



# COMMONWEALTH of VIRGINIA

## *Commonwealth Transportation Board*

Aubrey L. Layne, Jr.  
Chairman

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*Agenda item # 1*

### RESOLUTION OF THE COMMONWEALTH TRANSPORTATION BOARD

JULY 19, 2017

#### MOTION

**Made By: Ms. Valentine, Seconded By: Mr. Garczynski**

**Action: Motion Carried, Unanimously**

**Title: Authorization for the Commissioner of Highways to Enter into a Memorandum of Understanding Among the Virginia Department of Transportation, the Federal Highway Administration, 95 Express Lanes, LLC, and Capital Beltway Express, LLC Regarding Testing of Connected Vehicles.**

**WHEREAS**, to improve traveler safety and mobility the Federal Highway Administration of the United States Department of Transportation (the "FHWA") desires to research and test connected vehicle and vehicle automation technologies; and

**WHEREAS**, 95 Express Lanes, LLC operates and maintains the I-95 HOT Lanes within the Commonwealth, and Capital Beltway Express, LLC operates and maintains the I-495 HOT Lanes within the Commonwealth (together, the "HOT Lanes Facilities"); and

**WHEREAS**, the Virginia Department of Transportation (the "Department") owns the HOT Lanes Facilities and desires to permit the FHWA, in coordination with 95 Express Lanes, LLC and Capital Beltway Express, LLC, to research and test connected vehicle and vehicle automation technologies on the HOT Lanes Facilities; and

**WHEREAS**, the Department, FHWA, 95 Express Lanes, LLC, and Capital Beltway Express, LLC have developed an MOU (set out in Attachment A) that sets forth the purpose of, and that will govern access rights, security, safety, and other rights and duties that apply to, the

Resolution of the Board

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research and testing of connected vehicle and vehicle automation technologies on the HOT Lanes Facilities; and

**WHEREAS**, the Commonwealth Transportation Board (“CTB”) is authorized under Virginia Code § 33.2-221(A) to enter into contracts and agreements with the United States government and the Department seeks CTB approval of, and authorization for the Commissioner of Highways to execute, the MOU.

**NOW, THEREFORE, BE IT RESOLVED**, that the CTB hereby approves, and authorizes the Commissioner of Highways to execute, a memorandum of understanding among the Department, FHWA, 95 Express Lanes, LLC, and Capital Beltway Express, LLC, governing their rights and duties relating to the research and testing of connected vehicles and vehicle automation technologies, in substantially the form set out in Attachment A, with such changes as the Commissioner deems necessary or appropriate.

####

## CTB Decision Brief

Title: Authorization for the Commissioner of Highways to Enter into a Memorandum of Understanding Among the Virginia Department of Transportation, the Federal Highway Administration, 95 Express Lanes, LLC, and Capital Beltway Express, LLC Regarding Testing of Connected Vehicles.

**Issue:** To permit the Federal Highway Administration of the United States Department of Transportation (the “FHWA”) to research and test connected vehicle and vehicle automation technologies on the I-95 HOT Lanes and the I-495 HOT Lanes, it is necessary for the Virginia Department of Transportation (the “Department”), the FHWA, 95 Express Lanes, LLC, and Capital Beltway Express, LLC to enter into a Memorandum of Understanding (“MOU”). Approval of the MOU by the Commonwealth Transportation Board (“CTB”) and authorization for the Commissioner of Highways to execute the MOU are sought.

**Facts:** The purpose of this MOU is to perform research, development and demonstration tests at 95/495 Express Lanes in Virginia that will allow FHWA to assess the potential of Connected and Automated vehicles in a managed lanes or general purpose lanes scenario. It is the goal of this MOU to develop collaborative opportunities between the parties, and it is expected that the parties will benefit by virtue of the interaction afforded by the opportunity to answer the following critical questions as highway agencies are dealing with the technology disruption currently underway in the automobile and technology sectors:

- Is it feasible to implement speed harmonization along a managed lanes facility and what are the associated infrastructure elements required to accomplish this?
- What are the limitations/gaps of the existing communication media vis-à-vis vehicle-to-infrastructure and vehicle-to-vehicle communications to accomplish these aforementioned connected and automated vehicle applications and services?
- Is it possible to operate vehicles as a platoon in a managed lanes facility with mixed traffic without impacting the operations on the managed lane?
- Are we able to achieve string stability under multi-vehicle platoons?
- What are the infrastructure needs for DSRC in order for CACC to perform and how does this impact the operations of managed lanes?
- What are the impacts of these applications on mobility, safety and the environment?

The MOU will govern access rights, security, safety, and other rights and duties that apply to the research and testing of connected vehicle and vehicle automation technologies on the I-95 HOT Lanes and the I-495 HOT Lanes.

The Commonwealth Transportation Board (“CTB”) is authorized under Virginia Code § 33.2-221(A) to enter into contracts and agreements with the United States government.

**Recommendations:** The Department recommends that the CTB approve the MOU, attached hereto as Attachment A, and authorize the Commissioner of Highways to execute the MOU, with such changes that the Commissioner deems necessary or appropriate.

**Action Required by CTB:** The CTB will be presented with a resolution for a formal vote.

**Result, if approved:** The Commissioner will execute the MOU, which will permit research and testing of connected vehicle and vehicle automation technologies on the I-95 HOT Lanes and the I-495 HOT Lanes.

**Options:** Approve, Deny, or Defer

MEMORANDUM OF  
UNDERSTANDING BETWEEN  
THE FEDERAL HIGHWAY ADMINISTRATION,  
VIRGINIA DEPARTMENT OF TRANSPORTATION,  
CAPITAL BELTWAY EXPRESS LLC, AND 95  
EXPRESS LANES LLC

**I. PARTIES.** The Parties to this Memorandum of Understanding (MOU) are the Virginia Department of Transportation (VDOT), Capital Beltway Express LLC, 95 Express Lanes LLC, and Federal Highway Administration (FHWA), of the United States Department of Transportation.

**II. BACKGROUND AND PURPOSE.** Transportation operations research is in increasing demand due, in large part, to the ever increasing amounts of congestion in the United States (US) and demand for better services to support the growth of the US economy. The Federal Highway Administration (FHWA) Office of Operations Research and Development (HRDO), a component of FHWA's Turner Fairbank Highway Research Center (TFHRC), performs transportation operations research and development (R&D) that uses electronics, information processing, and communications technologies to improve the efficiency and sustain the existing surface transportation system. HRDO activities lead to increasing the effective handling capacity of the existing roadway system without the expense of building and maintaining new roads.

HRDO is focusing on near-term solutions with concepts using wireless communications- based Connected Vehicle (CV) technologies combined with vehicle automation such as longitudinal control to improve safety and mobility. HRDO has several projects intended to explore early applications of "connected and automated" vehicles that may be of interest to all parties to this MOU. HRDO believes that these applications have great potential for improving the safety and mobility of the US transportation system.

- **Speed Harmonization:** The goal of Speed Harmonization is to provide smooth operation of the traffic stream, which reduces bottlenecks, increases reliability, reduces environmental impacts, improves safety, and provides additional comfort and convenience. An infrastructure-based systems management function provides speed recommendations to individual vehicles on the corridor in order to optimize the network performance. This may be done as a speed advisory or in an automation framework where the optimal recommendations are placed directly into the vehicle control systems without driver interaction. A proof-of-concept project was just completed with a very limited vehicle fleet of three vehicles using modified off-the-shelf Adaptive Cruise Control systems. This experimentation was in partnership with Virginia Department of Transportation (VDOT) using I-66 inside the beltway. There could be a potential for using this application to mitigate the bottlenecks created at discharge locations on managed lanes facilities such as the 95/495 Express Lanes.
- **Cooperative Adaptive Cruise Control (CACC):** The goal of Cooperative Adaptive Cruise Control (CACC) is to increase the capacity of a highway by coordinating the

equipped vehicles to safely follow closer (i.e. platooning). The vehicles use CV technologies combined with vehicle automation to enable the formation of platoons. A proof-of-concept is underway that will take the next evolutionary step by using the FHWA's fleet of five passenger cars equipped with the added CACC functionality, on a test track, to test existing and new algorithms. The current project built, on a small scale, the framework to begin an exploration of the technical needs and mobility effect/benefits in the real world. This project will expand the understanding of the real world performance and capabilities focusing on near-term application in managed lanes. There could be a potential for using this application for increasing the capacity on managed lanes facilities such as the 95/495 Express Lanes.

- **Truck Platooning:** Building upon the aforementioned CACC algorithms a proof-of-concept is currently being developed that will enable the ability to test and demonstrate three-truck platooning using vehicle-to-vehicle and vehicle-to-infrastructure communications. If feasible, future development work may allow for the testing of mixed vehicle (e.g., trucks and cars) platooning concepts.
- **Lane Change/Merge:** The goal of the lane change and merging freeway lateral maneuvers application is to increase roadway throughput and safety. This will be done by optimizing and executing the lane change, merging and demerging tasks into and out of highways in an automated fashion. This will involve vehicle-to-vehicle and infrastructure-to-vehicle sensors and communications at fixed locations in the highway network. A proof-of-concept is underway that will take the next evolutionary step by using the FHWA's fleet of five test vehicles equipped with the functionality, on a test track, to test the algorithms.

The purpose of this MOU is to perform research, development and demonstration tests at 95/495 Express Lanes in Virginia that will allow FHWA to assess the potential of Connected and Automated vehicles in a managed lanes or general purpose lanes scenario. It is the goal of this Agreement to develop collaborative opportunities between the parties, and it is expected that the parties will benefit by virtue of the interaction afforded by the opportunity to answer the following critical questions as highway agencies are dealing with the technology disruption currently underway in the automobile and technology sectors:

- Is it feasible to implement speed harmonization along a managed lanes facility and what are the associated infrastructure elements required to accomplish this?
- What are the limitations/gaps of the existing communication media vis-à-vis vehicle-to-infrastructure and vehicle-to-vehicle communications to accomplish these aforementioned connected and automated vehicle applications and services?
- Is it possible to operate vehicles as a platoon in a managed lanes facility with mixed traffic without impacting the operations on the managed lane?
- Are we able to achieve string stability under multi-vehicle platoons?
- What are the infrastructure needs for DSRC in order for CACC to perform and how does this impact the operations of managed lanes?
- What are the impacts of these applications on mobility, safety and the environment?

- III. LEGAL AUTHORITIES.** The authority for FHWA to enter into this MOU includes 23 USC 502. The authority for VDOT to enter into this agreement is Virginia Code § 33.2-221 and § 33.2-225, and the authority granted by the Commonwealth Transportation Board pursuant to § 33.2-221.
- IV. GENERAL SCOPE OF AGREEMENT.** The research performed under this MOU shall be performed in accordance with the Statement of Work and Obligations of the Parties (SOW/OP), attached as Appendix A.
- V. RESPONSIBILITIES/ OBLIGATIONS OF THE PARTIES.** The Parties enter into this MOU with the intention of engaging in the fullest possible cooperation and coordination; however, nothing contained in this MOU imposes any specific program, resource, operational, legislative, or budget obligations on any Party, nor will any such cooperation result in the transfer of any existing intellectual property rights from one party to another . Each party shall be free to develop additional intellectual property based on their efforts under this MOU, and any such intellectual property shall be governed by any other applicable agreement between or among the respective parties with respect to the treatment of any applicable intellectual property rights. The utilization of the FHWA personnel, resources, facilities, equipment, skills, know-how, computer software and information will be consistent with its own policies, missions, and requirements. No federal funds are committed through this agreement. Accordingly, it is agreed that all research is to be performed on a best efforts basis. Any modification of the SOW/OP shall be by mutual agreement between the parties and shall be incorporated into this MOU by a formally executed written amendment.
- VI. FINANCIAL ARRANGEMENTS.** Each signatory agency will provide funds, human resources, equipment, supplies, facilities, training, public information, and expertise to the extent that its participation is needed and funds and other resources are available. This MOU is not a funds obligation document. Any activities involving transfer of funds between the Parties will be documented in separate implementing agreements. For the avoidance of doubt, each party will fund only its own responsibilities under this MOU unless otherwise agreed in writing.

This MOU defines in general terms the basis on which the Parties will cooperate, and as such, does not constitute a financial obligation to serve as a basis for expenditures. This MOU in no way restricts the Parties from participating in similar activities or arrangements with other public or private agencies, organizations, or individuals. This MOU is subject to the availability of funds and does not obligate the Parties to expend appropriations or to enter into any agreements, contracts, or other obligations.

Notwithstanding the provisions of this section, VDOT will not be obligated to provide any funds for testing or equipment necessary to complete any testing performed under this agreement.

- VII. SEVERABILITY.** Nothing in this MOU or any appendix or annex is intended to conflict with current law, regulation, orders, or directives of DOT, FHWA, TFHRC, or any other Federal agency or entity, or any current law, regulation, orders, or directives of VDOT. If

a provision of this MOU is inconsistent with that authority, then that provision will be invalid to the extent of such inconsistency, but the remainder of that provision and all other provisions, terms, and conditions of this MOU and any appendix or annex will remain in full force and effect.

**VIII. KEY CONTACTS**

Key contacts for this MOU are as follows:

**FHWA/TFHRC**

Name: Govindarajan Vadakpat  
Address: Federal Highway Administration  
Turner-Fairbank Highway Research Center  
6300 Georgetown Pike, McLean, VA 22101  
Telephone: (202) 493-3283

**COLLABORATING PARTY- VDOT**

Name: Larry Cloyed  
Address: 4975 Alliance Drive  
Fairfax, VA 22030  
Telephone: (703)-259-1735

**COLLABORATING PARTY- CAPITAL BELTWAY EXPRESS LLC AND 95 EXPRESS LANES LLC**

Name: Leigh Petschel  
Address: 6440 General Green Way  
Alexandria, VA 22312  
Telephone: (571) 419-6028

**IX. MODIFICATION.** This MOU may be amended, or modified at any time by mutual written agreement between the FHWA Associate Administrator for Research, Development, and Technology; Commissioner of Highways, VDOT; and Group General Manager, Capital Beltway Express LLC and 95 Express Lanes LLC.

**X. PERIOD OF AGREEMENT/TERMINATION.** This MOU shall be effective as of the date of final signature by all Parties and shall remain in effect for three (3) years from that date. The period of the agreement may be extended by written agreement of all Parties. Any party, upon 30 days written notice to the other parties, may terminate this MOU and any appendices and annexes.

Termination shall not affect any valid commitment of Funds that, in the mutual judgment of the Parties, had become final before the effective date of the termination.

The termination this MOU shall not affect the validity or duration of projects under this MOU that are initiated prior to such termination.

**XI. DISPUTE RESOLUTION.** In the event that disagreements or disputes arise between the parties regarding their respective roles and responsibilities identified in Section V, the FHWA Associate Administrator for Research, Commissioner of Highways, VDOT and Group General Manager, Capital Beltway Express LLC and 95 Express Lanes LLC or their

respective designees will determine the appropriate resolution by consensus.

**XII. FINANCIAL RESPONSIBILITY FOR DAMAGE OR CLAIMS.** Each Party agrees that it will be financially responsible for any damage, claims, lawsuits, or other liability to third parties or to another Party that arise from its own actions in connection with the performance of this MOU and the testing contemplated hereunder. Each Party will be responsible for such claims or damages to the extent permitted by law. Nothing in this MOU will be construed as a waiver of VDOT's sovereign immunity or VDOT's right to assert sovereign immunity for any damages, claims, liabilities to third parties or to another Party that arise from its actions in connection with the performance of this MOU and the testing contemplated hereunder.

**XIII. PUBLICATION AND RELEASE OF INFORMATION.** Any information furnished to the FHWA under this instrument is subject to the Freedom Of Information Act- FOIA 5 U.S.C. 552. Any information furnished to VDOT under this instrument is subject to the Virginia Freedom of Information Act, Virginia Code § 2.2-3700. This agreement does not prohibit any Party from publishing the data or information provided they assume sole responsibility and give appropriate credit to the other agency.

The Parties agree that sharing credit is mutually beneficial, and will make every effort to assure that appropriate citation and attribution, including the use of official agency emblems and seals, is given for work performed under this MOU. Parties shall not use each other's official seals, logos, or insignia without prior written approval. In a format that is reasonable and useable, FHWA shall provide VDOT and Capital Beltway Express LLC/95 Express Lanes LLC access to all data generated from the testing contemplated under this MOU free of cost.

Publicity and public information products, including news releases, reports, briefing papers, or other information products, may be prepared by any Party, or jointly, provided that all parties have an opportunity to review manuscripts prior to publication.

Any commitment of any party to preserve the confidentiality of information is subject to applicable United States laws and regulations.

**XIV. OTHER RIGHTS OR BENEFITS.** Nothing in this MOU is intended to diminish or otherwise affect the authority of each party to carry out its statutory, regulatory or other official functions, nor is it intended to create any right or benefit, substantive or procedural, enforceable at law by any party against the United States, its agencies or officers, or any other person.

FHWA is prohibited from officially endorsing non-federal entities. This MOU does not constitute an official endorsement of either VDOT or Capital Beltway Express LLC/95 Express Lanes LLC.

This instrument in no way restricts the FHWA, VDOT, or Capital Beltway Express LLC

and 95 Express Lanes LLC from participating in similar activities with other public or private agencies, organizations, and individuals.

Nothing in this MOU will give rise to a compensation event under any comprehensive agreement between the Department on the one hand, and any Transurban affiliate (including without limitation the Delaware limited liability companies: (i) 95 Express Lanes LLC and (ii) Capital Beltway Express LLC.

**IN WITNESS THEREOF**, the Parties hereto have caused this Memorandum of Understanding to be duly executed in triplicate as of the day and year last written below.

Federal Highway Administration  
U.S. Department of Transportation

Virginia Department of Transportation,  
an Agency of the Commonwealth of Virginia

Signature \_\_\_\_\_  
Name: Michael Trentacoste  
Title: Associate Administrator  
Research, Development, and Technology

Signature \_\_\_\_\_  
Name: Charles A. Kilpatrick, P.E  
Title: Commissioner of Highways

Date:

Date:

Capital Beltway Express LLC  
95 Express Lanes LLC

Signature \_\_\_\_\_  
Name: Jennifer Aument  
Title: Group General Manager  
Date:

## APPENDIX A

### STATEMENT OF WORK and OBLIGATION OF THE PARTIES

MOU No.: FHWA-2017-01

#### I. STATEMENT OF WORK

Objective: The objective of this MOU is to:

Conduct research and demonstration at 95 and 495 Express lanes in Virginia using the vehicle-to-infrastructure technology noted above to address the following research questions:

1. Is it possible to engage vehicles in a multi-vehicle platoon on an extended highway segment using vehicle-to-infrastructure and vehicle-to-vehicle communication to achieve a string stable CACC design?
2. Is it possible to quantify mobility benefits using speed harmonization along extended highway segments using vehicle-to-infrastructure and vehicle-to-vehicle communication?
3. Is it possible to engage trucks in a three vehicle platoon on an extended highway segment to achieve a string stable CACC design?
4. Is it possible to achieve lane change/merge for freeway lateral maneuvers using automation?

Scope: In this MOU, the FHWA-TFHRC will conduct the necessary research to conduct demonstration tests along 95 and 495 Express Lanes in Virginia that will allow FHWA to assess the potential of connected vehicle technology to address the following research questions:

1. Test and assess the performance of CACC for passenger cars considering all aspects including vehicle-to-vehicle and vehicle-to-infrastructure communications, algorithms and roadway features under a managed lanes condition. It is proposed that the initial testing be performed when the facility is closed with subsequent testing under light traffic conditions. The specific time and manner for testing will be one that is mutually agreeable to all parties.
2. Test and assess the performance of Speed Harmonization for passenger cars considering all aspects including vehicle-to-vehicle and vehicle-to-infrastructure communications, algorithms and roadway features under a managed lanes condition. It is proposed that the initial testing be performed when the facility is closed with subsequent testing under light traffic conditions. The specific time and manner for testing will be one that is mutually agreeable to all parties.
3. Test and assess the performance of CACC for trucks using platooning for three trucks considering all aspects including vehicle-to-vehicle and vehicle-to-infrastructure communications, algorithms and roadway features under a managed lanes condition. It is proposed that the initial testing be performed when the facility is closed with subsequent testing under light traffic conditions. The specific time and manner for testing will be one that is mutually agreeable to all parties.

4. Test and assess the performance of lane change/merge of freeway lateral maneuvers considering all aspects including vehicle-to-vehicle and vehicle-to-infrastructure communications, algorithms and roadway features under a managed lanes condition. It is proposed that the initial testing be performed when the facility is closed with subsequent testing under light traffic conditions. The specific time and manner for testing will be one that is mutually agreeable to all parties.

COLLABORATING PARTIES' considerable expertise and resources with regard to operating and managing vehicles under managed lanes conditions will be utilized to achieve the above objectives.

### Meetings

Meetings will be scheduled between FHWA-TFHRC and COLLABORATING PARTIES as needed at times and locations mutually acceptable to COLLABORATING PARTIES and FHWA-TFHRC.

### Deliverables

For each technology test – a report describing the technology, testing and results in addressing the technical objectives will be delivered to each signatory to the MOU.

### Contact with FHWA-TFHRC

All work will be coordinated by the FHWA-TFHRC's principal investigator.

## **II. RESPONSIBILITIES OF FHWA-TFHRC**

FHWA will provide the test-vehicles, vehicle based sensors and radios, infrastructure based radios and sensors, drivers to conduct the demonstration and all associated communication hardware and software necessary to perform and acquire the data during the testing.

At least 10 days prior to conducting any test on the 95 and 495 Express lanes in Virginia, FHWA will provide for review by VDOT a testing plan to VDOT and Capital Beltway Express LLC/95 Express Lanes LLC (VDOT and Capital Beltway Express LLC/95 Express Lanes LLC are the COLLABORATING PARTIES for purposes of this agreement), with the goal of establishing acceptable dates, times, and locations for testing. VDOT reserves the right to reject any testing plan if the testing plans dates, times, and locations conflict with VDOT requirements.

Prior to testing, FHWA will install any infrastructure based equipment (with any protocols determined by the parties). After testing, FHWA will remove any infrastructure based equipment.

FHWA will be responsible for liability for damage resulting from negligent or wrongful acts

or omissions of its employees acting within the scope of their official duties, including conducting the research described in this agreement.

FHWA will ensure that any contractor acting on behalf of FHWA in performance of the research described in this agreement maintains vehicular or water craft damage (collision and comprehensive), liability, and general public liability insurance with limits of liability for:

- (1) Bodily Injury of not less than \$1,000,000 for each person and \$2,000,000 for each occurrence; and
- (2) Property damage of not less than \$200,000 for each accident.

FHWA will ensure that any contractor acting on behalf of FHWA in performance of the research described in this agreement shall list both FHWA and VDOT as Additional Insured Parties of any policy obtained under the contract with such contractor as required by this agreement. FHWA will provide a current copy of the policy to VDOT prior to testing.

### **III. OBLIGATIONS OF COLLABORATING PARTIES**

COLLABORATING PARTIES will provide access to the 95 and 495 Express lanes in Virginia and provide technical direction to conduct the demonstration in a safe manner including safety training if necessary. The COLLABORATING PARTIES will also provide explicit guidelines on the timing windows available for accessing the facilities for testing and any other terms or conditions of use of the facilities. VDOT will provide review of all testing plans submitted by FHWA with the goal of establishing acceptable dates, times, and locations for testing.

The COLLABORATING PARTIES will notify and provide instructions if any escort vehicles need to be followed during the testing.

The COLLABORATING PARTIES will provide escort vehicles if necessary.

The COLLABORATING PARTIES will provide FHWA with reasonable access to property to install equipment in advance of testing and reasonable access after testing to remove equipment.

The provisions of this section require VDOT to provide only access to VDOT owned highway assets. No provisions require VDOT to assume financial responsibility neither for any testing performed under this agreement nor for any equipment required to perform such testing.