and America's Infrastructure: Examining the Effects of Emerging Autonomous Technologies on America's Roads and Bridges:" - http://bit.ly/2AP1zKY
  - ITSA Questions for the Record Senate EPW hearing on "Innovation and America's Infrastructure: Examining the Effects of Emerging Autonomous Technologies on America's Roads and Bridges:" - http://bit.ly/2F65S8L
  - ITSA testimony before House Highways and Transit Subcommittee hearing on :Innovation in Surface Transportation:" - http://bit.ly/2SR6tOA

Appendix D: Reading List

- James M. Anderson, Nidhi Kalra, Karlyn D. Stanley, Paul Sorensen, Constantine Samaras, Oluwatobi A. Oluwatola Autonomous Vehicle Technology: A Guide for Policymakers, RAND Corporation 2016. - http://bit.ly/2F7LdBj

- Jurisdictional Guidelines for the Safe Testing and Deployment of Highly Automated Vehicles - http://bit.ly/2SPAHRS

- Preparing for Automated Vehicle: Traffic Safety Issues for States, Governors Highway Safety Association (GHSA), 2018 - http://bit.ly/2RBj9Yc

- Roundtable on Data for Automated Vehicle Safety: Summary Report (USDOT) January 2018 - http://bit.ly/2yV7SLp

- The Autonomous Vehicle Revolution: Fostering Innovation with Smart Regulation, Center for the Study of the Presidency & Congress March 2017 - http://bit.ly/2RBjXMI

Tedx Talks - Brief discussions of AV topics

- The Social Dilemma of Driverless Cars by Iyad Rahwan - http://bit.ly/2PfeEpt

- Autonomous ride towards a new reality by Limmor Kfiri - http://bit.ly/2QvyJV2

- Driverless Cars – The Road Ahead by Finbarr Murphy - http://bit.ly/2qyqIDM

- The future of transportation by Ryan Janzen - http://bit.ly/2RFpt0Z

- Self-driving cars are coming – are you ready? By Jeff Owens - http://bit.ly/2D7D4dp

- The Potential of Self-Driving Vehicles by Raj Rajkumar - http://bit.ly/2zxtL2V

Connected Vehicles (CV)

Connected Vehicle Pilot Deployment Program, USDOT ITS JPO. The Fact Sheets of each pilot - https://www.its.dot.gov/pilots/

- NYC - http://bit.ly/2QoGDzN
- Tampa -http://bit.ly/2AP8NhR
- Wyoming - http://bit.ly/2zxiC2b

- ePrimer Module 13: Connected Vehicles - http://bit.ly/2PHzHAv

- Estimated Bounds and Important Factors for Fuel Use and Consumer Costs of Connected and Automated Vehicles, National Renewable Energy Laboratory (NREL) - http://bit.ly/2zHnSAz

- Guidelines for Applying Capability Maturity Model Analysis to Connected and Automated Vehicle Deployment, Federal Highway Administration (FHWA) - http://bit.ly/2JJRPEl

- Intelligent Transportation Systems (ITS) ePrimer, USDOT JPO - http://bit.ly/2DobZDR

"[CTG UAlbany] is one of the leading research institutions studying technology adoption by governments around the world and continues to push the envelope on how best to integrate technology and public policy towards a new frontier in openness and government accountability."

–Kirsten Gillibrand, United States Senator for New York

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