



TRANSPORTATION TECHNOLOGY STRATEGIC PLAN

NVTA Transportation Technology Strategic Plan

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List of Acronyms

ADAS	Advanced Driver Assistance Systems
AEB	Automatic Emergency Braking
AI	Artificial Intelligence
API	Application Program Interface
ATE	Automated Traffic Enforcement
AV	Autonomous Vehicle
BRT	Bus Rapid Transit
CAFE standards	Corporate Average Fuel Economy standards
CASE	Connected, Autonomous, Shared and Electric Vehicles
CAV	Connected and Autonomous Vehicles
C-V2X	Cellular Vehicle to Everything
DSRC	Dedicated Short Range Communications
DRT	Demand Responsive Transit
FMLM	First-Mile/Last-Mile
EV	Electric Vehicle
GHG	Greenhouse Gas
GPS	Global Positioning System
HAV	Highly Autonomous Vehicles
IOO	Infrastructure Owner Operator
IOT	Internet Of Things
ITS	Intelligent Transportation System
LiDAR	Light Detection and Ranging
MaaS	Mobility as a Service
ML	Machine Learning
NVTA	Northern Virginia Transportation Authority
OEM	Original Equipment Manufacturer
PDP-BRT	Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia
PMT	Person Miles Traveled
RM3P	Regional Multi-Modal Mobility Program
RSU	Road-Side Units
SMD	Shared Mobility Device
TDM	Transportation Demand Management
TDS	Transactional Data Specifications
TNC	Transportation Network Company
TSP	Transit Signal Priority
TTC	Transportation Technology Committee
TTSP	Transportation Technology Strategic Plan
V2G	Vehicle to Grid
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to Everything
VMT	Vehicle Miles Traveled
VR	Virtual Reality
ZOV	Zero Occupancy Vehicles
ZOV-p	Zero Occupancy passenger Vehicles

NVTA Transportation Technology Strategic Plan

Executive Summary

Executive Summary

The Transportation Technology Strategic Plan (TTSP) is a first-of-a-kind initiative to take such a comprehensive and multimodal position on how transportation technology can be leveraged to support the NVTA's vision for the NoVA transportation system in the coming years. This proactive initiative has also been integrated with TransAction, the long-range transportation plan for Northern Virginia¹, the most recent update to which was adopted in December 2022. As part of TransAction, the TTSP is now informing an update to the project selection process for Six Year Program updates. In addition, the TTSP supported the addition of a new priority to "Support use of effective transportation technology" into NVTA's Legislative Program in 2022², which has since been continued and expanded³. The associated Action Plan has also guided development of technology-related outreach/education and may inform future regional transportation policy guidance.

The TTSP is comprised of a series of strategies that have each been evaluated in terms of NVTA's three core values; **Equity, Safety, and Sustainability**. (More information about the Core Values and their application can be found in [Chapter 1.2](#), and in the "Application of Core Goals" section for each of the strategies in [Chapter 3](#).)

The TTSP:

- Is a resource that will inform a proactive approach to adoption of transportation technology;
- Considers how transportation technologies support the region's vision, i.e. needs-driven NOT technology-driven;
- Is a living document that will be updated as transportation technologies evolve;
- Includes an Action Plan that enables NVTA to think big, start small, and build momentum with respect to adoption of transportation technologies in the region.

The inaugural eight strategies and nine NVTA roles were identified and defined with the guidance of the Chief Executive Officer's (CEO) Transportation Technology Committee (TTC), and subsequently reviewed and vetted by NVTA's Statutory Committees (Planning Coordination Advisory Committee and Technical Advisory Committee) and the Planning and Programming Committee (an NVTA Standing Committee). Development of additional strategies or other major updates to the TTSP, including this current version, were guided by the TTC and approved by the Authority as a whole.

The strategies are listed below (please note that these are in no particular order and their numbering does not reflect prioritization or timing):

¹ <https://thenovaauthority.org/planning/process/>

² <https://thenovaauthority.org/wp-content/uploads/2022/05/Northern-Virginia-Transportation-Authority-NVTA-2022-Legislative-Program-1.pdf>

³ <https://thenovaauthority.org/wp-content/uploads/2023/01/2023-Legislative-Priorities.pdf>

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Strategies		Intent of Strategy (long term)
1	Reduce congestion and increase throughput	Support deployment of transportation technologies that improve performance and optimize efficiency of the regional multimodal transportation system
2	Maximize access to jobs, employees and housing	Support deployment of transportation technologies that increase travel options and awareness of them
3	Maximize cybersecurity and privacy for members of the public	Monitor concerns on behalf of Northern Virginians, and leverage NVTA processes where appropriate and feasible
4	Enhance operations of the multimodal transportation system through connectivity and automation	To maximize the potential benefits of Connected and Automated Vehicles, while addressing avoidable increases in passenger vehicle miles traveled.
5	Develop pricing mechanisms that manage travel demand and provide sustainable travel options	Identify technology-related measures at a regional scale to dynamically address congestion, including incentives; revenues will be re-invested in equitable solutions
6	Maximize the potential of physical and communication infrastructure to serve existing and emerging modes	Support adaptation of existing resources to support desirable technologies such as CASE vehicles, travel apps, micro modes and robust data collection
7	Enhance regional coordination and encourage interoperability in the transportation system	Leverage regional synergies in the deployment of transportation technologies
8	Advance decarbonization of the transportation system	Support deployment of transportation technologies that reduce greenhouse gas emissions and synergistic technologies that improve resiliency.
9	Enhance mobility in the region through innovation and emerging technologies in transit	Support an array of transit innovations, in a manner that is flexible enough to adapt to future innovation.

Table 1 - Strategy Intentions

To best accommodate the current observed pace of innovation, the strategies provide a high-level overview of their respective topics and strive to incorporate flexibility into the possible NVTA roles proposed to address them.

Descriptions of the roles can be found in [Chapter 1.4](#).

Strategy		NVTA Roles								
		Authority Roles			Shared Roles			Staff Roles		
Number	Name	Funding	Policy	Advocate	Champion	Facilitate	Stakeholder	Planning	Outreach/ Education	Observer
1	Reduce congestion and increase throughput	✓		✓	✓	✓		✓	✓	
2	Maximize access to jobs, employees and housing	✓			✓	✓		✓	✓	
3	Maximize cybersecurity and privacy for members of the public	✓					✓			✓
4	Enhance operations of the multimodal transportation system through connectivity and automation		✓	✓	✓	✓		✓	✓	
5	Develop pricing mechanisms that manage travel demand and provide sustainable travel options		✓	✓			✓	✓	✓	
6	Maximize the potential of physical and communication infrastructure to serve existing and emerging modes	✓			✓	✓		✓	✓	
7	Enhance regional coordination and encourage interoperability in the transportation system	✓			✓	✓		✓	✓	
8	Advance decarbonization of the transportation system	✓	✓	✓	✓	✓		✓	✓	
9	Enhance mobility in the region through innovation and emerging technologies in transit	✓		✓	✓	✓		✓	✓	

Table 2 - Strategies Mapped to NVTA Roles

The scope of innovation demands similar careful consideration and treatment, so the TTSP will focus on topics that are directly and feasibly applicable to the context of Northern Virginia and are supported by the Authority. Additionally, the strategies will not duplicate other mature efforts in the region (such as fare payment technologies, variable priced tolls on freeways or ride matching). However, some innovations, such as dynamic vanpool matching, may be revisited as

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relevant initiatives evolve) and will instead explore novel concepts. See [Chapter 2.1](#) for additional information about related initiatives.

NVTA staff view Strategic Plans as visionary documents, and thus created an Action Plan to help guide measurable and tangible progress towards TTSP objectives.

Actions included in the plan are traceable to at least one of the TTSP strategies and include measure(s) of effectiveness. The plan will also define who will be responsible for an action and when, as identified by trigger points, which may be internal or external (e.g. federal/state legislation or market penetration thresholds.) Typically, NVTA staff will initiate actions, but all actions will rely on the strong coordination and partnerships that are foundational to NVTA's work in the region. Finally, the plan details a process for monitoring, reviewing and updating of the TTSP and its Action Plan.

No significant TTSP changes/additions, as determined by the NVTA CEO, will occur without prior Authority approval. Examples of significant changes include, but are not limited to:

- Changes to the methodology for the project selection process associated with NVTA's Six Year Program
- Changes/additions to NVTA's annual legislative program
- Development of regional transportation policies
- Additions of new strategies or changes to the scope of existing strategies

As NVTA has not previously developed regional transportation policies, any such policies (whether they are in response to the TTSP or any other factor) will first require broad agreement on a collaborative process for policy development. As part of this policy development process, consideration will be given to a prioritized list of potential policy topics. Detailed regional transportation policy development will not commence prior to agreement on both a process and a list of prioritized topics.

As a living document, NVTA staff will revise the TTSP to reflect changing circumstances. The CEO's monthly report to the Authority will outline such changes together with other progress updates such as, but are not limited to:

- Ongoing monitoring of market trends and trigger points
- Development of outreach and education initiatives
- Process and prioritization of white papers related to potential future regional transportation policy

Through this process, the TTSP and its Action Plan aim to achieve the following benefits:

1. Proactive approach will leverage transportation technologies that support NVTA's vision, and mitigate those that do not, through planning, policy, advocacy, funding, and other means;
2. The TTSP informed development of the scenario analysis that was completed as part of TransAction 2045. The results of this analysis will support data driven decision making by the Authority, including project selection in future funding programs. The TTSP will continue to inform the development of future updates to TransAction and Six Year Programs. Consistent approach to NVTA's transportation technology investments will increase synergies and maximize return on investments and taxpayer dollars;
3. Coordinated planning, deployment and operations, especially enabled by secure, real-time information, will enhance multimodal travel choices and contribute to a more seamless travel experience for Northern Virginians;
4. By raising awareness and understanding of transportation technologies, NVTA will inform Northern Virginians about the features, benefits, costs, and appropriateness of deploying such technologies in the region.

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5. Open and regular exchange of ideas between NVTA staff and jurisdiction/agency staff will strengthen the regional approach to transportation technologies.

Log of Changes to this Document

This is the third version of the TTSP to be published publicly. The following changes have been made to the document since it was originally adopted on May 14th, 2020.

- Update 1, April, 2022 – none of these changes were deemed by the NVTA CEO to be significant, and thus no Authority approval was necessary.
 - Necessary updates to projects referenced in [Chapter 2 – Related Initiatives](#).
 - Addition of a Technology Timeline, which can be seen in [section 2.2.1](#).
 - Updates to any references to the NVTA Chief CEO, to reflect a title change. (The previous title for that position was Executive Director.)
 - Any appropriate grammatical corrections.
- Update 2, October, 2022 - none of these changes were deemed by the NVTA CEO to be significant, and thus no Authority approval was necessary.
 - Necessary updates to discussion of the relationship between the TTSP and TransAction, to reflect the successful adoption of updated TransAction goals, which can be seen in [section 1.3.2](#). Corresponding changes were also made in the “Relevant TransAction Goal” section for each strategy in [Chapter 3](#).
 - Any appropriate grammatical corrections.
- Update 3, September, 2023 – this is the first substantive update to the TTSP, comprised of the expansion of scope for two existing strategies and the addition of one new strategy. These changes were [unanimously endorsed by the TTC](#) when they met on July 6th, 2022, and [unanimously adopted by the Authority](#) during their November 10, 2022, meeting.
 - Expansion of the scope of strategy #4 from focusing on minimizing potential negatives, to also maximizing potential benefits, taking a more comprehensive approach to CAVs. The strategy’s title is also updated from “Minimize Potential for Zero Occupancy passenger Vehicles” to “Enhance operations of the multimodal transportation system through connectivity and automation.” Corresponding changes/additions were also made to the Action Plan.
 - Expansion of the scope of strategy #8 to support deployment of transportation technologies that reduce greenhouse gas emissions, such as hydrogen propulsion, and synergetic technologies that improve resiliency, such as Vehicle to Grid (V2G.) Corresponding changes/additions were also made to the Action Plan.
 - Addition of a new strategy #9 to support an array of transit innovations, in a manner that is flexible enough to adapt to future innovation. It will be titled “Enhance mobility in the region through innovation and emerging technologies in transit.” Corresponding changes/additions were also made to the Action Plan.
 - Necessary updates to projects referenced in the Related Initiatives section, which was previously included Chapter 2, but has now been moved to an Appendix.
 - Necessary updates to the Technology Timeline, which can be seen in section 2.2.1.
 - Addition of Artificial Intelligence (AI) to Emerging Business Models detailed in section 2.2.2. AI was also added to the Technologies and Challenges and Opportunities tables, List of Acronyms, and Glossary.

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- Addition of a new table that details technology-related projects that have received HD2313 30% funds and necessary introductory text.
- Updates to the Action Plan, to reflect the passage of time and progress made.
- Updates to section 4.2.1 which describes the impacts of Covid-19.
- Any necessary updates to the List of Acronyms, and Glossary.
- Any appropriate grammatical corrections.
- Other tweaks or rephrasing throughout the document, as appropriate. These are not substantive and do not change the overall direction or intention of any portion of the TTSP.
- Update 21, May 2024 - none of these changes were deemed by the NVTA CEO to be significant, and thus no Authority approval was necessary.
 - Any formatting for listed items, punctuation, and grammatical corrections.
 - Edits to specific words (e.g. capitalization of “Core Values”)/phrases/font size to maintain global consistency.

Chapter 1 – Introduction

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Overarching Core Values

1.1 Introduction

The TTSP is a first-of-a-kind initiative to take such a comprehensive and multimodal position on how transportation technology can be leveraged to support the NVTA's vision for the NoVA transportation system in the coming years. It is comprised of a series of strategies that have each been evaluated in terms of NVTA's three core values of **Equity, Safety, and Sustainability**. Additionally, the TTSP identifies roles NVTA may undertake to bring these strategies to fruition. This plan seeks to acknowledge the rapid pace and transformative nature of innovation, and to maximize its potential benefits while mitigating any negative impacts. This proactive approach has been integrated with TransAction and supports NVTA's Legislative Program, technology-related outreach/education, and may inform development of regional transportation policy guidance.

1.1.1 Purpose and Scope

In 2019, the CEO of the NVTA, established a Transportation Technology Committee⁴ (TTC.) The TTC is tasked with keeping the CEO and the Authority apprised of transportation trends, making recommendations for related actions, and establishing a body of knowledge to inform regional transportation policy. Towards these ends, the Committee worked closely with NVTA staff to develop a Transportation Technology Strategic Plan (TTSP.)

It identifies a series of strategies that focus on mobility, accessibility, and resilience, while embracing NVTA's Core values of Equity, Safety, and Sustainability. The strategies are supplemented by an Action Plan, comprised of clearly defined roles, but this alone will not be sufficient to achieve the desired outcomes. This will require a broad coalition of support among jurisdictions, transit agencies, other regional partners, and stakeholders. NVTA is uniquely positioned to build these relationships and values opportunities to share best practices with others.

The TTSP will be agnostic to types of technologies (and manufacturers), seeking instead to provide a framework for leveraging innovation to meet existing and identified regional needs. The scope of topics considered will be limited to those that meet three criteria:

1. They are relevant to the Northern Virginia context.
2. They are supported by the Northern Virginia Transportation Authority members.
3. They are not already addressed by other modern and mature efforts in the region*.

**Existing legacy systems will not be excluded from consideration by the TTSP, if emerging technologies may improve their functionality and/or better achieve the deliverables/objectives of said legacy systems.*

1.2 Overarching Core Values

These Core Values were derived from NVTA's Vision for TransAction, which was approved by the Authority on December 17th, 2020.

*"Northern Virginia will plan for, and invest in, a **safe, equitable, sustainable**, and integrated multimodal transportation system that enhances quality of life, strengthens the economy, and builds resilience."*

The Core Values have and will continue to guide the development of this plan and its outputs in regard to project selection, policy development and process.

⁴ <https://thenovaaauthority.org/about/committees/transportation-technology-committee-2/>

NVTA Transportation Technology Strategic Plan

Overarching Core Values

Core Values			
	Equity	Safety	Sustainability
NVTA's Definition	An equitable transportation system ensures fairness in mobility and accessibility, to meet the needs of the region and all travelers, particularly underserved populations. (e.g., low-income, minority, elderly, children, women, people with Limited English Proficiency (LEP), people with disabilities.) It facilitates social and economic opportunities through reliable and affordable transportation options. It recognizes past inequities, commits to addressing them when possible, and actively avoids further injustices.	A safe transportation system minimizes fatalities and severe injuries, while increasing safe, healthy, and equitable mobility for all. It also addresses community perceptions of safety.	A sustainable transportation system meets the needs of the present, without compromising the ability of future generations to meet their needs. It considers sustainability to be comprised of three pillars, that focus on economic, environmental, and social impacts, and addresses the interactions between these.
Considerations for transition period	As certain members of our communities have historically been underserved, their needs and preferences should be understood and addressed, especially in terms of equitable access to transportation technologies and the potential benefits that they offer. Additionally, the period of transition to full adoption of a new transportation technology may be particularly challenging for traditionally underserved populations and care must be taken to communicate/educate effectively to/with these groups. It is also critical to ensure that these communities are not further underserved by the integration of technologies, in part by working with them and learning from them.	In all cases of technological transition, the following should be considered, in terms of safety: who will be affected (i.e., users of the technology or everyone? Is there a geographical limit?) Will the safety opportunities associated with the technology be realized during the transition or only after? Is there a chance for reduced safety during the transition? How long will the transition last? Is there an amount of short term, increased risk that is tolerable, to gain the ultimate improvement in safety? Are the motivations for adopting this technology worth any/all potential risks?	During transition periods, it will be important to evaluate if the espoused sustainability benefits of a technology are realized with actual use patterns and if these impacts will change with rates of adoption.

Table 3 - Core Values

Public input was sought on how to best apply these Core Values, in the context of the TTSP, through the TransAction public outreach process. Topics addressed in the TTSP will continue to be considered in NVTA public engagement processes, including but not limited to recurring perception surveys and public comment periods for Six Year Program updates, as appropriate.

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1.3 Vision and Goals

1.3.1 Vision

On December 17th, 2020⁵, the NVTA unanimously voted to approve a revised vision statement for the update to TransAction, the long-range transportation plan for Northern Virginia. The TTSP will commit to and seek to contribute towards the manifestation of the same vision statement, in harmony with TransAction.

“Northern Virginia will plan for, and invest in, a safe, equitable, sustainable, and integrated multimodal transportation system that enhances quality of life, strengthens the economy, and builds resilience.”

1.3.2 Goals

Three Goals have been identified for TransAction going forward.⁶ The strategies included in the TTSP have been mapped to these Goals (see Table 4), to ensure the Plans are well aligned and synergistic.

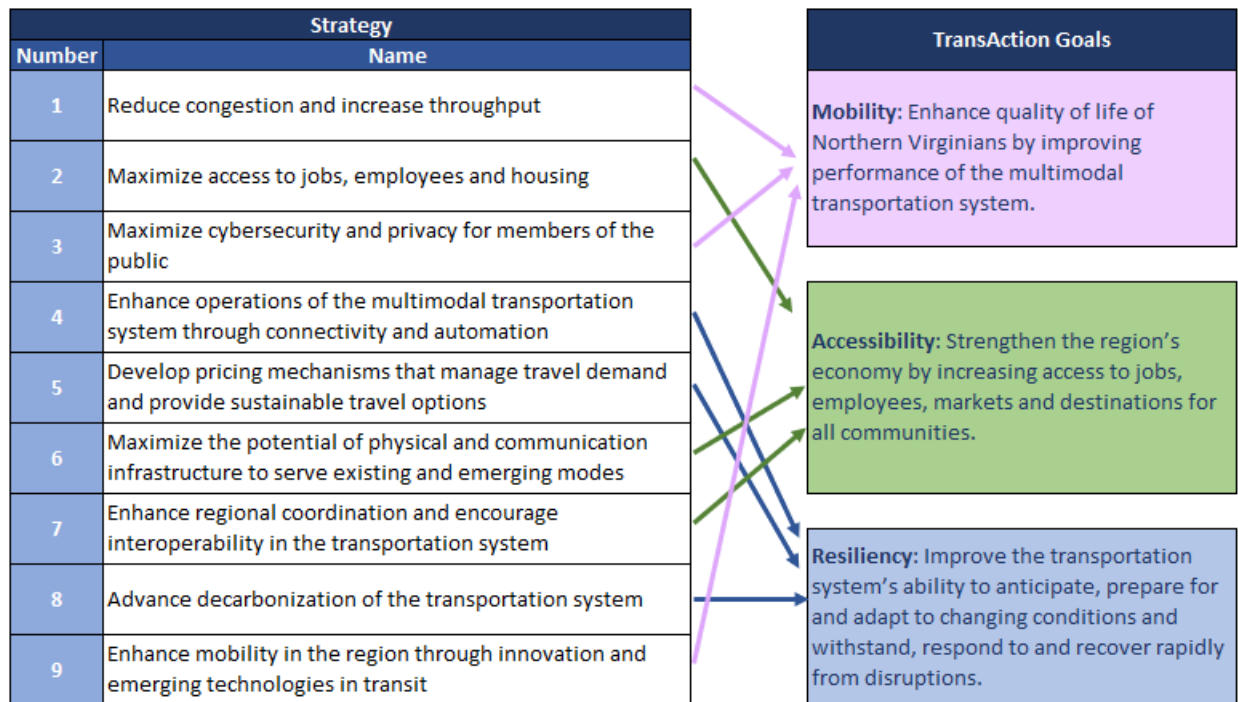


Table 4 - Mapping TTSP Strategies to TransAction Goals

⁵ <https://mailchi.mp/74a677f9f821/authority-meeting-highlights-december-2020?e=820d128a71>

⁶ https://nvtatransaction.org/wp-content/uploads/2022/07/DR2_NVTA_TransActn_Summary-Report_July2022_Final.pdf#page=4

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1.4 NVTA Roles

This document considers the term “The Authority” to refer to NVTA’s governing body which is comprised of seventeen elected or appointed members representing Planning District 8.⁷ The term “staff” generally refers to NVTA’s own staff, unless otherwise specified.

NVTA Roles	Authority Roles	Funding	There are two ways in which the Authority could further the TTSP through funding. First, the plan's strategies could be incorporated as factors for consideration in funding decisions, either as a top-down entry category in the TransAction project list and/or as a qualitative factor in evaluating funding applications through the Six Year Program process. Second, the Authority may consider making funding of projects contingent on the inclusion of physical components (i.e., communications cabinets) or use of specifications (data requirements or software types) that support TTSP strategies. Learn more about NVTA’s planning and programming process in this FAQ document.
		Policy	The Authority may develop and adopt regional transportation policies that encourage and/or support its member jurisdictions in contributing to a regionally consistent approach to deployment of transportation technologies. Examples of such policies include those that encourage consistent pricing schemas and payment options for EV charging, as well as interoperable charging infrastructure. Other policies could support the deployment of transit (particularly electric, demand-responsive micro transit) in areas that are accessible by other modes or discourage Zero Occupancy passenger Vehicle (ZOV-p) trips/miles.
		Advocate	The Authority may express support for TTSP-related positions that may either require or benefit from legislative action at the state or federal level. For example, the Authority introduced a new position in its 2022 Legislative Program titled “Support use of effective transportation technology” and has since included it in subsequent Legislative Programs . It could also take other action to advocate for said positions. Examples of this could include support for regulation of Zero Occupancy Miles traveled or privacy requirements in regard to big data collection to support adoption of Autonomous Vehicles (AVs.)
	Shared Roles	Champion	Both Authority members and NVTA staff may champion TTSP strategies. This could take the form of discussions, letters of support or participation in regional or statewide initiatives that align with the TTSP. No suggestion of a Champion role indicates a guarantee or mandate on behalf of NVTA or any member jurisdiction.
		Facilitate	Authority members and NVTA staff can facilitate manifestation of TTSP strategies through expressions of support, provision of technical assistance or even the creation/maintenance of centralized databases and research that member jurisdictions can leverage in justifying projects and/or securing funding from external sources.
		Stakeholder	Members of the Authority and/or NVTA staff may represent the region, if called upon to advise the Commonwealth on its related initiative(s.) Additionally, staff may support member jurisdictions, or other entities and agencies, in developing relevant initiatives/policies by serving on stakeholder committees or provision of technical assistance.

⁷ <https://thenovaauthority.org/about/membership/>

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Staff Roles	Planning	All TTSP strategies and core values map directly to TransAction, which is one of NVTA's statutory requirements and primary responsibilities. The TTSP has and will be used to further inform/develop existing planning efforts and may contribute to the development of the TransAction project list and/or associated scenario-planning exercises. It will also inform future NVTA planning initiatives such as the Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT.) ⁸
	Outreach/ Education	NVTA staff should stay abreast of developments in various transportation technologies and use the knowledge to inform the CEO, the Authority, and relevant committees. Additionally, staff will continue efforts to education and inform stakeholders and members of the public about innovations in transportation technologies, through initiatives like the Dirven By InNoVation newsletters.
	Observer	In regard to some innovations and their impacts, there may not be significant opportunities for direct action, given NVTA's position as a regional planning and programming entity, and/or due to the stage of development of the associated technologies. Despite this, some TTSP strategies may be affected by these innovations and/or would be impacted in the case of substantial progress. In these contexts, it will be important for NVTA staff to carefully observe and monitor progress.

Table 5 - NVTA Roles

⁸ <https://thenovaauthority.org/about/business-opportunities/>

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NVTA Transportation Technology Strategic Plan

NVTA Funded Projects

2.1 NVTA Funded Projects

On April 3, 2013, the Virginia General Assembly approved the final version of House Bill 2313 (HB 2313)[1]. This legislation established a dedicated, sustainable funding stream for transportation projects in Northern Virginia. HB 2313 separated these funds into “70% Regional Revenue,” which is allocated by the Authority for regional transportation projects; and “30% Local Distribution Revenue,” which is distributed to jurisdictions for their transportation projects and purposes. The 30% Local Distribution Revenue funds are distributed to the member localities on a pro-rata basis, if they meet certain criteria set forth in HB 2313. Starting in July 2013, the Authority has programmed the 70% Regional Revenues based on the vision and projects outlined in the prevailing version of TransAction.

2.1.1 70% Regional Revenue Funds

The Northern Virginia Transportation Authority (NVTA) has supported innovation since its inception, as demonstrated through inclusion of technology-related project(s) in each of its funding programs. Table 6 provides details about document projects to which this funding had been allocated to and through the FY2022-2027 program. Real-time information and additional details about these (and other NVTA funded projects) can be found on the [NoVA Gateway platform](#).

Tech. Focus	Project Title	Project Sponsor	Program		Other Mode(s)	Description	Total Project Cost	NVTA funded Portion	
			Year Adopted	Funding Cycle				Per project	Total
Primary	Glebe Road Corridor ITS Improvements	Arlington County	2015	2015-16	N/A	Design and construction of Intelligent Transportation System (ITS) and Adaptive Traffic Control System, including various other ITS features.	\$ 2,000,000.00	\$ 2,000,000.00	\$ 19,695,491.00
	Lee Highway Corridor ITS Enhancements	Arlington County	2016	2017	N/A	Address regional and local mobility constraints by installing an Intelligent Transportation System and corresponding Adaptive Traffic Control System program components. The project will install additional Bluetooth devices, count stations, CCTV cameras, and Forward Looking Infrared (FLIR) detectors in order to monitor traffic flow and safety of all modes. At the interchange of Lee Highway and I- 66, the project will upgrade two signals, providing a better-timed connection between I-66 and Lee Highway. The project will also upgrade existing mast arm signals and add or improve existing street lights along Lee Highway.	\$ 3,000,000.00	\$ 3,000,000.00	
	Intelligent Transportation System Improvements	Arlington County	2018	2018-23	Bus, Bike and Pedestrian	Install transit signal priority, ATMS, adaptive signal optimization, Bluetooth devices, count stations, CCTV cameras, FLIR detectors, etc. to improve overall congestion, transit performance, and facilitate future CAVs. Locations include Washington Blvd (Glebe Rd to Columbia Pike), Crystal City/Pentagon City streets, Columbia Pike (Carlin Springs Rd to Southgate Rd).	\$ 10,000,000.00	\$ 10,000,000.00	
	Duke Street Transit Signal Priority Installation	City of Alexandria	2015	2015-16	N/A	Implement traffic signal updates, Transit Signal Priority (TSP), and queue jumps on the Duke Street corridor	\$ 850,000.00	\$ 850,000.00	
	Alexandria ITS Projects	City of Alexandria	2018	2018-23	Bus	Install/enhance transit vehicle signal priority systems on King St (Dawes Avenue to Quaker Lane) and Duke Street (Walker Street to Telegraph Road).	\$ 1,195,491.00	\$ 1,195,491.00	
	Alexandria Bus Network ITS	City of Alexandria	2018	2018-23	Bus	Upgrade real-time passenger and in-house information capabilities for DASH. Implement Mobile CAD application for DASH that will allow field supervisors and the public real-time bus arrival information on electronic devices and SMS text messages. It will also provide five real-time information signages.	\$ 150,000.00	\$ 150,000.00	
	Loudoun County - Route 7 Corridor ITS Implementation Program	Loudoun County	2022	2022-27		A series of technology projects designed to improve traffic operations and provide information to travelers. These include integration with Waze's Connected Citizen program; additional camera coverage; portable message signs; road condition monitoring; real-time traffic signal management and AC shuttle circulator service.	\$ 3,777,000.00	\$ 2,500,000.00	
Secondary	Route 1 Widening - Mount Vernon Memorial Highway to Napper Road	Fairfax County	2015/ 2018/ 2020	2015-16 / 2018-23 / 2020-25	Roadway, Bus, Bike and Pedestrian	Widen from 4 to 6 lanes and provide multimodal improvements between Jeff Todd Way and Sherwood Hall Lane	\$ 372,000,000.00	\$ 128,000,000.00	<i>This total is not calculated for projects in which technology is a secondary mode because of the difficulties of determining which portion of the funds</i>
	Richmond Highway Bus Rapid Transit	Fairfax County	2018	2018-23	Bus, Bike and Pedestrian	Median running BRT from Huntington Metro station to Fort Belvoir with new transit stations and improved bike/ped facilities.	\$ 730,000,000.00	\$ 250,000,000.00	

NVTA Transportation Technology Strategic Plan

NVTA Funded Projects

Tech. Focus	Project Title	Project Sponsor	Program		Other Mode(s)	Description	Total Project Cost	NVTA funded Portion	
			Year Adopted	Funding Cycle				Per project	Total
	Shelters and RTI for DASH/WMATA	City of Alexandria	2013	2014	Bus	Construct bus shelters and provide associated amenities such as real time information at high ridership stops.	\$ 2,649,478.00	\$ 450,000.00	<i>are either completely or partially dedicated to the technology components.</i>
	Alexandria Duke St Transitway	City of Alexandria	2018/2020	2018-23 / 2020-25	Bus, Bike and Pedestrian	Provide dedicated curb-side transit and business access lanes for BRT service between Diagonal Road (King Street Metro) and Walker Street (Landmark Mall).	\$ 114,800,000.00	\$ 12,000,000.00	
	DASH Transit Service Enhancements and Expansion	City of Alexandria	2018	2018-23	Bus	Install infrastructures for electric buses, to support a complete fleet of electric/Zero Emission Vehicle (ZEV) buses for DASH.	\$ 23,068,161.00	\$ 11,933,161.00	
	8 New Battery Electric Buses - Fairfax Connector Buses for Tysons to Franconia Service	Fairfax County	2022	2022-27	Bus	Capital funding to purchase eight (8) Zero Emission Vehicle (ZEV) battery electric transit buses to support limited stop peak hour bus service connecting Tysons, Dunn Loring and Franconia-Springfield.	\$ 10,000,000.00	\$ 10,000,000.00	

Table 6 - NVTA Funded Projects

2.1.2 30% Local Distribution revenue Funds

As of August 2023, jurisdictions have allocated portions of this funding to the technology-related projects described in Table 7. More information about these and other projects funded with 30% Local Distribution Revenues can be found in [NVTA’s Annual Report to the Joint Commission on Transportation Accountability](#).

Project Title	Project Sponsor	30% Local Funds Allocated	Total
Intelligent Transportation Systems (includes TMC and CCTV upgrades)	Arlington	\$ 3,688,804	\$ 14,842,155
Traffic Signal Rebuilds, Infrastructure Upgrades, Facilities (multiple locations)	Arlington	\$ 4,194,208	
Transit ITS and Planning (Includes TSP)	Arlington	\$ 3,152,864	
Traffic Signal Preemption	City of Fairfax	\$ 405,060	
Emergency Power Battery Backup	City of Fairfax	\$ 93,067	
Traffic Signal Upgrades	City of Fairfax	\$ 35,214	
Downtown Electronic Parking Signage	City of Fairfax	\$ 170	
N Wash & Columbia Signal & Intersection Improvements	City of Falls Church	\$ 288,517	
N West & Great Falls Signal	City of Falls Church	\$ 75,000	
Infrastructure Programs - Signals- S Maple Ave and W Annandale Rd Signal	City of Falls Church	\$ 679,051	
Streetlight LED Conversion	City of Falls Church	\$ 180,000	
Traffic Signal Coord & Upgrades (Citywide)	City of Manassas	\$ 500,000	
Traffic Signal Upgrades	City of Manassas Park	\$ 11,500	
Traffic Signal Uninterruptable Power Supply (UPS) for Town Arterial Roadways	Town of Herndon	\$ 350,000	
Traffic Management System/Emergency Evacuation System (Townwide)	Town of Leesburg	\$ 908,700	
Traffic Signal - Sycolin Rd & Gateway Dr	Town of Leesburg	\$ 280,000	

Table 7 - Projects supported by NVTA 30% funding

NVTA Transportation Technology Strategic Plan

Transportation Technology Timeline and Trends

2.2 Transportation Technology Timeline and Trends

2.2.1 Technology Timeline

Below is a timeline of major milestones in the history of NVTa and recent transportation technology developments. It is meant to be illustrative only and is in no way a comprehensive overview of technology.

Year	NVTa History		Technology Milestones	
	Event	Source	Event	Source
2002	NVTa was created by the Virginia General Assembly.	https://thenovaauthority.org/legislation/		
2003			MySpace is launched.	https://www.britannica.com/topic/Myspace
2004			First DARPA Grand Challenge (This event is largely credited as the impetus for serious pursuit of Autonomous Vehicle technology.)	https://www.darpa.mil/news-events/2014-03-13
			Facebook is launched.	https://www.britannica.com/topic/Facebook
2005			Second DARPA Grand Challenge.	https://www.darpa.mil/news-events/2014-03-13
			YouTube launched.	https://www.britannica.com/topic/YouTube
			Amazon Prime debuted.	https://money.cnn.com/2018/04/28/technology/amazon-prime-timeline/index.html
2006	TransAction 2030 was adopted.	https://thenovaauthority.org/planning/long-range-transportation/transaction-2030/	"Google" was added to the dictionary as a verb.	https://www.nbcbnews.com/technology/no-googling-says-google-unless-you-really-mean-it-1c9078566
2007			DARPA's Urban Challenge.	https://www.darpa.mil/news-events/2014-03-13
			Twitter launched.	https://www.britannica.com/topic/Twitter
			Amazon launched the Kindle e-reader.	https://www.aboutamazon.com/news/devices/a-look-back-at-10-years-of-the-amazon-kindle
			Apple popularized touchscreen technology through the iPhone 1, revolutionizing smartphones.	https://time.com/4837176/iphone-10th-anniversary/
2009			Google began private testing of autonomous vehicle technology.	https://www.businessinsider.com/google-driverless-car-history-photos-2016-10
			Bitcoin launched, using blockchain technology.	https://www.investopedia.com/terms/b/blockchain.asp
2010			Inaugural test flight of SpaceX's Falcon 9 project.	https://www.popularmechanics.com/space/rockets/q32758515/falcon-9-anniversary/
			Arlington County and DDOT launch Capital Bikeshare.	https://www.capitalbikeshare.com/press-kit

NVTA Transportation Technology Strategic Plan Transportation Technology Timeline and Trends				
Year	NVTA History		Technology Milestones	
	Event	Source	Event	Source
2012	TransAction 2040 was adopted.	https://thenovaauthority.org/planning/long-range-transportation/transaction-2040/		
2013	NVTA revenue stream began.	https://thenovaauthority.org/funding/	Zoom launched webinar platform.	https://www.computerworld.com/article/3570623/the-zoom-meeting-app-explained-understanding-and-using-the-popular-video-chat-software.html
	NVTA adopted the FY2014 Program which included two technology-related project(s): Shelters and RTI for DASH/WMATA	https://thenovaauthority.org/funded-projects/		
2014		-	Amazon introduced Alexa.	https://fortune.com/2019/11/06/amazon-alexa-echo-5-anniversary-dave-limp-interview/
			Virginia and TNCs (Uber, Lyft, etc.) reached an agreement on regulatory framework.	https://www.washingtonpost.com/news/dr-gridlock/wp/2014/08/06/virginia-reaches-deal-with-uber-lyft-to-allow-services-to-operate-in-the-state/
2015	NVTA adopted the FY2015-2016 Program which included three technology-related project(s): - Glebe Road Corridor ITS Improvements - Duke Street Transit Signal Priority Installation - Route 1 Widening - Mount Vernon Memorial Highway to Napper Road	https://thenovaauthority.org/funded-projects/		-
2016	NVTA holds its inaugural Northern Virginia Transportation Roundtable.	https://thenovaauthority.org/meetings-events/northern-virginia-transportation-roundtable/	USDOT published their Federal Automated Vehicles Policy.	https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016
	NVTA adopted the FY2017 Program which included one technology-related project: Lee Highway Corridor ITS Enhancements	https://thenovaauthority.org/funded-projects/		
2017	TransAction update adopted.	https://thenovaauthority.org/planning/long-range-transportation/transaction-2040-update/	Apple App Store reached 2.2 million apps.	https://www.statista.com/statistics/263795/number-of-available-apps-in-the-apple-app-store/
			The state of Massachusetts made an early attempt at regulating ZOVs with fees.	https://www.lwellsun.com/2017/01/23/new-bill-creates-framework-for-electric-self-driving-cars/
	NVTA’s 5-Year Strategic Plan adopted.	https://thenovaauthority.org/about/five-year-strategic-plan/	Internal Combustion Engine (ICE) vehicles hit peak global sales.	https://about.bnef.com/electric-vehicle-outlook/

NVTA Transportation Technology Strategic Plan Transportation Technology Timeline and Trends				
Year	NVTA History		Technology Milestones	
	Event	Source	Event	Source
2018	NVTA adopted the FY2018-2023 Six Year Program which included seven technology-related project(s):• Intelligent Transportation System Improvements• Alexandria ITS Projects• Alexandria Bus Network ITS• Route 1 Widening - Mount Vernon Memorial Highway to Napper Road• Richmond Highway Bus Rapid Transit• Alexandria Duke St Transitway• DASH Transit Service Enhancements and Expansion	https://thenovaauthority.org/funded-projects/	Amazon selected NYC and Arlington County for locations of HQ2.	
2019	The NVTA CEO established a Transportation Technology Committee.	https://thenovaauthority.org/transportation-technology/	The first commercial drone delivery took place in Christiansburg, VA.	
2020	On December 17th, 2020, the Northern Virginia Transportation Authority unanimously voted to approve a revised vision statement for the forthcoming update to TransAction, the long-range transportation plan for Northern Virginia.	https://mailchi.mp/74a677f9f821/authority-meeting-highlights-december-2020?e=820d128a71	The Federal government granted its first driverless car exemption.	https://www.theverge.com/2020/2/6/21125358/nuro-self-driving-delivery-robot-r2-fmvss-exemption
			Amazon ordered 100,000 electric delivery vehicles.	https://www.businessinsider.com/amazon-creating-fleet-of-electric-delivery-vehicles-rivian-2020-2
			Virgin Hyperloop completed first manned pilot test.	https://www.theverge.com/2020/11/8/21553014/virgin-hyperloop-first-human-test-speed-pod-tube
	NVTA adopted the FY2020-2025 Six Year Program which included two technology-related project(s): • Route 1 Widening - Mount Vernon Memorial Highway to Napper Road • Alexandria Duke St Transitway	https://thenovaauthority.org/funded-projects/	Virginia’s first on-street autonomous transit shuttle pilot began in Mosaic District, Fairfax County. The project concluded, after an extension, in 2023.	https://www.fairfaxcounty.gov/transportation/autonomous-shuttle-pilot
			iPhone 12 launched.	https://www.techradar.com/reviews/iphone-12
			Former VA Governor Northam declares a state of emergency in the Commonwealth of VA due to the potential spread of COVID-19 on March 12, 2020.	https://www.fmcva.dot.gov/emergency/va-governor-northam-3-12-2020-declaration-state-emergency-due-novel-coronavirus-covid-19#:~:text=Therefore%2C%20on%20this%20date%2C%20March,disease%20of%20public%20health%20threat.
			VDOT issued its Connected and Automated Vehicle Program Plan.	https://www.virginiadot.org/programs/resources/cav/2020_VDOT_CAV_Program_Plan_Sept_2020.pdf

NVTA Transportation Technology Strategic Plan Transportation Technology Timeline and Trends				
Year	NVTA History		Technology Milestones	
	Event	Source	Event	Source
2021	On May 13, 2021, the Authority adopted the inaugural NVTA Transportation Technology Strategic Plan’s Action Plan and Eight Strategies within, that focus on mobility, accessibility, and resilience, while embracing the core values of Equity, Safety, and Sustainability.	https://thenovaauthority.org/wp-content/uploads/2021/05/FINAL-Press-Release-TTSP-Strategies-and-Action-Plan-Adoption-5.14.21.pdf	President Biden issued an Executive Order setting a national target for electric vehicles to make up half of U.S. auto sales by 2030.	https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis/
			The Biden-Harris Electric Vehicle Charging Action Plan was released.	https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan/
	A new position to “Support use of effective transportation technology” was introduced into NVTA’s 2022 Legislative Program.	https://thenovaauthority.org/wp-content/uploads/2022/05/Northern-Virginia-Transportation-Authority-NVTA-2022-Legislative-Program-1.pdf	New York required all passenger vehicles sold in state to be emission-free by 2035.	https://thehill.com/policy/energy-environment/571385-hochul-signs-law-requiring-zero-emission-passenger-vehicles-by-2035
			The 2020 General Assembly established the Transit Ridership Incentive Program (TRIP).	https://www.drpt.virginia.gov/studies-and-reports/transit-ridership-incentive-program-fy2022-overview/
2022	NVTA adopted the FY2022-2027 Six Year Program which included two technology-related project(s): - Loudoun County - Route 7 Corridor ITS Implementation Program - Fairfax County - 8 New Battery Electric Buses - Fairfax Connector Buses for Tysons to Franconia Service	https://thenovaauthority.org/fy2022-2027-six-year-program/	TPB adopted CAV Principles.	https://www.mwcog.org/documents/2022/01/20/r8-2022---resolution-to-adopt-cav-principles-for-the-national-capital-region/
			Connected DMV issued the “DMV Hydrogen Greenprint”.	https://www.connecteddmv.org/hydrogen
			NHTSA (National Highway Traffic Safety Administration) issued first occupant protection safety standards for AVs.	https://www.nhtsa.gov/press-releases/nhtsa-finalizes-first-occupant-protection-safety-standards-vehicles-without-driving
	TransAction update adopted.	https://nvtatransaction.org/2022/12/09/northern-virginia-transportation-authority-adopts-northern-virginias-updated-long-range-transportation-plan/	The US Federal Communications Commission (FCC)'s reallocation of a portion of the "safety spectrum" (the 5.9 GHz band) to Wi-Fi use, is upheld by the courts, after protest from US DOT.	https://www.reuters.com/legal/us-court-upholds-fcc-reallocation-auto-safety-spectrum-2022-08-12/
	The position to “Support use of effective transportation technology” was continued into NVTA’s 2023 Legislative Program.	https://thenovaauthority.org/wp-content/uploads/2023/01/2023-Legislative-Priorities.pdf	President Biden invoked Defense Production Act for EV battery production.	https://www.cnbc.com/2022/03/31/biden-to-invoke-defense-production-act-for-ev-battery-materials.html
	NVTA adopted the first substantive updates of the Transportation Technology Strategic Plan, which included the	https://us9.campaign-archive.com/?e=test_email_8u=0865a20f4b7e65b3c6bd75068&id=b752638b0c	The California Air Resources Board (CARB) approved regulation to ban	https://highways.dot.gov/newsroom/historic-step-all-fifty-states-plus-dc-

NVTA Transportation Technology Strategic Plan Transportation Technology Timeline and Trends				
Year	NVTA History		Technology Milestones	
	Event	Source	Event	Source
	expansion of two existing strategies and the addition of one new strategy.		sale of new Internal Combustion Engine (ICE) vehicles by 2035.	and-puerto-rico-greenlit-move-ev-charging-networks
			The Biden-Harris Administration approved NEVI (National Electric Vehicle Infrastructure formula program) plans for all 50 states, D.C and Puerto Rico.	https://www.fhwa.dot.gov/bipartisan-infrastructure-law/nevi_formula_program.cfm
2023	NVTA adopted FY24 budgets, which included a Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT).	https://thenovaauthority.org/about/business-opportunities/	Waymo robotaxis logged 1 million rider-only miles in Los Angeles with a very low amount of collisions and zero reported injuries.	https://electrek.co/2023/02/28/waymo-cruise-1-million-test-miles-will-begin-driverless-rides-los-angeles/
			The Biden-Harris Administration Announced New Standards and Major Progress for a Made-in-America National Network of Electric Vehicle Chargers.	https://www.whitehouse.gov/briefing-room/statements-releases/2023/02/15/fact-sheet-biden-harris-administration-announces-new-standards-and-major-progress-for-a-made-in-america-national-network-of-electric-vehicle-chargers/
			DOT FTA Announced \$1.7B to Modernize Transit Fleets with Low- and No-Emission Buses.	https://www.transit.dot.gov/low-no
			The US Federal Communications Commission (FCC) granted a joint waiver request to deploy cellular Vehicle to Everything (C-V2X) technology on the 5.9 GHz band.	https://www.itsinternational.com/its4/its6/its7/news/fcc-59-ghz-waiver-opens-road-c-v2x-deployment-us
			Several major automakers announced agreements to have their new EVs adopt Tesla's proprietary North American Charging Standard (NACS) plug.	https://www.carranddriver.com/news/a44388939/tesla-nacs-charging-network-compatibility/
			CDC declared the end of the Federal COVID-19 public health emergency on May 11,2023.	https://www.cdc.gov/coronavirus/2019-ncov/your-health/end-of-phe.html
			New York City received approval for a first-in-US congestion tolling initiative.	https://www.bloomberg.com/news/articles/2023-06-26/nyc-congestion-pricing-first-of-its-kind-gets-final-approval?utm_source=website&utm_medium=share&utm_campaign=mobile_web_share

Table 8 - Technology Timeline

NVTA Transportation Technology Strategic Plan

Transportation Technology Timeline and Trends

2.2.2 Overview of Technology Trends

In the early 2020s, there are many new technologies emerging in the field of transportation. They are greatly varied in scale, ranging from improvements to existing systems, to complete revolution. Table 9 - Mapping Technologies to TTSP Strategies, lists a few high-profile examples, to demonstrate the nuance of their potential impacts. However, the pace of innovation makes it nearly impossible to compile an exhaustive list of transportation technologies, and it would be even more difficult to keep such a list current. Additionally, this Plan aims to take a technology agnostic approach to furthering established transportation goals in the region, to ensure that innovation is incorporated into the Northern Virginia network in a manner that addresses need, rather than novelty. For these reasons, this section will explore three overarching trends many technologies are following, at the time of this publication: automation, sharing and electrification.

2.2.2.1 Automation

Automation is often associated with increased speed, reliability, and consistency, and there is hope that many of these benefits can continue to translate into the realm of transportation and contribute to safety improvements as well. Automation of vehicle transmissions, brake systems and headlights have improved vehicle travel in the past, laying the groundwork to automate speed regulation, parking, and even lane position. (Completely autonomous vehicles are a natural but ambitious extension of this concept, which has yet to be achieved, but is increasingly feasible.) Other applications of automation include data transmission to improve system optimization and incident mitigation, or traffic signal management, including Transit Signal Priority.

2.2.2.2 Sharing

There are many manifestations of the notion of sharing, which can pertain to both physical items and intangible assets and can take the form of shared ownership and/or shared use. The early 2000s saw a revolution in sharing vehicles and their capacity, in the form of rideshare services (building on the long-standing precedence of vanpooling) and Transportation Network Companies, or TNCs, and now lessons learned are being adapted to create new, demand-responsive transit options. This type of joint access to/use of vehicles is made possible through the sharing of usage data, location digital transactions and more. Nowhere is the power of technology-enabled sharing more clearly demonstrated than in the case of bikeshare, which was first attempted in the 1960s and experienced several failed iterations before the introduction of electronic payment and tracking options led to its global resurgence.⁹ Further, this evolution has gone on to open doors for sharing other modes, like scooters, and there are no signs of this trend slowing.

2.2.2.3 Electrification

As concerns about the environmental impacts and sustainability of the transportation sector increase in prominence, and demand on the networks compounds the need for efficiency, alternatives to the Internal Combustion Engine (ICE) and traditional energy sources will become increasingly important. One promising option is electric power, and there has been significant progress in its use in private and fleet vehicles in recent years. Efficiencies in battery technology have improved both the capability of the technology, in terms of weight capacity and distance traveled between charges. However, “range anxiety” (the fear that one will run out of charge in an Electric Vehicle, and/or not be able to find a place to charge it) is still a factor for many consumers that needs to be overcome.¹⁰ Despite this, improvements in electric power technology have also made more alternatives to personal vehicles accessible to a larger portion of the population, through things like electric bike and scooter share.¹¹

⁹ <https://www.smartcitiesdive.com/ex/sustainablecitiescollective/amsterdam-beijing-global-evolution-bike-share/1100421/>

¹⁰ <https://newsroom.aaa.com/2020/01/aaa-owning-an-electric-vehicle-is-the-cure-for-most-consumer-concerns/>

¹¹ <https://www.populus.ai/micro-mobility-2018-july>

NVTA Transportation Technology Strategic Plan

Emerging Business Models

2.2.2.4 Artificial Intelligence

AI is a field of technology that encompasses a wide range of techniques and applications, several of which are [already in common use](#). Examples include personalization of news, social media feeds or search engine results; fraud detection in banking; and navigation recommendations based on collection of real-time data on traffic congestion. In fact, NVTA is a Co-Sponsor of the Regional Multi-Modal Mobility Program (RM3P)¹², which includes an AI-based Decision Support System, designed to “help predict the impact of disruptions to the transportation network and provide coordinated response options to agencies.” Each of these are impressive and predicated on incredible innovation, but collectively only scratch the surface off what is possible with AI. In the future it could enable [fundamental shifts in how humans approach everything](#)¹³ from predictive health care treatment, to the onset of “hyperwar” tactics. AI’s ability to advance both healing and destruction is one clear example of why the field of technology cannot be unilaterally described as “good” or “bad” but should be viewed as a powerful tool that must be guided by sound thinking and careful policy.

The most advanced application of AI in transportation currently considered in popular discourse is fully autonomous, or self-driving, vehicles also known as AVs, however AI has the potential to impact nearly every mode of transportation to some extent. There will be many ways in which careful and proactive planning will be critical to the effective integration of this technology.¹⁴ This should include, but is not limited to guiding policy development to avoid repeating or exasperating past injustices or creating new inequities; encouraging and guiding development and use of data sets that adequately address, and allow for analysis of, key planning concepts or measures and community needs; and maximizing opportunities for public engagement with or using these tools.

2.3 Emerging Business Models

The business models used to bring many of the aforementioned trends to fruition evolve as quickly as the technologies themselves and make the point that iteration and innovation go hand in hand. Below are brief descriptions of a few representative emerging business model types, provided with the intention of providing context for the primary content of this Plan, at the time of its publication, and with the understanding that additional models will develop, and may warrant additional consideration, in the future.

- Shift from private vehicle ownership to subscription-based usage
 - Shared/subscription use of vehicles was first seen in car share models, followed by shared bikes and scooters. Car sharing services had been experiencing a decline in use, but have recently been increasing in popularity, due to hesitancy to share spaces (in Transit or TNCs), during/after the Covid-19 pandemic.¹⁵ TNCs, like Uber or Lyft, also create opportunities for individuals to share use of their private vehicles. Once fully Autonomous Vehicles (AV) penetrate the market and achieve public acceptance, there may be possibilities to subscribe to use of an AV, rather than owning one privately.
- The availability of privately owned and operated transit and/or microtransit
 - Technology has made it possible to operate transit (on a small scale) without the historically necessary capital outlay associated with bus route planning and stop facilities, thanks to ride matching/hailing and dynamic route optimization software. These services have the potential to reduce reliance on Single Occupancy Vehicles (SOV), mitigate [transit deserts](#) or address the First-Mile/Last-Mile (FMLM) challenge, but they can act as competition to traditional transit.
- Increased variation in use of curb space and the economic impacts of this
 - The notion of [Curbside Management](#) evolved from new and increasing demands for curb use, resulting from diversification of modes (i.e., [Shared Mobility Devices](#) (SMDs) like bikeshare and scooter share,

¹² <https://rm3pvirginia.org/>

¹³ <https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/>

¹⁴ <https://www.planning.org/publications/document/9263250/>

¹⁵ <https://www.theguardian.com/technology/2020/aug/12/car-sales-covid-19-coronavirus-uber-zipcar>

NVTA Transportation Technology Strategic Plan

Emerging Business Models

etc.), the accelerating demand for delivery services, and use of shared vehicles and rides, which often are bookended by a pick-up/drop-off, rather than parking. This demand creates opportunities to manage, and thus monetize the curb, and fosters higher rates of turnover near attractors, which may yield additional economic activity.

- Changes in development patterns, in regard to provision of parking or other transportation options
 - Diversification of transportation options (through SMDs, microtransit, ride and vehicle sharing etc.), could allow for more dense development, by reducing demand for parking. That said, propensity towards these travel behavior shifts depends on, among many factors, the willingness of individuals to share space and devices/vehicles, which may have changes after the Covid-19 pandemic. AVs, regardless of ownership, may also require less space for parking, due to their projected ability for more precise movement and removal of the need for space to allow humans to exit the vehicle in a parking facility. However, AVs also may have the potential to increase urban sprawl, by facilitating longer commutes. A recent hypothetical study of the Atlanta metro area used a model to simulate future home location choices in the context of a scenario in which Shared Autonomous Vehicles (SAV) are popular. The study found that while SAVs may not trigger unfettered sprawl, most households would choose to move further from the Central Business District and asserted that “policymakers need to find ways for making the operation of SAVs more attractive in the core urban areas while discouraging PAV ownership. In addition, existing land use regulations can be directed for slowing new development in greenfields and encourage infill development in the urban core (especially to reuse redundant parking lots in the future.)¹⁶

¹⁶ <https://journals.sagepub.com/doi/pdf/10.1177/0739456X18776062>

NVTA Transportation Technology Strategic Plan

Technologies Considered in Planning the TTSP

2.4 Technologies Considered in Planning the TTSP

Strategies		Technologies											
No.	Name	Automated/ Autonomous vehicles	Shared Mobility Devices (SMDs)	Signal technologies	Apps	System optimization	Drones	Changes to delivery and freight systems	Surveillance/ monitoring (including telematics)	Data generation/ collection/ sharing	Improvements to mass transit (including BRT)	Smart technologies/ cities and IoT	Artificial Intelligence (AI)
1	Reduce congestion and increase throughput	●	●	●	●	●	●	●	●	●	●	●	●
2	Maximize access to jobs, employees and housing		●	●	●	●	●	●	●	●	●	●	
3	Maximize cybersecurity and privacy for members of the public	●	●	●	●	●			●	●		●	●
4	Enhance operations of the multimodal transportation system through connectivity and automation	●	●	●	●	●	●	●	●	●	●	●	●
5	Develop pricing mechanisms that manage travel demand and provide sustainable travel options	●	●		●	●	●	●	●	●	●	●	●
6	Maximize the potential of physical and communication infrastructure to serve existing and emerging modes	●	●	●		●	●	●			●	●	
7	Enhance regional coordination and encourage interoperability in the transportation system	●	●	●	●	●	●	●	●	●	●	●	●
8	Advance decarbonization of the transportation system	●	●			●							
9	Enhance mobility in the region through innovation and emerging technologies in transit	●	●	●	●	●			●	●	●	●	

Key					
Will definitely be helpful	Potential to be helpful	Equal potential to be helpful or detrimental	Potential to be detrimental	Likely to be detrimental	Not applicable or Insufficient Information Available
●	●	●	●	●	

Table 9 - Mapping Technologies to TTSP Strategies

NVTA Transportation Technology Strategic Plan

Technologies Considered in Planning the TTSP

2.4.1 Opportunities and Challenges Opportunities and Challenges

	Opportunities						Challenges					
	Reduced reliance on fallible humans	System optimization (reliability, compliance, management)	Reduced congestion	Reduced pollution	Facilitate emergency management	Resiliency and redundancies	Reliance on resource-intensive technology	Transition challenges	Need for cross-jurisdictional coordination	Technologies outpace legislation (certifications, regulations)	Privacy concerns	Cyber security concerns
Automated / Autonomous vehicles												
SMDs												
Signal technologies												
Apps												
System optimization												
Drones												
Changes to delivery and freight systems												
Surveillance/ monitoring (including telematics)												
Data generation/ collection/sharing												
Improvements to mass transit (including BRT)												
Smart technologies/cities and IoT												
Artificial Intelligence (AI)												

Key		
Potential Opportunity	Neutral	Potential Challenge

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NVTA Transportation Technology Strategic Plan

Strategy #1: Reduce Congestion and Increase Throughput

3.1 Strategy #1: Reduce Congestion and Increase Throughput

3.1.1 Description

HB 2313 (2013) codified that NVTA *shall give priority to selecting projects that are expected to provide the greatest congestion reduction relative to the cost of the project.*¹⁷. NVTA has funded nearly \$2.5 billion in multimodal projects since HB 2313 created NVTA's revenue stream beginning on July 1, 2013. However, by 2040 a growing regional economy and population (which has been projected to see 24% growth in population and 37% growth in employment between 2016 and 2040¹⁸), means that significant increases in congestion may still occur, despite an expected decrease in VMT per capita¹⁹. Expanding road capacity creates challenges including the potential for induced demand, however it will likely remain an important option for the region, particularly as it works to improve equitable access to the transportation network. That said, this option should continue to be considered as part of a comprehensive multimodal approach that advances all of NVTA's Core Values of Equity, Safety and Sustainability.

One technique NVTA can leverage in mitigating congestion is to contribute to reducing the ratio between Vehicle Miles Traveled (VMT) and Person Miles Traveled (PMT.) Several transportation technologies could help unlock the capacity of the existing transportation network, by maximizing efficiency. Examples include demand-responsive microtransit, shared mobility devices (SMDs), advances in e-commerce, and emerging options like Automated Bus Rapid Transit (ABRT)²⁰ all of which may reduce the need for short and/or single-purpose vehicular trips.

Strategy #1 seeks to leverage transportation technologies that optimize transportation systems operations and management, encourage more efficient use of existing roadway infrastructure through transit or shared occupancy ridesharing, better manage travel demand (including careful consideration of First-Mile/Last-Mile (FMLM) connections), or facilitate use of micro modes like walking, biking or scooting. Shared use of autonomous vehicles (AVs) would also contribute towards congestion reduction²¹.

3.1.2 Relevant NVTA TransAction Goal

Mobility: Enhance quality of life of Northern Virginians by improving performance of the multimodal transportation system.

¹⁷ <https://thenovaauthority.org/legislation/governing-legislation/house-bill-2313/>

¹⁸ https://nvtatransaction.org/wp-content/uploads/2018/11/TransAction_Technical-Report_Nov.-2018-FINAL-1.pdf

¹⁹ <https://www.mwcog.org/file.aspx?D=PXVsN0KkMkgXNwvPyDMX1kLIQFFp2OJN0YoTa%2bUimA%3d&A=7xHcSpkGbtnCMhK%2fQTirVScizz%2flnwCEKleZaqWs3K0%3d>

²⁰ <https://www.roboticresearch.com/abrt-whitepaper/>

²¹ <https://www.mdpi.com/2199-8531/5/2/24/htm>

NVTA Transportation Technology Strategic Plan

Strategy #1: Reduce Congestion and Increase Throughput

3.1.3 NVTA Roles

Authority Roles	Funding	- Projects to purchase rolling stock for transit systems and/or regionally significant micromobility capital, should continue to be supported through TransAction. - Infrastructure projects designed to support technologies that may encourage shared rides and/or alternative modes of transportation should continue to be supported through TransAction. - Technology deployments for system optimization should continue to be supported through TransAction. - When the Authority seeks to apply for funding from an external source, the application should be written in such a way as to facilitate and encourage innovation in fulfilling the need or goal that drove the application. - When the Authority seeks to purchase goods or services (i.e., modeling platforms, consultant services, data subscriptions or analysis software etc.) to support its mission, careful attention should be paid to approach the procurement process in such a way that balances the need to achieve certain predetermined goals with the need to allow for a flexibility in methodology that enables innovation. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	Ongoing
	Advocate	- The Authority may develop policies that encourage mass and microtransit and/or other forms of ride sharing. For example, a policy may encourage creation of transit stations (or coverage by demand-responsive transit) in predetermined target areas (to help make First-Mile/Last-Mile (FMLM) connections) or to allow microtransit in bus lanes (with the caveat that they do not interfere with the high-frequency service operating using those lanes.) - The Authority may encourage member jurisdictions to reduce parking minimums for residential and business land uses and/or policies that allow for exemptions from such minimums for parcels within specified distances from mass transit routes and/or in the occasion of the provision of robust microtransit service.	Immediate
Shared Roles	Champion	- The Authority may encourage (and/or support) member jurisdictions to explicitly establish congestion reduction as a primary objective of their transportation efforts. Further, the Authority may encourage and/or support member jurisdictions to integrate technology into their public positions on congestion reduction and vice versa. - NVTA staff may encourage (and/or support) other planning efforts in the region to incorporate the connection between congestion reduction and technologies into their missions, objectives, guiding principles etc.	Near Term
	Facilitate	- Authority Members can facilitate the use of technology to reduce congestion by publicly expressing support for the goal, through adoption of this plan. - The Authority can facilitate the use of technology to reduce congestion by submitting letters of support for related projects (i.e., for funding applications to external entities.) - NVTA staff can facilitate the use of technology to reduce congestion by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Near Term
Staff Roles	Planning	- NVTA staff should continue to consider the use of technology to reduce congestion in long-range planning efforts (in terms of crafting project descriptions for inclusion in TransAction, the reevaluation of project scoring metrics and scenario analysis.) - NVTA staff should continue to consider²² if terminology and project descriptions used in current planning efforts allow for the introduction of innovative solutions. For example, would continued use of “bicycle and pedestrian” exclude other emerging micro modes? Should the measures used to evaluate use of transit as a means of access to jobs, employees, markets and destinations be updated to reflect the potential for demand-responsive microtransit that may or may not rely on traditional stops or stations?²³ - Planning efforts should remain technology agnostic in long-range planning initiatives, to accommodate innovation and unknown developments. - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Near Term
	Outreach/ Education	- NVTA staff should stay abreast of developments in various technologies and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - NVTA staff should continue to share information about transportation technologies with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 11 - Strategy #1, NVTA Roles

²² <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf>

NVTA Transportation Technology Strategic Plan

Strategy #1: Reduce Congestion and Increase Throughput

3.1.4 Application of Core Values

Equity

Effectively managing congestion can improve travel time reliability²⁴. This allows commuters to more judiciously budget their time and avoid missing work shifts or incurring extra childcare costs etc., which may have disproportionate impact on low-income persons.

Additionally, mitigating congestion caused by personal vehicles can improve reliability and speed of transit (mass and micro) and shared rides, improving the viability of these modes as alternatives to car ownership, which can be cost prohibitive²⁵. These shared modes also have the potential to provide increased mobility to the people with disabilities²⁶.

Safety

A recent study by the Victoria Transportation Policy Institute²⁷ found that lessening congestion can reduce the frequency of crashes, but may increase severity, due to increased speeds of free-flowing traffic. However, efforts to shrink vehicular travel overall (including those that achieve this through mode shift to transit, ride sharing and active modes) reduce crash risk.

Sustainability

The transportation sector is the largest producer of Greenhouse Gas Emission in the United States²⁸ and produces a series of other pollutants that reduce air quality²⁹. These negative environmental impacts contribute significantly to climate change³⁰ and directly harm human health by exasperating chronic conditions like cardiovascular disease, asthma and increase risks for certain cancers etc.³¹ Mitigating congestion can reduce all of these negative impacts and ensure more efficient use of a critically important but resource-intensive network, however, care should be taken to mitigate any potential increases in VMT that may inadvertently be made possible due to a reduction in congestion.

Table 12 - Strategy #1, Application of Core Values

Potentially Applicable Technologies

- Automated/ Autonomous Vehicles
- SMDs
- Signal Technologies
- Apps
- System Optimization
- Drones
- Changes to Delivery and Freight
- Surveillance/ Monitoring
- Data Generation/ Collection/ Sharing
- Improvements to Mass Transit
- Smart Technologies/ Cities and IOT

²³ <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-D.pdf>

²⁴ https://ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm

²⁵ <https://www.nerdwallet.com/article/loans/auto-loans/total-cost-owning-car>

²⁶ <https://www.worldbank.org/en/news/feature/2015/12/03/for-persons-with-disabilities-accessible-transport-provides-pathways-to-opportunity>

²⁷ <https://www.vtpi.org/safetrav.pdf>

²⁸ <https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation>

²⁹ <https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution>

³⁰ <https://www.epa.gov/transportation-air-pollution-and-climate-change/learn-about-air-pollution-transportation>

³¹ <https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health>

NVTA Transportation Technology Strategic Plan

Strategy #2: Maximize Access to Jobs, Employees and Housing

3.2 Strategy #2: Maximize Access to Jobs, Employees and Housing

3.2.1 Description

The most reliable recurring congestion historically results from commute trips between work and housing locations during morning and evening peak commuting periods. The consistency in trip routes and purposes creates a series of control factors that facilitate efforts to understand, react to and influence complex travel behaviors. Additionally, employment and business are the foundation of any community's economy and a significant factor in quality of life. This unique combination of critical importance and the presence of robust data that empowers planners to most efficiently effectuate change, establishes maximizing access to jobs, employees and housing as a primary goal of NVTA. The Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments (MWCOC) projects that this region will have an additional million jobs by the year 2045.³² While these employment opportunities will increasingly be concentrated in activity centers served by many modes, vehicular congestion will continue to be an issue, as more people move to pursue those jobs³³. Additionally, the Greater Washington Partnership asserts, "Excessive roadway congestion creates unreliable trip conditions that negatively impact employees and employers by restricting access to jobs and the region's rich amenities."³⁴ This indicates additional, and perhaps novel, efforts will be necessary to ensure continued (and improving) access to jobs, employees and housing.

Strategy #2 will focus on methods of improving accessibility that are technology-enabled (such as existing travel demand management programs like MWCOC's Commuter Connections³⁵ and VDOT's Transform 66³⁶) and have not been addressed elsewhere. MWCOC's 2019 State of the Commute report indicates that use of transit increases with proximity to stations³⁷ so using technologies to bring services closer to users could contribute to access to jobs, employees and housing. Strategy #2 could encourage demand-responsive microtransit systems and use of shared rides or subscription-based services for autonomous vehicles, as a way to bring transit in closer proximity to traffic generators. (In fact, a recent review of Av research concluded that "From a policy perspective, deployment of SAVs in First-Mile/Last-Mile (FMLM) (integrated [Public Transport and Shared Autonomous Vehicle, or PT-SAV] system) can contribute to the sustainability of the transportation system."³⁸) Strategy #2 could also support others in improving transit access by improving regional transportation data collection and sharing (both with the public and among planning departments, to inform decision making about services); and contributing to discussions about transportation-related land use policies (like allocation of curb space, parking minimums or reuse plans for parking garages³⁹.)

3.2.2 Relevant NVTA TransAction Goal

Accessibility: Strengthen the region's economy by increasing access to jobs, employees, markets and destinations for all communities.

³² <https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/>

³³ <https://www.mwcog.org/newsroom/2018/10/10/how-will-a-million-more-people-get-around-in-2045/>

³⁴ <https://www.greaterwashingtonpartnership.com/blueprint/solution-4.html>

³⁵ <https://www.mwcog.org/transportation/programs/commuter-connections/>

³⁶ http://outside.transform66.org/commuter_options/default.asp

³⁷ <https://www.mwcog.org/newsroom/2019/09/24/three-big-takeaways-from-the-2019-state-of-the-commute-survey/>

³⁸ https://www.researchgate.net/profile/Manos_Chaniotakis/publication/338405765_Shared_autonomous_vehicle_services_A_comprehensive_review/links/5e30ea67a6fdccd965733b3e/Shared-autonomous-vehicle-services-A-comprehensive-review.pdf

³⁹ <https://spectrum.ieee.org/cars-that-think/transportation/self-driving/autonomous-parking>

NVTA Transportation Technology Strategic Plan

Strategy #2: Maximize Access to Jobs, Employees and Housing

3.2.3 NVTA Roles

Authority Roles	Funding	- Projects to purchase rolling stock for transit systems and/or regionally significant micromobility capital, should continue to be supported through TransAction. - Infrastructure projects designed to support technologies that may encourage shared rides and/or alternative modes of transportation should continue to be supported through TransAction. This may include mode-specific infrastructure like bike lanes, HOV lanes, curbside management treatments or even parking garages optimized for AVs. - Technology deployments for system optimization should continue to be supported through TransAction. This may include Intelligent Transportation System (ITS), fare collection systems, incident response systems, etc. - Technology deployments that contribute to data collection and sharing should be considered through TransAction. This may include counters on roads or trails, or in transit vehicles. It could also include purchase of data storage or creation of data lakes or response systems. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP. (It is important to consider the potential for obsolescence of technologies, which may vary. See Strategy #6 for additional detail.)	Mid Term
	Champion	- The Authority may encourage member jurisdictions to reduce parking minimums for residential and business land uses and/or policies that allow for exemptions from such minimums for parcels within specified distances from mass transit routes and/or in the occasion of the provision of robust microtransit service. Similarly, the Authority may consider encouraging Parking Maximums, as used by Alexandria. - The Authority may encourage implementation of subscription-services for AVs and/or other ridesharing systems.⁴⁰ - The Authority and Staff may encourage member jurisdictions to consider active approaches to curbside management (such as the Pick Up and Drop Off (PUDO) zones implemented in Washington D.C.⁴¹), to support use of shared and subscription-based rides, as well as new freight delivery options (drones, robo delivery bots⁴² etc.) and micro modes. - NVTA staff may encourage (and/or support) other planning efforts in the region to address innovative methods to support accessibility to jobs, employees and housing.	Immediate
Shared Roles	Facilitate	- Authority Members can facilitate innovative approaches to access by publicly expressing support for the goal, through adoption of this plan. - The Authority can facilitate the innovative approaches to access by submitting letters of support for related projects (i.e., for funding applications to external entities.) - Staff can facilitate innovative approaches to access by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Immediate
	Planning	- NVTA staff should continue to consider innovative approaches to maximizing access to jobs, employees and housing in long-range planning efforts (in terms of project eligibility criteria, the reevaluation of project scoring metrics and scenario planning.) - NVTA staff should consider if the metrics and terminology used in current planning efforts allow for the most effective evaluation of goals to maximize access to jobs, employees and housing. For example, it should be determined what level of granularity and/or aggregation of data type(s) are appropriate in modeling. It is also critical to find methods to evaluate the impact(s) of all modes. This may involve diversifying data sources and/or analysis tools available to staff. - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Immediate
Staff Roles	Outreach/ Education	- NVTA staff should stay abreast of developments in various technologies and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - NVTA staff should continue to share information about transportation technologies with the public, via outreach mechanisms like Driven By Innovation	Ongoing

Table 13 - Strategy #2, NVTA Roles

⁴⁰ <https://journals.sagepub.com/doi/pdf/10.1177/0739456X18776062>

⁴¹ <https://ddot.dc.gov/release/ddot-expand-pick-and-drop-zones-through-research-pilot>

⁴² <https://www2.gmu.edu/news/574036>

NVTA Transportation Technology Strategic Plan

Strategy #2: Maximize Access to Jobs, Employees and Housing

3.2.4 Application of Core Values

Improving the viability of multimodal access to housing and employment may disproportionately benefit low-income individuals by providing effective alternatives to cost prohibitive car ownership. Robust deployment of transit and shared ride services, or subscription-based AV service, may also empower individuals with disabilities to independently pursue employment.

Equity

Proactive steps should also be taken to ensure that new technologies which may contribute towards maximizing access to jobs, employees and housing are themselves accessible by all demographics. Examples of this may include mandatory equity-based deployment zones for micromobility devices; setting limits on microtransit fares and providing options for cash-based payment and smart-phone free access for all services.

Safety

Encouraging increased use of mass and microtransit, micromobility and/or AVs could reduce the number of vehicle operators on the roads, thus limiting the number of fallible human drivers in the system. This, in turn, may reduce vehicular crashes and secondary crashes.

Sustainability

The transportation sector is the largest producer of Greenhouse Gas Emission in the United States⁴³ and produces a series of other pollutants that reduce air quality⁴⁴. These negative environmental impacts contribute significantly to climate change⁴⁵ and directly harm human health by exasperating chronic conditions like cardiovascular disease, asthma and increase risks for certain cancers etc.⁴⁶ Maximizing the potential of our regional transportation network in serving the most recurring demand, commuting, ensures more efficient use of a critically important but resource-intensive network.

Table 14 - Strategy #2, Application of Core Values

Potentially Applicable Technologies

- SMDs
- Signal Technologies
- Apps
- System Optimization
- Drones
- Changes to Delivery and Freight
- Surveillance/Monitoring
- Data Generation/Collection/Sharing
- Improvements to Mass Transit
- Smart Technologies/Cities and IOT

⁴³ <https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation>

⁴⁴ <https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution>

⁴⁵ <https://www.epa.gov/transportation-air-pollution-and-climate-change/learn-about-air-pollution-transportation>

⁴⁶ <https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health>

NVTA Transportation Technology Strategic Plan

Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

3.3 Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

3.3.1 Description

Connective technologies are becoming integral to transportation, either supplementing existing systems (through things like Transit Signal Priority (TSP)) or enabling the development of new modes, such as autonomous vehicles (AVs) or Shared Mobility Devices (SMDs.) This connectivity is beneficial in many ways but there are, of course, risks that need to be addressed. These include potential invasions of personal privacy of the users, and attacks on the systems. For these reasons, the Virginia Information Technologies Agency (VITA) has established/is growing a trust framework and legal arrangements to facilitate secure data exchange⁴⁷. This may be a useful starting point for developing standards to address emerging needs, like the unique cybersecurity demands of AVs⁴⁸ and Smart City technologies like TSP and other Intelligent Transportation Systems (ITS⁴⁹.) These systems rely on the rapid and reliable transmission of small packets of information between infrastructure, vehicles and data systems. Interruptions to this transmission can have cascading effects, for system functionality and safety.

Strategy #3 will encourage approaches to cybersecurity (and its inclusion in procurement) that stay abreast of evolving threats and vulnerabilities. For example, blockchain is a decentralized storage method that links small pieces of data together in ever-lengthening chains that become increasingly difficult to disrupt or alter. These factors make blockchain a potential candidate for relaying critical transportation signals and messages, but latency and prolific energy consumption⁵⁰ are concerns. Both the Federal Highway Administration Exploratory Advanced Research Program⁵¹ and a private consortium of technology firms lead by IBM, called Mobility Open Blockchain Initiative (MOBI)⁵², are exploring the possibility of using blockchain to address transportation needs or opportunities.

Personal privacy is an increasingly relevant consideration in transportation, as more information and data are shared. For example, one's physical location, commute patterns, payment information and home addresses may be shared with a SMD service provider⁵³ and insurance companies are able to monitor driver behaviors through telematics⁵⁴. Privacy and a feeling of control over one's own information contributes to quality of life, which NVTA is committed to enhancing where possible. To this end, Strategy #3 will identify how government agencies address privacy and will encourage inclusion of privacy considerations (such as data anonymization, aggregation and the option for participants to "opt out" of data collection) in procurement processes.

3.3.2 Relevant NVTA TransAction Goal

Mobility: Enhance quality of life of Northern Virginians by improving performance of the multimodal transportation system.

⁴⁷ <https://www.vita.virginia.gov/policy--governance/enterprise-architecture/ea-archive/enterprise-information-architecture/>

⁴⁸ <https://www.vtti.vt.edu/utc/safe-d/index.php/projects/automated-vehicle-behavior-monitoring-for-vulnerability-management/>

⁴⁹ <https://www.its.dot.gov/factsheets/cybersecurity.htm>

⁵⁰ <https://www.nytimes.com/interactive/2021/09/03/climate/bitcoin-carbon-footprint-electricity.html>

⁵¹ <https://beta.sam.gov/opp/75f5fea0e3ec47d08bc2ffb9d7b34c33/view>

⁵² <https://www.ibm.com/blogs/blockchain/2018/06/introducing-mobi-the-mobility-open-blockchain-initiative/>

⁵³ <https://sprite.utsa.edu/publications/papers/sureshkanthAutoSec20.pdf>

⁵⁴ <https://www.oecd.org/pensions/Technology-and-innovation-in-the-insurance-sector.pdf>

NVTA Transportation Technology Strategic Plan

Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

3.3.3 NVTA Roles

Authority Roles	Funding	- When the Authority seeks to apply for funding from an external source (as was the case with the RM3P⁵⁵ program), the application should be written in such a way as to encourage/foster cyber security and privacy considerations in fulfilling the need or goal that drove the application. - When the Authority seeks to purchase goods or services (i.e., consultant services, data analysis software, public outreach services or tools etc.) to support its mission, careful attention should be paid to approach the procurement process in such a way that encourages/fosters cyber security and privacy considerations in fulfilling the need or goal that drove the application. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	Near Term
Shared Roles	Stakeholder	- The Authority would represent the needs and desires of the region if called upon to advise the Commonwealth or other regional entities as they draft policies and procure goods that may contain cyber security or privacy elements. - NVTA staff would represent the needs and desires of the region if called upon to advise member jurisdictions as they draft policies and procure goods that may contain cyber security or privacy elements.	Near Term
Staff Roles	Planning	If the Authority were to seek funding from an external source(s), purchase goods or services, or consider adding an additional scoring metric to its funding application process, it would be critical for these action(s) to be supported by meaningful planning efforts.	Near Term
	Observer	- NVTA staff should stay abreast of developments in both threats to cybersecurity and personal privacy (in the realm of transportation) and techniques to address said threats. The CEO, the Authority and committees like the TTC and RJACC, may call upon staff to provide expertise resulting from these continued observations, when necessary. - NVTA staff seek to understand any Federal action taken in regard to cybersecurity of emerging 5G technology⁵⁶, as this communications technology has many use cases in transportation, such as enabling AV communications.	Immediate

Table 15 - Strategy #3, NVTA Roles

⁵⁵ <https://rm3pvirginia.org/>

⁵⁶ <https://www.summitstrategies.us/wp-content/uploads/2019/11/5G-Policy-Primer-November-2019-1.pdf>

NVTA Transportation Technology Strategic Plan

Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

3.3.4 Application of Core Values

Equity Care should be taken that the same level of protection is afforded to all system users regardless of how (or if) they pay for a service. (I.e., equivalently stringent recordkeeping and anonymization practices should be deployed for both card and cash-based payments.)

Safety Any interference with critical transportation information relay (particularly in regard to signal timing, the control of connected or automated vehicle features or start/stop functions of SMDs) could cause crashes or other physical harm. Malicious interference (such as hacking, signal blocking, denial of service etc.) may be mitigated through effective and regularly updated cyber security measures.

If malicious actors are able to obtain Personally Identifiable Information (PI), this could be used to physically locate an individual or cause other harm such as identity theft. Proactive efforts to ensure user privacy can help to avoid these risks. ⁵⁷

Sustainability Many of the modes that are most susceptible to hacking or other nefarious interference have potential to reduce negative transportation impacts on the environment. (I.e., transit, AVs, SMDs.) Mitigating cybersecurity and privacy concerns helps improve the viability of these modes and the public perception/adoption of them.

Table 16 - Strategy #3, Application of Core Values

⁵⁷ <https://nacto.org/2019/05/30/managing-mobility-data/>

NVTA Transportation Technology Strategic Plan

Strategy #4: Enhance Operations of the Multimodal Transportation System Through Connectivity and Automation

3.4 Strategy #4: Enhance Operations of the Multimodal Transportation System Through Connectivity and Automation

3.4.1 Description

Full vehicular autonomy, the ability of a vehicle to operate without human intervention in all circumstances (level 5 automation, as classified by the Society of Automobile Engineers, or SAE⁵⁸), is something researchers and technologists have been pursuing for years. Concerted efforts arguably began with the first Grand Challenge hosted by the Defense Advanced Research Projects Agency, or DARPA, in 2004⁵⁹, which was a prize-based competition to autonomously navigate the desert and accelerate development of technology to spare personnel from dangerous supply convoys and other military operations. Since that time, applications for Autonomous Vehicle (AV) technology have been found in many other fields, including farming⁶⁰, mining⁶¹, freight⁶² and even passenger transportation. The benefits of these applications can be many-fold and include improvements to safety, mobility and efficiency, and the potential to reduce environmental impacts of transportation and provide societal benefits.⁶³ Despite this and all the time and effort that has gone into AV technology, it will still likely be years before true, level 5 autonomy is realized and available to the mass market.⁶⁴ This lead time allows localities and regulators to understand what a technology will be/do before it fully enters the market and right of way, and in turn, an excellent opportunity to proactively establish a vision for its successful integration.

Progress towards autonomy will be incrementally manifested in the public sphere through ever-advancing forms of automation.⁶⁵ That is to say, developers may enhance the functioning of certain aspects or subsystems of a vehicle, in pursuit of eventual autonomous functioning, and be able to deploy those advancements to Human-Driven Vehicles (HDVs) quickly. Instances of this often improve safety, with key examples being lane departure warnings, blind spot warnings, adaptive cruise control and lane centering. The incremental and often synergistic benefits of automation may also be applied to transportation infrastructure, through things like Automated Traffic Enforcement (ATE.) All types of progress towards automation may generate improvements to, and new use cases for, connected vehicles and infrastructure. Policies designed to prepare for the introduction of AVs should also aim to maximize the potential benefits of increased automation and connectivity.

Once full automation has been achieved, there will be a period of transition, during which both AVs and HDVs operated in the same space, as it typically takes 15 years to turn over the American vehicular fleet.⁶⁶ However, this time may be lengthening since Americans have been holding onto their vehicles longer since 2009.⁶⁷ Policy makers must consider the safety ramifications of direct interaction between HDVs and AVs that may occur during this time.⁶⁸ Additionally, it will be critical to address potential barriers to access to AVs before they become ubiquitous (such as cost of ownership, or ADA access)⁶⁹ that may create or exacerbate existing inequities.

⁵⁸ <https://www.sae.org/blog/sae-j3016-update>

⁵⁹ <https://www.darpa.mil/news-events/2014-03-13>

⁶⁰ <https://www.fastcompany.com/90704876/this-is-where-driverless-vehicles-can-really-scale-and-it-will-surprise-you>

⁶¹ <https://www.cnn.com/2020/07/16/mining-looks-to-electric-autonomous-vehicles-to-improve-efficiency.html>

⁶² <https://fortune.com/2022/04/07/autonomous-long-haul-trucking-to-transform-u-s-logistics/>

⁶³ <https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety>

⁶⁴ <https://www.theguardian.com/technology/2022/mar/27/how-self-driving-cars-got-stuck-in-the-slow-lane#:~:text=Carmakers%20General%20Motors%20and%20Geely,in%20San%20Francisco%20this%20year.>

⁶⁵ <https://www.forbes.com/sites/forbestechcouncil/2021/04/01/the-path-from-automation-to-autonomy-is-swarming-with-activity/?sh=6666673a3716>

⁶⁶ <http://energyfuse.org/americas-aging-vehicles-delay-rate-fleet-turnover/#:~:text=At%20the%20current%20rate%2C%20it,economic%20conditions%2C%20or%20other%20factors.>

⁶⁷ <https://www.eia.gov/todayinenergy/detail.php?id=36914>

⁶⁸ <https://www.sciencedirect.com/science/article/pii/S1369847822000201>

⁶⁹ <https://www.vtpi.org/avip.pdf>

NVTA Transportation Technology Strategic Plan

Strategy #4: Enhance Operations of the Multimodal Transportation System Through Connectivity and Automation

Automated Vehicles (AVs) have the potential to contribute to a reduction in congestion, if shared ownership and/or subscription services, and shared occupancy are encouraged.⁷⁰ (This can be referred to using the acronym SAV, for Shared Autonomous Vehicles.) A recent comprehensive review of studies of the potential impacts of AVs goes so far as to say *“From a policy perspective, autonomous vehicles have to be introduced in shared mobility services. Further, shared mobility services in the form of an independent system can induce risk of modal shift from public transport and hence, such services have to be integrated with an efficient public transport system. Ride– sharing has to be encouraged and incentivized, and public transport fusion is recommended”*⁷¹ In fact, an analysis conducted by the Union of Concerned Scientists⁷² found that pairing SAV use with a strong transit system would provide the greatest increase in accessibility to jobs for low-income individuals (in comparison to other AV deployment scenarios.) Furthermore, it reported that AV technology could be applied to transit vehicles directly, and could, for example, reduce BRT travel times by 35%.

Even with all the above nuances taken into consideration, there is still a possibility for Zero Occupancy passenger Vehicles (ZOV-p) miles to occur when an AV is waiting for the return of a passenger and/or seeking parking, etc. Depending on location and time of day, such vehicles will not only add VMT but also potentially increase congestion.

Strategy #4 will explore proactive policies to encourage use patterns that not only reduce potential detriments to regional goals, but also contribute positively towards them. It will focus on autonomous vehicles that are intended for passenger transportation, rather than those intended for freight or parcel delivery, which may not accommodate and/or benefit from carrying a passenger(s.) Additionally, it will encourage SAV usage and seek to employ best practices and lessons learned from the introduction of Transportation Network Companies (TNCs), like Lyft and Uber, and Shared Mobility Devices (SMDs), like bikeshare and eScooters in doing so.

3.4.2 Relevant NVTA TransAction Goal

Resiliency: Improve the transportation system’s ability to anticipate, prepare for and adapt to changing conditions and withstand, respond to and recover rapidly from disruptions.

⁷⁰ <https://www.cts.umn.edu/publications/report/advancing-social-equity-with-shared-autonomous-vehicles-literature-review-practitioner-interviews-and-stated-preference-surveys>

⁷¹ https://www.researchgate.net/profile/Manos_Chaniotakis/publication/338405765_Shared_autonomous_vehicle_services_A_comprehensive_review/links/5e30ea67a6fdccd965733b3e/Shared-autonomous-vehicle-services-A-comprehensive-review.pdf

⁷² <https://www.jstor.org/stable/resrep24063.8?seq=1>

NVTA Transportation Technology Strategic Plan

Strategy #4: Enhance Operations of the Multimodal Transportation System Through Connectivity and Automation

3.4.3 NVTA Roles

Authority Roles	Policy	- The Authority may develop policies that discourage ZOV-p miles traveled. - The Authority may advocate for the Commonwealth to provide local jurisdictions with the ability to levy fees on autonomous vehicles. - The Authority may develop a vision for the successful integration of AVs and other connected vehicle and infrastructure technology in the region.	Near Term
	Advocate	- The Authority may advocate for legislation that limits ZOV-p miles traveled. - The Authority may advocate for state entities to continue to provide, and perhaps expand, funding for innovative pilot projects and/or research efforts. - The Authority may advocate for state entities to conduct research, provide technical assistance for integration of AVs. They may also encourage or support state leadership to work with the Federal government to establish clear guidelines on topics like safety, liability, cyber security, and data sharing.	Long Term
Shared Roles	Champion	- NVTA staff may encourage (and/or support) other planning efforts in the region to address the potential for ZOV-p Miles Traveled. - Authority members and Staff can champion the benefits of increasing interoperable and coordinated connectivity in the region. - Authority members and Staff can champion the benefits of shared (or pooled) use of AVs, also known as SAVs, particularly in the context of providing FMLM solutions and to otherwise supplement the transit systems in the region.	Long Term
	Facilitate	- Authority Members can facilitate minimization of ZOV-p Miles Traveled and maximizing benefits of AVs and connective technologies, by publicly expressing support for the goal, through adoption of this plan. - The Authority can facilitate minimization of ZOV-p Miles Traveled and maximizing benefits of AVs and connective technologies, by submitting letters of support for related projects (i.e., for funding applications to external entities.) - NVTA staff can facilitate minimization of ZOV-p Miles Traveled and maximizing benefits of AVs and connective technologies, by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Immediate
Staff Roles	Planning	- NVTA staff should continue to consider minimization of ZOV-p Miles Traveled and maximizing benefits of AVs and connective technologies, in long-range planning efforts (in terms of project eligibility criteria, the reevaluation of project scoring metrics and scenario planning.) - NVTA staff should consider the potential safety ramifications of direct interaction between AVs and HDVs in assessing the functioning of the transportation system(s) and in conducting gap analysis. - NVTA staff should consider potential barriers to access to AVs or other connective technology that may create inequities or exacerbate existing issues. - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Immediate
	Outreach/ Education	- NVTA staff should stay abreast of developments in various technologies and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - NVTA staff should continue to share information about transportation technologies with the public, via outreach mechanisms like Driven By Innovation. - It will be critical for staff to understand the safety impacts of various AV, automation and connectivity technologies (and the significance/validity of any certifications or standards they espouse⁷³, to ensure member jurisdictions can make informed decisions and provide accurate information to citizens.	Ongoing

Table 17 - Strategy #4, NVTA Roles

⁷³ <https://scipol.org/content/how-uber-might-self-certify-its-own-autonomous-vehicles-carry-public-nevada>

NVTA Transportation Technology Strategic Plan

Strategy #4: Enhance Operations of the Multimodal Transportation System Through Connectivity and Automation

3.4.3 Application of Core Values

Increasing the availability and viability of alternatives to personal vehicle ownership may reduce the cost of living for members of our community. Reductions may be significant enough for additional people to afford to co-locate near their place of work, reducing their commute times and facilitating civic engagement.

Practices and policies that contribute to the use of certain modes (particularly AVs⁷⁴), which may be exclusionary, and/or exclusionary policies or land uses that may result from the use of new transportation technologies, should be avoided.

Equity

Proactive steps should also be taken to ensure that new technologies which may contribute towards a desirable balance of VMT and PMT are accessible by all demographics. Examples of this may include mandatory equity-based deployment zones for micromobility devices; setting limits on microtransit fares and providing options for cash-based payment and smart-phone free access for all services. Fully autonomous vehicles may also increase access to persons with limited mobility, including children, the elderly, and people with disabilities, if Universal Design principles are applied. This could represent significant quality of life improvements, as *“Six million Americans with disabilities have difficulties accessing transportation, contributing to 1.9 million people with disabilities being homebound”* and the population over 65 years of age is expected to double by 2050.⁷⁵

Safety

Encouraging increased use of mass and microtransit, micromobility and/or SAVs could reduce the number of vehicle operators on the roads, thus limiting the number of fallible human drivers in the system. This, in turn, may reduce vehicular crashes⁷⁶ and secondary crashes.

AVs also have the potential to reduce aggressive and defensive driving and may provide automated vehicular inspection capabilities⁷⁷, to reduce incidents of component failure during operations. Despite this, it is critical to address potential safety issues that may arise from the interaction of AVs and HDVs. Additionally, the safety for all persons must remain a top priority, including those in and around AVs.⁷⁸

Finally, safety in emergency situations will necessitate careful policy development. For example, details of how AVs will interact

Potentially Applicable Technologies

- Automated/Autonomous Vehicles
- SMDs
- Signal Technologies
- Apps
- System Optimization
- Drones
- Changes to Delivery and Freight
- Surveillance/Monitoring
- Data Generation/Collection/Sharing
- Improvements to Mass Transit
- Smart Technologies/Cities and IOT

⁷⁴ <https://www.vtpi.org/avip.pdf>

⁷⁵ https://static1.squarespace.com/static/596fb16003596e0fa70a232f/t/5c9bab319b747a61663ac9bc/1553705778370/ITSAmerica_Driverless+Cars+Accessibility+Mobility_April2019.pdf

⁷⁶ <https://www.vtpi.org/safetrav.pdf>

⁷⁷ <https://patents.google.com/patent/US20190066398A1/en>

⁷⁸ <https://www.mwcog.org/documents/2022/01/20/r8-2022---resolution-to-adopt-cav-principles-for-the-national-capital-region/>

NVTA Transportation Technology Strategic Plan

Strategy #4: Enhance Operations of the Multimodal Transportation System Through Connectivity and Automation

with emergency vehicles⁷⁹ are still being sorted out, as are questions of liability for AV operations.⁸⁰ Additionally, the Governors Highway Safety Association (GHSA) is advocating for training for first responders to effectively and safely work with AVs.⁸¹

Sustainability

In the United States, the transportation sector contributes 29% of all Green House Gas (GHG) emissions, making it the largest single source in the country.⁸² Creating a more modally diverse transportation system that leverages the passenger capacity of all vehicles will ensure that our communities are making the most responsible use of this resource intensive system (even if VMT itself cannot be reduced due to continued population growth.) This is critically important as the impacts and severity of climate change are increasingly understood and the need to mitigate human impact on the environment becomes more urgent.⁸³

Increasing the connectivity of multi-passenger, fleet vehicles can also maximize their use, through predictive maintenance⁸⁴, that allows fleet managers to more efficiently distribute use across the fleet, reducing need to replace the vehicles.

Table 18 - Strategy #4 Application of Core Values

⁷⁹ <https://www.forbes.com/sites/tiriasresearch/2018/07/31/how-will-autonomous-cars-respond-to-emergency-vehicles/?sh=1f2c80c427ef>

⁸⁰ <https://www.mdpi.com/2032-6653/12/2/62/htm>

⁸¹ <https://www.ghsa.org/resources/news-releases/Preparation-for-Automated-Vehicle-Technology21>

⁸² <https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation>

⁸³ <https://www.transportationandclimate.org/content/about-us>

⁸⁴ <https://ruor.uottawa.ca/handle/10393/40086>

NVTA Transportation Technology Strategic Plan

Strategy #5: Develop Pricing Mechanisms that Manage Travel Demand and Provide Sustainable Travel Options

3.5 Strategy #5: Develop Pricing Mechanisms that Manage Travel Demand and Provide Sustainable Travel Options

3.5.1 Description

The cost to use various modes of transportation can be a significant factor in which options are available/attractive to whom, how frequently and for which purposes people are inclined to use a mode, and the ability of the provider to operate a system. Given the pervasive impact of costs, any pricing mechanism(s) must be given careful consideration, with special attention paid to the potential ramifications for other modes. There are many ways to price transportation, several of which (including toll roads⁸⁵ and congestion pricing⁸⁶) are already deployed in the region. Additionally, the Commonwealth is exploring the feasibility of fees based on Vehicle Miles Traveled⁸⁷.

These goals can also be approached from a system level, rather than a mode-specific perspective, which is the goal of the Regional Multimodal Mobility Program (RM3P⁸⁸). Through this Program, NVTA partners with the Virginia Department of Transportation (VDOT) and the Virginia Department of Rail and Public Transportation (DRPT) to apply best practices from the Integrated Corridor Management Program⁸⁹ to the entire region. This sets a powerful precedence for future efforts to balance a multimodal system and achieve optimal network functioning.

Strategy #5 will focus on pricing schemas and incentives that are directly related to emerging transportation technologies and are supported by the will of the Authority. (Local Express Lanes, like 459 NEXT⁹⁰, could potentially serve as precedence.) This may include evaluating how existing mechanisms could be enhanced to further NVTA goals to reduce congestion and improve the sustainability of the transportation network (for example, VMT fees could be made variable to encourage desirable travel patterns or behaviors.) It could also lead to the evaluation of novel or developing dynamic pricing options, such as Curbside Management techniques, or the Performance Parking pilot the Virginia Department of Transportation is supporting in Arlington County⁹¹. Strategy #5 will also consider ways in which revenues from pricing initiatives could be used to enhance/encourage use of alternatives to ZOV-ps/ Single Occupancy Vehicles (SOVs), including transit (mass and micro) and micromobility.

3.5.2 Relevant NVTA TransAction Goal

Resiliency: Improve the transportation system's ability to anticipate, prepare for and adapt to changing conditions and withstand, respond to and recover rapidly from disruptions.

⁸⁵ <https://www.tollroadsinvirginia.com/>

⁸⁶ http://66expresslanes.org/about_the_lanes/default.asp

⁸⁷ http://www.ctb.virginia.gov/resources/2019/mar/pres/8_legislative_update.pdf

⁸⁸ <https://rm3pvirginia.org/>

⁸⁹ <https://www.fampo.gwregion.org/wp-content/uploads/2011/06/Intgrated-Corridor-Management.pdf>

⁹⁰ <https://www.495northernextension.org/>

⁹¹ <https://www.arlnow.com/2020/12/08/arlington-county-to-launch-variable-parking-pricing-along-metro-corridors/>

NVTA Transportation Technology Strategic Plan

Strategy #5: Develop Pricing Mechanisms that Manage Travel Demand and Provide Sustainable Travel Options

3.5.3 NVTA Roles

Authority Roles	Policy	- The Authority may consider pricing and incentive mechanisms to reduce congestion and encourage sustainable transportation options. - The authority may develop policies that suggest ratios, ranges or other types of comparisons for capping fees for microtransit services, relative to local mass transit fees. - The Authority may develop policies for ensuring consistent pricing schemas for micromobility services across member jurisdictions.	Mid Term
	Advocate	Advocate that the Commonwealth coordinate with the region to develop pricing and incentive measures, to optimize the transportation network in a sustainable manner.	Near Term
Shared Roles	Stakeholder	- The Authority would represent the needs and desires of its constituents in developing NVTA policies associated with this goal. - The Authority members would need to advocate for the implementation of the NVTA policies and/or creation of complimentary policies or initiatives by their local government. - Staff would be instrumental in researching and drafting the policies associated with this goal. - The policies associated with this goal would significantly impact the planning responsibilities of NVTA staff.	Immediate
Staff Roles	Planning	- NVTA staff should explore the potential impacts of the institution of various pricing mechanisms on other long-range planning goals and scenarios. - NVTA staff should monitor actual impacts of the implementation of any policies. - NVTA staff should consider pricing mechanisms in long-range planning efforts (in terms of project eligibility criteria, the reevaluation of project scoring metrics and scenario planning.) - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Immediate
	Outreach/ Education	- NVTA staff should stay abreast of developments in various technologies and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - NVTA staff should work closely with the regional joint PIO group to develop consistent messaging and outreach around pricing mechanisms. - NVTA staff may research pricing mechanisms in other localities, to identify best practices and lessons learned.	Near Term

Table 19 - Strategy #5, NVTA Roles

NVTA Transportation Technology Strategic Plan

Strategy #5: Develop Pricing Mechanisms that Manage Travel Demand and Provide Sustainable Travel Options

3.5.4 Application of Core Values

Equity

Pricing mechanisms can be used to help maximize the potential of public resources, like roads, to serve people, rather than personal devices (vehicles), which may be prohibitively expensive for many.

Policies intended to cap or otherwise regulate the costs of using transit or micromobility ensure that a range of viable travel options are available to all. In fact, AARP lists affordability as one of its top transportation principals for fostering livable communities in its 2019 Policy Book.⁹²

Safety

Pricing mechanisms can control the number of vehicles on the road and in this case, will be specifically created with the goal of mitigating congestion. Reducing the number of vehicles, along with the stress and physical proximity of congestion, may reduce crashes⁹³. However, speeds may increase as congestion is reduced, which may in turn lead to more severe crashes. For this reason, efforts to balance congestion and safety will need to be nuanced.

Sustainability

Maximizing the number of people served, through pricing mechanisms that encourage shared occupancy of vehicles encourages efficiency in the already resource-intensive transportation sector. In explaining the benefits of similar congestion pricing schemas already in use in the Commonwealth, the Virginia Department of Transportation asserts that the program “[r]educes fuel consumption and vehicle emissions since vehicles are not idling in traffic.”⁹⁴

Encouraging use of transit (mass and micro) and micromobility through pricing mechanisms may improve the viability of a mode or modes as an alternative to single occupancy vehicles, which, in turn, reduces congestion.

Table 20 - Strategy #5, Application of Core Values

Potentially Applicable Technologies

- Automated/
Autonomous
Vehicles
- Shared Mobility
Devices (SMDs)
- Apps
- System
Optimization
- Drones
- Changes to Freight
and Deliveries
- Surveillance/
monitoring
- Data generation/
Collection/ Sharing
- Improvements to
Mass Transit
- Smart
Technologies/
Cities and IOT

⁹² <https://www.aarp.org/ppi/issues/livable-communities/transportation/>

⁹³ <https://www.vtpi.org/safetrav.pdf>

⁹⁴ https://www.virginiadot.org/info/resources/congestion_pricing/benefits_congestion_pricing.pdf

NVTA Transportation Technology Strategic Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

3.6 Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

3.6.1 Description

Technology has the potential to revolutionize the transportation sector, and how the public thinks about mobility. Despite this, some things will remain the same, and most of the most innovative treatments will rely on existing types of infrastructure, either as a supplement⁹⁵ or as a base to build upon. For example, Autonomous Vehicles (AVs) and Shared Mobility Devices (SMDs) will continue to utilize paved surface routes that connect destinations and, for the time being, benefit from traffic signals to control travel flow on these.

Private industry agrees with the need to balance existing and emerging transportation solutions, as discussed during the 5th annual Northern Virginia Transportation Roundtable⁹⁶, and in Uber's four Federal Infrastructure Principles⁹⁷, which state:

"Uber is not interested in replacing traditional public transit modes. Rather, we believe ridesharing companies and their many product offerings can play a vital role in helping transit systems perform more efficiently and can assist transit agencies in providing more mobility options to transit riders."

Given the current and continued importance of basic infrastructure and the costs associated with related projects, it is critical to maximize infrastructure use cases and minimize risks of obsolescence. Incorporating foundational technologies into current projects can facilitate a transition to a more technologically enhanced system, both in terms of the built environment and public perception, while simultaneously creating a context that attracts innovation. (One example of this approach is Virginia Tech Transportation Institute's recent successful application for funding from the U.S. Department of Transportation, to develop the concept of "mixed-fleets." The objective of which is to gradually and synergistically introduce autonomous trucks to the traditional freight industry⁹⁸.) Additionally, thoughtful proactive action can limit the need for costly retrofits.

Communications Infrastructure: Strategy #6 will encourage efforts to maximize the potential of communications infrastructure, which may include: integrating smart and connective technologies (like Transit Signal Priority or other Adaptive Signal Control options) into every new signal; encouraging installation of communications technology-ready cabinets on road projects; exploring opportunities for existing infrastructure (lighting poles, stop lights, etc.) to support the installation of communications devices like 5G transmitters⁹⁹, or creating a "digital twin"¹⁰⁰ of a locality, which can be used to simulate infrastructure changes as part of planning processes.

Physical Infrastructure: Strategy #6 will seek to maximize the potential of physical infrastructure, which may include: reprioritizing use of curbs and making space/time allocations (the curbside management efforts implemented in Washington DC, like "Pick Up and Drop Off Zones", set positive precedence¹⁰¹); placing greater emphasis on shared use and separated facilities (like trails and paths, but also on-road facilities), to encourage use of Shared Mobility Devices (SMDs); and encouraging infrastructure types or procurements that mitigate concerns about obsolescence, like Electric Vehicle (EV) charging stations that accept multiple plug types.

⁹⁵ <https://omniride.com/omniride/assets/File/PRTC-Recommendations-Summary.pdf>

⁹⁶ <https://mailchi.mp/1fd7506e46b2/driven-by-innovation-special-edition-transpo-roundtable-recap?e=224f69d532>

⁹⁷ <https://medium.com/uber-under-the-hood/ubers-federal-infrastructure-principles-9f214841ff3b>

⁹⁸ <https://vtnews.vt.edu/articles/2020/03/031720-vtti-usdottruckgrant.html>

⁹⁹ <https://www.summitstrategies.us/wp-content/uploads/2019/11/5G-Policy-Primer-November-2019-1.pdf>

¹⁰⁰ https://www.ey.com/en_us/government-public-sector/four-ways-5g-connectivity-will-make-cities-smarter

¹⁰¹ <https://ddot.dc.gov/release/ddot-announces-next-innovation-curbside-management-program>

NVTA Transportation Technology Strategic Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

Additive Infrastructure: Strategy #6 will seek to address the potential for technologies to add entirely new functionalities to existing infrastructure, that are distinct from the original purpose of said infrastructure. For example, Automated Traffic Enforcement (ATE) devices¹⁰² can be installed on existing lighting poles or stoplights, introducing an enforcement functionality (for either red light non-compliance and/or speeding) through use of existing resources.

3.6.2 Relevant NVTA TransAction Goal

Accessibility: Strengthen the region's economy by increasing access to jobs, employees, markets and destinations for all communities.

¹⁰² <https://www.iihs.org/news/detail/safety-groups-create-automated-enforcement-checklist-to-encourage-well-designed-programs>

NVTA Transportation Technology Strategic Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

3.6.3 NVTA Roles

Authority Roles	Funding	- When the Authority seeks to apply for funding from an external source (as was the case with the RM3P¹⁰³ program), the application should be written in such a way as to encourage project components that minimize potential for obsolescence. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with the potential of the project to adapt to future technologies likely to be adopted in the region. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	Near Term
Shared Roles	Champion	- The Authority may encourage (and/or support) member jurisdictions to prioritize forward-thinking infrastructure in their transportation efforts. - Staff may encourage (and/or support) other planning efforts in the region to prioritize forward-thinking infrastructure in their missions, objectives, guiding principles etc.	Immediate
	Facilitate	- Authority Members can facilitate the prioritization of forward-thinking infrastructure by publicly expressing support for the goal, through adoption of this plan. - The Authority can facilitate the creation of forward-thinking infrastructure by submitting letters of support for related projects (i.e., for funding applications to external entities.) - NVTA staff can facilitate the prioritization of forward-thinking infrastructure by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Near Term
Staff Roles	Planning	- NVTA staff should continue to consider the long-term viability and adaptability of infrastructure projects in planning efforts (in terms of crafting project descriptions for inclusion in TransAction, the reevaluation of project scoring metrics and scenario planning.) - NVTA staff should continue to consider¹⁰⁴ if terminology and project descriptions used in current planning efforts allow for preparation for innovative solutions. For example, would continued use of “bicycle and pedestrian” exclude other emerging micro modes? Should the measures used to evaluate use of transit as a means of access to jobs, employees and housing, be updated to reflect the potential for demand-responsive microtransit that may or may not rely on traditional stops or stations? ¹⁰⁵ - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Near Term
	Outreach/ Education	- NVTA staff should stay abreast of developments in various methods for retrofitting existing infrastructure for future technologies and/or building infrastructure that is adaptable and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - NVTA staff should continue to share information about forward-thinking infrastructure with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 21 - Strategy #6, NVTA Roles

¹⁰³ <https://rm3pvirginia.org/>

¹⁰⁴ <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf>

¹⁰⁵ <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-D.pdf>

NVTA Transportation Technology Strategic Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

3.6.4 Application of Core Values

Equity

It should be acknowledged that full market penetration of any technology will take place over time and at varying rates, often depending on various demographic characteristics. For this reason, care should be taken to ensure that systems continue to provide access to people with disabilities, have low technical literacy, are unbanked, have low income, or use English as a second language. This may mean that it will be necessary to operate multiple fare payment systems or ensure that traffic lights and roads continue to serve human-drive vehicles in addition to AVs, to ensure maximum usability.

Safety

It should be acknowledged that the addition of any new functionalities to existing infrastructure requires new analysis of the equitable use of said infrastructure. For example, racial and economic equity should be considered in the process of introducing ATE components to an existing infrastructure.

Preparing the current infrastructure systems to readily receive/support emerging transportation technologies also readies the system to benefit from all of the safety improvements said technologies might yield as quickly as possible. For example, AVs may reduce crashes and 5G may facilitate the movement of emergency vehicles¹⁰⁶. Additionally, some communications technologies are being developed/evaluated specifically to increase safety, such as Collision Avoidance Warning Systems (CAWS) that can be specialized for personal vehicle use or transit.¹⁰⁷ Additive technologies such as ATE can be used to reduce speed, which was a factor in 29% of all crash fatalities in the US in 2020.¹⁰⁸

Sustainability

Preparing the current infrastructure systems to readily receive/support emerging transportation technologies also readies the system to benefit from all of the environmental improvements said technologies might yield as quickly as possible. For example, transit (mass and micro) and SMDs have the potential to reduce impacts on the environment, and in turn, damage to human health. Proactive approaches to infrastructure also reduce the need to retrofit, which can be disruptive to the environment and create waste.

Potentially Applicable Technologies

- Automated/Autonomous Vehicles
- SMDs
- Signal Technologies
- System Optimization
- Drones
- Changes to Delivery and Freight
- Improvements to Mass Transit
- Smart Technologies/Cities and IOT

Table 22 - Strategy #6, Application of Core Values

¹⁰⁶ <https://www.summitstrategies.us/wp-content/uploads/2019/11/5G-Policy-Primer-November-2019-1.pdf>

¹⁰⁷ https://www.researchgate.net/publication/322851325_Active_Safety-Collision_Warning_Pilot_in_Washington_State

¹⁰⁸ <https://www.iihs.org/topics/speed>

NVTA Transportation Technology Strategic Plan

Strategy #7: Enhance Regional Coordination and Encourage Interoperability in the Transportation System

3.7 Strategy #7: Enhance Regional Coordination and Encourage Interoperability in the Transportation System

3.7.1 Description

The communities in Northern Virginia (Planning District 8¹⁰⁹) are deeply interconnected, due to close physical proximity of densely populated areas, cross-jurisdictional employment, housing and community/cultural opportunities, and the relative ease of inter-jurisdictional travel. Regional leaders recognize this and work in concert to provide a consistent quality of life to the citizens of the region, as epitomized by the Northern Virginia Transportation Authority itself.

As the number of transportation modes and technological enhancements continue to increase, so will the opportunities and needs to build on the already strong regional coordination efforts, to ensure interoperability in the region. (In fact, the Greater Washington Partnership lists “Cross-Jurisdiction Capital Region Data Management System to Power All Technology Actions and Improve Regional Mobility” as one of the goals of its Capital Region Blueprint for Regional Mobility.¹¹⁰) Interregional interoperability should also be considered, when possible and appropriate. The Virginia Information Technologies Agency’s Enterprise Information Architecture may be a good starting point and/or precedence in this.⁴⁷ Interoperability should be a key consideration in three arenas: infrastructure, policy, and data collection and sharing requirements.

Infrastructure: Strategy #7 will encourage standardization of the physical/stationary components of any smart system in the region, to ensure that mobile components of the system, can communicate easily and quickly, regardless of trip location. This applies to things like Transit Signal Priority (or other Adaptive Signal Control) systems; connected infrastructure (i.e., Cellular Vehicle to Everything [CV2X] enabled devices for Autonomous Vehicles [AVs]¹¹¹), and even software packages like those used for transit system monitoring and management.

Policy: Strategy #7 will explore policy approaches for working with private mobility service providers (SMDs and microtransit) to ensure consistency across the region. This may increase the attractiveness of Northern Virginia as a partner in innovative transportation deployments, which can contribute to recruitment and retention of business partners and top talent¹¹². (For example, untapped capacity in the public transportation systems in the DMV was a factor in Amazon’s decision to locate its second headquarters in Alexandria, Virginia.¹¹³) This type of consistency also facilitates use of these modes and may thus help achieve other NVTA goals like reducing congestion and lessening environmental impacts of the transportation network. Components that should be coordinated include pricing schemas (both for operator permits and system users); fleet size limitations; vehicle/device equipment standards (i.e., the presence of a bell or light on SMDs); service distribution requirements; criteria for service restrictions (i.e., in which contexts would Personal Delivery Devices¹¹⁴ be authorized to operate on sidewalks/crosswalks); equity programs and requirements for cybersecurity and privacy.

Data: Strategy #7 will encourage standardization of data collection and sharing (from both private and public service providers) to facilitate interoperability across systems (including those that are currently in place and those that have yet to be established), analysis, reporting and planning efforts¹¹⁵. This also reduces the need for potentially complex and costly data fusion, creates opportunities for comparisons and collaborations across the region and provides a

¹⁰⁹ <https://www.dhcd.virginia.gov/pdcs>

¹¹⁰ <https://www.greaterwashingtonpartnership.com/blueprint/solution-6.html>

¹¹¹ <https://www.auto-talks.com/technology/dsrc-vs-c-v2x-2/>

¹¹² <https://www.citylab.com/transportation/2017/09/amazons-hq2-hunt-is-a-transit-reckoning/541296/>

¹¹³ https://www.alexandriava.gov/news_display.aspx?id=106767

¹¹⁴ <https://lis.virginia.gov/cgi-bin/legp604.exe?201+sum+SB758&201+sum+SB758>

¹¹⁵ <https://www.brookings.edu/research/modernizing-approach-to-data/>

NVTA Transportation Technology Strategic Plan

Strategy #7: Enhance Regional Coordination and Encourage Interoperability in the Transportation System

predictable and reliable business environment for Public Private Partnerships¹¹⁶. Items that should be standardized include data fields and types to be collected (special attention should be paid to the types of safety data collected like number of crashes or disengagements etc.); quality standards; collection and sharing cycles; reporting formats and units; opportunities to provide qualifying supporting information (or other qualitative feedback) and any guidance for anonymization or aggregation. Some effective techniques to achieve these goals include encouraging open Application Programming Interfaces [API] for any services contracted, using nationally accepted/prevaling data formats (like General Transit Feed Specification [GTFS]¹¹⁷, General Bikeshare Feed Specification [GBFS]¹¹⁸, Transactional Data Specifications [TDS]¹¹⁹, and Mobility Data Specification [MDS]¹²⁰) and establishing reasoning and objectives for data collection.

3.7.2 Relevant NVTA TransAction Goal

Accessibility: Strengthen the region's economy by increasing access to jobs, employees, markets and destinations for all communities.

¹¹⁶ <https://omniride.com/omniride/assets/File/PRTC-Recommendations-Summary.pdf>

¹¹⁷ <http://gtfs.org/>

¹¹⁸ <https://github.com/NABSA/gbfs>

¹¹⁹ <https://www.aarp.org/ppi/info-2020/modernizing-demand-responsive-transportation.html>

¹²⁰ <https://github.com/openmobilityfoundation/mobility-data-specification>

NVTA Transportation Technology Strategic Plan

Strategy #7: Enhance Regional Coordination and Encourage Interoperability in the Transportation System

3.7.3 NVTA Roles

Authority Roles	Funding	- Technology deployments that contribute to data collection and sharing should be considered through TransAction. This may include counters on roads or trails, or in transit vehicles. It could also include purchase of data storage or creation of data lakes or response systems. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	Mid Term
Shared Roles	Champion	- The Authority may encourage member jurisdictions to seek/use/create policies, data standards and infrastructure that are interoperable. - The Authority and staff may take efforts to ensure the member jurisdictions are aware of systems, policy and data standards in use in the region and how those may or may not interact with each other. - Staff may encourage (and/or support) other planning efforts in the region to include interoperability as a primary goal.	Immediate
	Facilitate	- Authority Members can facilitate the prioritization of interoperability in the region by publicly expressing support for the goal, through adoption of this plan. - The Authority can facilitate the prioritization of interoperability in the region by submitting letters of support for related projects (i.e., for funding applications to external entities.) - NVTA staff can facilitate the prioritization of interoperability in the region by assisting member jurisdictions in making the case for related projects and/or providing technical expertise. - NVTA may consider the creation of a committee or panel of experts that can be convened to review member jurisdictions' (new or established) policies and/or procurement scoping documents and advise on potential for barriers or synergies for interoperability across the region. This body may consist of jurisdictional representatives and/or the members of the private sector (although care should be taken in establishing and/or convening this body to avoid any conflicts of interest in procurement processes.) The committee could be convened to review NVTA's own documents/processes or to review member jurisdiction documents/processes, at the request of said jurisdiction.	Immediate
Staff Roles	Planning	- NVTA staff should continue to consider interoperability in long-range planning efforts (in terms of project eligibility criteria, the reevaluation of project scoring metrics and scenario planning.) - NVTA staff should consider if the metrics and reporting formats used in current planning efforts best support evaluation of interoperability moving forward. For example, are the metrics requested sufficiently granular for multiple use cases? Is there data available that is not being collected? This may involve diversifying data sources and/or analysis tools available to staff. - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Immediate
	Outreach/ Education	- NVTA staff should stay abreast of developments in various technologies (including data standards used in the region, the country and around the world) and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - NVTA staff should continue to share information about transportation technologies with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 23 - Strategy #7, NVTA Roles

NVTA Transportation Technology Strategic Plan

Strategy #7: Enhance Regional Coordination and Encourage Interoperability in the Transportation System

3.7.4 Application of Core Values

Equity	A 2017 report from the Brookings Institution, on the topic of emerging transportation data, asserts that: <i>"Simply put, data is better than it has ever been, and public agencies have an incredible opportunity to institute the data-related reforms that will help them deliver more equitable, sustainable, and efficient communities."</i>¹²¹ Data provides opportunities for increased understanding and awareness that may help illuminate undocumented (or insufficiently documented) inequities and empower localities to seek solutions. Encouraging interoperability and communications between Demand Responsive Transit systems (DRT) could also bolster those systems' ability to serve historically underrepresented populations by facilitating cross system and inter-jurisdictional travel or trip chaining. Additionally, measures to assist disadvantaged or underserved populations in accessing publicly available data should be encouraged.
Safety	Fostering the interoperability in the regional transportation network is critical in supporting emerging technologies and readies the system to benefit from all of the safety improvements said technologies might yield, as quickly as possible. For example, encouraging increased use of mass and microtransit, micromobility and/or AVs could reduce the number of vehicle operators on the roads, thus limiting the number of fallible human drivers in the system. This, in turn, may reduce vehicular crashes and secondary crashes. AVs also have the potential to reduce aggressive and defensive driving and may provide automated vehicular inspection capabilities, to reduce incidents of component failure during operations.
Sustainability	Interoperability in policies and data can facilitate synergies in a multimodal network that provides alternatives to Single Occupancy Vehicles. Ensuring that physical infrastructure accommodates easy use of transportation options across jurisdictional boundaries supports improvements to transit (mass and micro) and adoption of AV and EV vehicles. These modes have the potential to decrease the production of Greenhouse Gas emissions in the transportation sector.

Table 24 - Strategy #7, Application of Core Values

Potentially Applicable Technologies

- Automated/ Autonomous Vehicles
- SMDs
- Signal Technologies
- Apps
- System Optimization
- Drones
- Changes to Delivery and Freight
- Surveillance/ Monitoring
- Data Generation/ Collection/ Sharing
- Improvements to Mass Transit
- Smart Technologies/ Cities and IOT

¹²¹ <https://www.brookings.edu/research/modernizing-approach-to-data/>

NVTA Transportation Technology Strategic Plan

Strategy #8: Advance Decarbonization of the Transportation System

3.8 Strategy #8: Advance Decarbonization of the Transportation System

3.8.1 Description

Policy makers and vehicle manufacturers across the globe are setting goals to reduce or phase out use of Internal Combustion Engines (ICE)¹²², largely due to their environmental impacts. Recent technological breakthroughs, coupled with political will and increases in acceptance from the public have established Zero Emission Vehicles (ZEVs) as a viable alternative to ICE vehicles, and make ambitious goals to change the way travel is fueled possible. There are several alternative fuels or propulsion or technologies under development¹²³ including hydrogen, and more specifically, “clean hydrogen”, which shows great potential. In fact, hydrogen is a key component in the International Energy Agency (IEA)’s Net-Zero by 2050 analysis, designated to fill the gaps where use of other energy forms is difficult.¹²⁴ The Greater Washington Partnership identifies medium and heavy-duty transportation as sectors, among others, as having strong opportunities for hydrogen use by 2030, and thus advocates for preparations to utilize this energy source begin post haste.¹²⁵ Despite the value of alternative fuels like hydrogen, electrification is still widely envisioned to be the primary energy source for transportation going forward, and it is gaining momentum in the Commonwealth.¹²⁶ Virginia’s efforts are also synergistic with the National Electric Vehicle Infrastructure (NEVI) Program which aims to create a nationwide network of 500,000 EV chargers that are no more than 50 miles apart on designated Alternative Fuel Corridors.¹²⁷

Electric Vehicles (EV) typically cost less to power¹²⁸, and yield reduced emissions¹²⁹, when compared to Internal Combustion Engine (ICE) vehicles. Creation of an electric charging network could reduce vehicle operating costs and mitigate environmental impacts of vehicle fleet operations, a powerful combination that would benefit current fleet operators in the region and bolster the attractiveness of Northern Virginia as a business location. While most owners of private EVs charge their vehicles at home¹³⁰, developing a network in such a manner that it could be used by individuals as well, could reduce “range anxiety”, and allow for greater market penetration. The reduction in greenhouse gas and other emissions resulting from expanded adoption would be beneficial to the environment. Additionally, there is the possibility for charging structure to be developed in a way that would support Vehicle to Grid, or V2G, functionality, in which an EV can store power, and redistribute it to the grid. This could be a boon to the resiliency of the transportation and electric grid systems, by providing energy storage that can be leveraged during surges of demand or emergencies.¹³¹

Strategy #8 will explore continuing to fund purchase of low/Zero Emissions transit vehicles (in the FY 2018-2023 program [NVTA funded a project from the City of Alexandria](#) which included the purchase of 8 electric buses and supporting infrastructure and in the FY2022-2027 program [NVTA funded purchase of 8 Zero Emission Vehicle \(ZEV\) battery electric transit buses Connector buses](#)¹³²) going forward. In considering applications for this funding, special consideration could be given to low/Zero Emissions microtransit, as this demand-responsive mode can create transit options in locations where none currently exist and/or to address First-Mile/Last-Mile (FMLM) challenges. This may include autonomous low/Zero Emissions transit vehicles, building on the precedence of the Autonomous Electric Shuttle Pilot Project in

¹²² <https://theicct.org/blog/staff/global-ice-phaseout-nov2020#:~:text=California%20is%20the%20latest%20jurisdiction,California%20must%20be%20zero%20emission>.

¹²³ <https://afdc.energy.gov/fuels/>

¹²⁴ <https://www.iea.org/reports/net-zero-by-2050>

¹²⁵ https://www.hydrogenprint.org/?_hsmi=216440819&_hsenc=p2ANqtz-80iTMa2EcmT0lvYyR7kGtRsjhVxIh5VcsweZDDfz2l96EmW1DJLfn2RyNbqmmkSWTSVuz05kzGASDKqapiMr9YJ6wkru63UIXZMerpaYFEUH1BmM&utm_content=216440819

¹²⁶ http://www.ctb.virginia.gov/resources/2021/march/pres/ev_readiness_study_ctb_presentation_03-17-21_final.pdf

¹²⁷ <https://www.fhwa.dot.gov/environment/nevi/>

¹²⁸ <https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs>

¹²⁹ <https://www.energy.gov/eere/electricvehicles/reducing-pollution-electric-vehicles>

¹³⁰ <https://www.energy.gov/eere/electricvehicles/charging-home>

¹³¹ <https://www.electrificationcoalition.org/wp-content/uploads/2022/06/Advancing-V2G-Technology-Adoption.pdf>

¹³² <https://thenovaauthority.org/funded-projects/>

NVTA Transportation Technology Strategic Plan

Strategy #8: Advance Decarbonization of the Transportation System

Fairfax County¹³³. The strategy will also seek to facilitate regional coordination in participating in the Commonwealth's NEVI Plan.

To ensure enduring success with this technology, it will be critical to plan for continual innovation (including the potential for obsolescence of charging technologies), as noted by SAFE, in their "Electrification Roadmap"¹³⁴, and to proactively prepare for future uses of the technology, such as V2G. This strategy should also be flexible enough to adapt to consider alternative fuels, or propulsion technologies if/when they become feasible for use in the region. In the case of hydrogen, it may also be appropriate to encourage the development of policies and infrastructure that support the feasibility of its use.

3.8.2 Relevant NVTA TransAction Goal

Resiliency: Improve the transportation system's ability to anticipate, prepare for and adapt to changing conditions and withstand, respond to and recover rapidly from disruptions.

¹³³ <https://www.fairfaxcounty.gov/transportation/autonomous-shuttle-pilot>

¹³⁴ https://secureenergy.org/wp-content/uploads/2016/03/EC_Roadmap.pdf

NVTA Transportation Technology Strategic Plan

Strategy #8: Advance Decarbonization of the Transportation System

3.8.3 NVTA Roles

Authority Roles	Funding	- Purchase of low/Zero Emissions fleet vehicles, specifically those that facilitate First-Mile/Last-Mile (FMLM) connections, should continue to be supported via TransAction. - Projects to create publicly available and/or fleet charging (or other low/Zero Emissions fueling) facilities should continue to be supported via TransAction. Particularly those that provide benefits for resiliency as well, through technologies like V2G. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	Mid Term
	Policy	- The Authority may develop a policy to establish regionally consistent pricing/charging schemas and payment options. - The Authority may develop a policy to address the interoperability of the charging (or low/Zero Emissions fueling) infrastructure. - The Authority may develop a policy to proactively prepare for low/Zero Emissions fueling options, such as hydrogen. - The Authority may develop a policy that encourages re-use or multiple use cases for propulsion technologies, like V2G that increases resilience in the transportation and electric systems.	Near Term
	Advocate	- The Authority may advocate for the Commonwealth to adopt legislation to require at-station payment options, ensure equitable access and protect user privacy and cybersecurity. - The Authority may advocate for legislation that prohibits price gouging. - The Authority may advocate for legislation to regulate how Energy providers charge residential customers for EV charging. - The Authority may advocate for the creation of a statewide EV battery reclamation policy and reuse system (this may leverage or create Public Private Partnerships.) One use of this system may be repurposing vehicle batteries as a component of EV charging stations.¹³⁵ - The Authority may advocate for other sectors, such as power generation, to increase their coordination with the transportation sector.	Near Term
Shared Roles	Champion	- Authority Members can encourage their jurisdictions to seek out and apply for funding for low/Zero Emissions related projects and/or to seek ways incorporate EV infrastructure into existing projects. - NVTA Staff may encourage (and/or support) other planning efforts in the region to consider EV or low/Zero Emissions fueling infrastructure, technologies. - NVTA staff may encourage (and/or support) preparations for other viable low/Zero Emissions fueling technologies and infrastructure to begin or progress in the region.	Ongoing
	Facilitate	- Authority Members can facilitate the creation of an EV charging network, or low/Zero Emissions fueling infrastructure, by publicly expressing support for the goal, through adoption of this plan. - The Authority can facilitate the creation of an EV charging network, or low/Zero Emissions fueling infrastructure, by submitting letters of support for related projects (i.e., for funding applications to external entities.) - NVTA staff can facilitate the creation of an EV charging network, or low/Zero Emissions fueling infrastructure, by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Mid Term
Staff Roles	Planning	- NVTA staff should consider EV and low/Zero Emissions technologies in long-range planning efforts (in terms criteria to be eligible for inclusion in TransAction, the reevaluation of project scoring metrics and scenario planning.) - Scenarios for planning exercises may include creation of a charging network that would be available to service public fleets (and perhaps private fleets) only and the creation of charging network that would be available to both public fleets and private vehicles. - NVTA Staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Immediate
	Outreach/ Education	- NVTA staff should stay abreast of developments in EV and low/Zero Emissions technologies and use the knowledge to inform the CEO, the Authority, and committees like the TTC and RJACC. - NVTA staff should continue to share information about EV and low/Zero Emissions technologies with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 25 - Strategy #8, NVTA Roles

¹³⁵ https://www.ey.com/en_us/automotive-transportation/why-the-ev-battery-life-cycle-is-more-important-than-the-battery-life

NVTA Transportation Technology Strategic Plan

Strategy #8: Advance Decarbonization of the Transportation System

3.8.4 Application of Core Values

Equity

Low/ZEV technology may be able to facilitate increased modal options and access to transit by improving the business models for mass and microtransit with reduced operating costs. The reductions in costs of personal vehicle fueling may also benefit some members of the community. Additionally, replacing gas powered/diesel buses with low/ZEV buses also reduces health and environmental impacts on communities located closest to bus depots, or other locations where diesel vehicles idle for extended periods of time.

Steps should be taken to ensure that stations in the charging (or low/ZEV fueling) network (and/or the fleet(s) it supports) are accessible to people with disabilities, have low technical literacy, are unbanked, or use English as a second language. This may include things like providing station use instructions in multiple languages (including braille), providing cash payment options, or ensuring that curbs do not block physical access to payment screens or transit vehicles. Additionally, there may be a need for public investment in charging or low/ZEV fueling infrastructure in disadvantaged communities, since the business case for private investment may not be as robust in these contexts.

Safety

Creation of a robust electric vehicle-charging (or other low/Zero Emissions fueling) network may facilitate/encourage use of microtransit and autonomous vehicles, both of which have the potential to reduce or remove the number of fallible human drivers on the roads.

Sustainability

Low/Zero Emission Vehicles (ZEVs) generate little to no tail pipe emissions.¹³⁶ This represents such a significant reduction in environmental impact that benefits can be seen over their entire life span, even when factoring in a production process that is more resource intensive than that of standard vehicles.¹³⁷ Additionally, EVs and low/ZEVs have the potential to get more efficient over time, as more efficient methods of electricity generation are perfected and adopted.¹³⁸ Finally, EVs may create the potential to store energy and return it to the grid, through V2G technology. This could be a boon for resilience of the systems and there are already real-world deployments underway in the United States, using school buses.¹³⁹

Potentially Applicable Technologies

- Automated/Autonomous vehicles
- SMDs
- System optimization

Table 26 - Strategy #8, Application of Core Values

¹³⁶ https://ec.europa.eu/transport/themes/urban/vehicles/road/electric_en

¹³⁷ https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf

¹³⁸ <https://blog.ucsusa.org/dave-reichmuth/new-data-show-electric-vehicles-continue-to-get-cleaner>

¹³⁹ <https://www.prnewswire.com/news-releases/nuvve-and-coloradowest-equipment-deploy-first-v2g-electric-school-bus-solution-in-colorado-301446080.html>

NVTA Transportation Technology Strategic Plan

3.9 Strategy #9: Enhance Mobility in the Region through Innovation and Emerging Technologies in Transit

3.9.1 Description

The importance of transit to maximizing the functioning of a multimodal transportation network, and to achieving environmental and equity goals cannot be understated. Using a single vehicle to meet the demand of many travelers helps to alleviate congestion and reduces emissions, which benefit all members of a community, and creates possibilities to provide travel options at little to no cost for the rider, which contributes to equitable access to desirable destinations.

There are now more methods of providing transit services than ever before, with innovation making it possible to use a greater variety of vehicles, optimize routing, maximize scheduling flexibility, reduce operating costs, and improve passenger access and comfort. There are many examples of these across the region, Commonwealth, and Country, as detailed in the [Appendix of this document](#). Two key examples of this include Bus Rapid Transit and Microtransit.

Bus Rapid Transit, or BRT, systems utilize high-capacity buses in dedicated lanes to provide transit service that has many of the benefits of rail at a lower cost. This is made possible through physical components like enhanced bus stop locations, typically referred to as stations, but also relies heavily on innovative systems like Transit Signal Priority (TSP), real-time bus tracking and fare collection methods that expedite the on-boarding process. The speed, frequency and reliability of BRT improves trips for those who already use transit regularly and increases the attractiveness of the mode to others as well. For these reasons, BRT projects are highly consistent with NVTA's primary metric of Congestion Reduction Relative to Cost (CRRC). In fact, NVTA has already allocated funding to several BRT projects in the region, as detailed below. It has also established a region-wide BRT Working Group (which also includes members from outside the region, in D.C. and Maryland, to facilitate regional connectivity), to maximize synergies between existing projects and to encourage development of a coordinated network of BRT routes.

1. Richmond Highway Bus Rapid Transit - Phases I & II - \$250,000,000¹⁴⁰
2. Duke Street Transitway - \$87,000,000¹⁴¹
3. West End Transitway - \$2,400,000¹⁴²
4. Metroway Extension - \$28,850,000¹⁴³
5. Envision Route 7 - \$838,000¹⁴⁴

Microtransit is a nascent transit option that can utilize virtually any size of vehicle, but tends towards smaller buses and vans, to provide on-demand scheduling on both fixed and flexible routes, using powerful dispatch software. This flexibility can create opportunities to minimize deadheading (running buses without passengers), the need for lengthy dwell times at time check stops, maintenance of advanced licensure for operators, and the potential expansion of service areas or hours. Additionally, the concept is readily transferable to many different contexts, from urban to rural, and can be

¹⁴⁰ <https://novagateway.org/Dashboard/Overview/7>

¹⁴¹ <https://novagateway.org/Dashboard/Overview/45>

¹⁴² <https://novagateway.org/Dashboard/Overview/40>

¹⁴³ <https://novagateway.org/Dashboard/Overview/4>

¹⁴⁴ <https://novagateway.org/Dashboard/Overview/119>

NVTA Transportation Technology Strategic Plan

Strategy #9: Enhance Mobility in the Region through Innovation and Emerging Technologies in Transit

developed to facilitate accessibility for a variety of target demographics. For example, the Virginia Department of Rail and Public Transportation (DRPT), is currently undertaking a pilot through the Microtransit Deployment Initiative¹⁴⁵, that developed this type of service specifically for older individuals in rural contexts. The two deployments, being conducted in partnership with Bay Transit, a Division of Bay Area Aging, and Mountain Empire Older Citizens, have thus far yielded very positive results. In fact, at the 2022 Conference of the Intelligent Transportation Society of Virginia (ITSVA)¹⁴⁶ Michael Norvell of Bay Transit shared that the microtransit service pilot taking place in that system had eclipsed the ridership of their fixed-route services at a lower cost, and customer satisfaction was high. Other Virginia localities are considering deploying this technology in different circumstances, in the hopes of yielding similar results. For example, transit service provider OmniRide, has converted one fixed-route service to microtransit, in the City of Manassas Park.¹⁴⁷ To support the potential benefits of projects like this, a microtransit project has been included in the project list¹⁴⁸ of the recent update of TransAction, the long-range transportation plan for Northern Virginia.¹⁴⁹

There are other innovations and technologies emerging to support and enhance transit services all the time, from big data initiatives that support information sharing with the public and system optimization on the back end¹⁵⁰, to Advanced Traffic Management Systems (ATMS) and adaptive signal optimization. Through this TTSP strategy NVTA seeks to stay abreast of these and future developments, and to support their future integration as appropriate to reduce congestion and enhance mobility options for Northern Virginians, in a matter that is consistent with NVTA's Core Values.

3.9.2 Relevant NVTA TransAction Goal

Enhance quality of life by improving the mobility of Northern Virginians on the region's multimodal transportation system. [Mobility]

3.9.3 NVTA Roles

¹⁴⁵ <https://content.govdelivery.com/accounts/VADRPT/bulletins/2e59372>

¹⁴⁶ <https://www.itsva.org/wp-content/uploads/2022/05/ITSVA-Annual-Conference-Schedule.pdf>

¹⁴⁷ <https://omniride.com/service/connect/>

¹⁴⁸ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTA_TransActn_Project-List_Dec2022_Final.pdf

¹⁴⁹ <https://thenovaaauthority.org/wp-content/uploads/2022/05/TAC-2022.05.18-Mtg-Full-Packet-V2.pdf#page=55>

¹⁵⁰ <https://www.drpt.virginia.gov/transit/mobility-for-all/>

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Authority Roles	Funding	- Projects to purchase rolling stock for transit systems should continue to be supported through TransAction and careful attention should be paid to ensuring enabling language is flexible enough to allow for a variety of vehicle types and propulsion technologies. - Support for infrastructure and technology projects that enable fast, frequent, and reliable transit services which may encourage shared rides and/or alternative modes of transportation should continue to be supported through TransAction. - Technology deployments for system optimization should continue to be supported through TransAction. - When the Authority seeks to apply for funding from an external source, the application should be written in such a way as to facilitate and encourage innovation in fulfilling the need or goal that drove the application. - When the Authority seeks to purchase goods or services (i.e., modeling platforms, consultant services, data subscriptions or analysis software etc.) to support its mission, careful attention should be paid to approach the procurement process in such a way that balances the need to achieve certain predetermined goals with the need to allow for a flexibility in methodology that enables innovation. - An additional scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	Ongoing
	Advocate	- The Authority may develop policies that encourage mass and microtransit and/or other forms of ride sharing. For example, a policy may encourage creation of transit stations (or coverage by demand-responsive transit) in predetermined target areas (to help make First-Mile/Last-Mile (FMLM) connections) or to allow microtransit in bus lanes (with the caveat that they do not interfere with the high-frequency service operating using those lanes.) - The Authority may encourage exploration of new transit modes and innovations as part of alternatives analysis for any Authority-funded project.	Immediate
Shared Roles	Champion	- The Authority may champion efforts to create or support seamless interjurisdictional travel via transit systems. - NVTA staff may champion project components or proactive planning efforts that support interoperability across jurisdictions and transit systems.	Near Term
	Facilitate	- Authority Members can facilitate the use of technology to reduce congestion by publicly expressing support for the goal, through ongoing implementation of this plan. - The Authority can facilitate the use of technology to reduce congestion by submitting letters of support for related projects (i.e., for funding applications to external entities.) - NVTA staff can facilitate the use of technology to reduce congestion by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Near Term

NVTA Transportation Technology Strategic Plan

Strategy #9: Enhance Mobility in the Region through Innovation and Emerging Technologies in Transit

Staff Roles	Planning	- NVTA staff should continue to consider the use of technology to reduce congestion in long-range planning efforts (in terms of crafting project descriptions for inclusion in TransAction, the reevaluation of project scoring metrics and scenario analysis.) - NVTA staff should continue to consider¹⁵¹ if terminology and project descriptions used in current planning efforts allow for the introduction of innovative solutions. For example, would continued use of “bicycle and pedestrian” exclude other emerging micro modes? Should the measures used to evaluate use of transit as a means of access to jobs, employees, markets and destinations be updated to reflect the potential for demand-responsive microtransit that may or may not rely on traditional stops or stations? ¹⁵² - Planning efforts should remain technology agnostic in long-range planning initiatives, to accommodate innovation and unknown developments. - NVTA staff should continue to facilitate inter and intra-regional coordination, to foster synergies between transportation systems and/or innovations. - NVTA staff should consider the potential benefits and negatives of using technology or other innovative approaches in all planning efforts, such as the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT.)	Near Term
	Outreach/ Education	- NVTA staff should stay abreast of developments in various technologies and use the knowledge to inform the CEO, the Authority and committees like the TTC and RJACC. - Staff should continue to share information about transportation technologies with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 27 - Strategy #9, NVTA Roles

¹⁵¹ <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf>

¹⁵² <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-D.pdf>

NVTA Transportation Technology Strategic Plan

Strategy #9: Enhance Mobility in the Region through Innovation and Emerging Technologies in Transit

3.9.4 Application of Core Values

Equity	The average Social Vulnerability Index (SVI)¹⁵³ is, on average, 21% higher in transit deserts (areas in which the demand for transit services is greater than the supply) than in surrounding areas. In the DC Metro area, the average SVI was 44.1% higher in transit deserts.¹⁵⁴ APTA reports¹⁵⁵ that all forms of transit are becoming more ADA accessible, with 99% of buses being accessible by 2020. However, it is important to note that station and stop design also impact this. The Virginia DRPT is currently conducting a Transit Equity and Modernization Study, to assess the equitability of transit in the Commonwealth and make recommendations for improving it.¹⁵⁶
Safety	The American Public Transportation Association (APTA), reports that there were 134 times less fatalities on transit than on highways in 2019 and cities with higher number of average transit trips per person have even lower fatality rates.¹⁵⁷ (It is important to note that these figures were derived before the onset of the Covid-19 pandemic and may have changed.) While this indicates transit systems are typically operated safely in the United States, it is critical to understand other aspects of user safety, as well as perceptions of safety, that may influence use of the mode. For example, although women comprise more than half of transit riders in the U.S., they are “three times as likely to be concerned for their safety on transit.”¹⁵⁸
Sustainability	The transportation sector is the largest source of Greenhouse Gas (GHG) emissions in the United States, accounting for 27% of total emissions. Passenger vehicles comprised the largest share of the sector’s total emissions in 2020, at 37.8%. This indicates that providing alternatives to passenger vehicle use has significant potential to reduce overall transportation emissions.¹⁵⁹ Additionally, “[t]he FTA estimates that, on a national level, the average transit system emits 0.45 lbs CO2 per passenger mile compared with a single occupancy private vehicle at 0.96 lbs CO2 per passenger mile.” Several other studies have since found similar results, indicating transit is more efficient in general. If technological advancements have the potential to optimize transit systems, this is certainly worth exploring as doing so could further improve the sustainability of these modes.

Table 28 - Strategy #9, Application of Values

Potentially Applicable Technologies

- Automated/ Autonomous Vehicles
- Signal Technologies
- Apps
- System Optimization
- Data Generation/ Collection/ Sharing
- Improvements to Mass Transit
- Smart Technologies/ Cities and IOT

¹⁵³ <https://www.atsdr.cdc.gov/placeandhealth/svi/index.html#:~:text=Social%20vulnerability%20refers%20to%20the,human%20suffering%20and%20economic%20loss.>

¹⁵⁴ https://dc.uwm.edu/cgi/viewcontent.cgi?article=1169&=&context=ijger&=&sei-redir=1&referer=https%253A%252F%252Fscholar.google.com%252Fscholar%253Fas_ylo%253D2021%2526q%253Dtransit%252Bdesert%2526hl%253Den%2526as_sdt%253D0%252C47#search=%22transit%20desert%22

¹⁵⁵ <https://www.apta.com/wp-content/uploads/APTA-2021-Fact-Book.pdf>

¹⁵⁶ <https://www.vatransitequity.com/>

¹⁵⁷ <https://www.apta.com/wp-content/uploads/APTA-2021-Fact-Book.pdf>

¹⁵⁸ <https://wagner.nyu.edu/files/faculty/publications/Pink%20Tax%20Report%202.10.22.pdf>

¹⁵⁹ <https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-main-text.pdf>

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NVTA Transportation Technology Strategic Plan

Data Needs

4.1 Data Needs

The Northern Virginia Transportation Authority takes a data-driven approach to planning and programming. This can be seen in the careful scenario planning and modeling conducted as part of the TransAction¹⁶⁰ and associated Six Year-Program updates.¹⁶¹ A similar modeling approach was also taken in NVTA's initial analysis of the potential impacts of the Covid-19 pandemic.¹⁶²

Data will continue to be integral to NVTA's analysis of the transportation network and needs, and thus, to its understanding and action around new technologies as well (as discussed in [Strategy #7.](#)) NVTA is agnostic to data specifications, so long as the format:

- Adequately satisfies identified analysis needs across the region
- Contributes to a comprehensive and multimodal understanding of the transportation network
- Facilitates efficient interoperability, region wide (and to the extent possible, with areas external to the region)
- Protects privacy of community members and can be secured with effective cybersecurity measures (as discussed in [Strategy #3](#))

4.2 Caveats and Assumptions

The nature of innovation and preparing for the future inherently involves some unknowns, many of which have been discussed hereto. For this reason, it is necessary to make some assumptions, which are listed below:

- All Autonomous Vehicles (AVs) are likely to eventually also be Electric Vehicles (EVs), as many countries and consumers are making efforts to phase out Internal Combustion Engines (ICE), in pursuit of a more sustainable transportation sector.¹⁶³
- The DC, Maryland, Virginia (DMV) region will continue to experience population growth and increasing travel demand, in keeping with the Metropolitan Washington Council of Government's Cooperative Forecasts per Transportation Analysis Zones.¹⁶⁴
- The existence of transit services is not sufficient to attract and retain ridership. The service must also be safe, reliable, and affordable. It may be necessary to collect and analyze data to achieve this.
- The most beneficial combination of decarbonization technologies, and possibly synergies with technologies to improve resiliency, will be unique to each community and may indeed vary within a community. Data will be integral to making these decisions.

4.2.1 Impacts of Covid-19

In June of 2020, the Northern Virginia Transportation Authority teamed with AECOM to do scenario modeling of the potential impacts of the COVID-19 pandemic on transportation and used the results to

¹⁶⁰ <https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-E-1.pdf>

¹⁶¹ <https://thenovaaauthority.org/fy2024-2025-six-year-program-update/>

¹⁶² <https://thenovaaauthority.org/wp-content/uploads/2020/09/PPC-Meeting-Packet-9-29-2020-FINAL.pdf>

¹⁶³ https://www.nature.com/articles/s41560-020-0644-3.epdf?sharing_token=cE6vaPzu-NDODFHLXk06PdRgN0jAjWel9jnR3ZoTv0PkV4h-0BfuDxTt20euiNiwgJB6g8CLgd2HJNRMDTCSC8_8JcBgF0-pv7-mboFgY-h88dzdolggR95UkvMkCdlw2hfiGxCUzDwlWphvJ5ecSDurTdn-t4gEFdDq8Le_8BePUwATi1b2KiUt4axz5edlaKtcBQmW1y2ZxMBpK3nrgA%3D%3D&tracking_referrer=www.wired.com

¹⁶⁴ <https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/>

NVTA Transportation Technology Strategic Plan

Caveats and Assumptions

make several suggestions for modifying/improving the approach of the then-upcoming TransAction¹⁶⁵ planning process.

NVTA also continues to monitor other regional efforts, such as Telework Survey from Commuter Connections, a commuter survey from Virginia Department of Transportation (VDOT)/Virginia Department of Rail and Public Transportation (DRPT), and an employer survey from the Greater Washington Partnership, to contextualize results of its own modeling results.

In 2021, NVTA staff began monitoring travel trends in Northern Virginia and comparing them to data from 2019, to better understand the impacts of the Covid-19 pandemic. Results from these ongoing analyses are presented to the Authority quarterly. Data from the 4th quarter of 2022 indicated that highway travel volumes and travel ridership on local bus services are close to pre-pandemic levels.¹⁶⁶

Despite the most significant impacts of the Covid-19 pandemic receding, there are still outstanding questions about its long-term impacts on travel behavior, including:

- Will teleworking be a larger part of commuting patterns, in the post-pandemic era?
- Will differences in return of ridership continue to differ between local and commuter bus/mass transit services?
- Will transit and rail systems be able to effectively recover from financial hardships associated with the pandemic?
- Will the number of jobs in the region remain similar and on a similar growth trajectory as in the pre-pandemic era?
- Will changes in travel behaviors (particularly peak spreading on highway travel) have long-lasting impacts on average speed and safety?

¹⁶⁵ <https://nvtatransaction.org/>

¹⁶⁶ <https://thenovaauthority.org/wp-content/uploads/2023/03/March-9-2023-Authority-Meeting-Packet.pdf>

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NVTA Transportation Technology Strategic Plan: Action Plan

Action Plan

5.1 Action Plan

The TTSP describes strategies for advancing the beneficial use of technology in transportation, in alignment with NVTA Core Values, and identified roles the NVTA can take in pursuit of them. It also recognizes that the objectives of the TTSP cannot be achieved by NVTA alone and relies on the strong coordination and partnerships that are foundational to NVTA's work in the region. For these reasons, the Action Plan includes a list of Partners for each action, which may be involved to varying degrees (from receiving information to taking direction action), depending on context. It should be noted that these lists of partners are considered a baseline for involvement and should not be interpreted to exclude or limit participation of other entities.

This section of the TTSP aims to map the roles to direct actions and details any assumptions that were made in doing so. A potential trigger point, metrics for measuring success of each action, and a general timeframe for its completion are also suggested. The timeframes referenced are generally understood to mean the following:

Time Frames	Immediate	Near Term	Mid Term	Long Term
Amount of time from the date of most recent substantive update of the TTSP	1 calendar year	2 – 4 calendar years	5 – 9 calendar years	10+ calendar years

This Action Plan will concern itself with NVTA roles that may produce tangible deliverables on a finite timeline, that said, the timing of some items is still unknown and/or flexible, due to the influence of external factors. It focuses primarily on Authority roles in funding, policy, and advocacy, as well as staff planning roles. It is assumed that, in most cases, other roles (champion, facilitate, stakeholder, outreach/education and observer) will be undertaken continually to serve to lay the foundation for other tangible actions.

5.1.1 Past Outcomes

- The TTSP informed development of a technology-related scenario, for TransAction scenario (sensitivity) analysis. This scenario focused on “adoption of connected, automated, shared and electric (CASE) vehicles” and how travel behaviors could change as a result of integration of these emerging technologies.¹⁶⁷
- Introduction of technology-related priorities into NVTA's Legislative Program. This can be seen in:
 - The Legislative Program for FY2022¹⁶⁸
 - The Legislative Program for FY2023¹⁶⁹
- Creation of a series of InNoVation Lunch and Learns designed to provide opportunities for pragmatic information exchange about technologies or innovations that are feasible immediately or in the near future (1-5 years). Each session focuses on topics supported by NVTA's Transportation Technology Strategic Plan (TTSP.)

5.1.2 Possible Future Outcomes

- Technology-related outreach/education
 - Facts and Myths: Connected, Autonomous, Shared, and Electric (CASE) vehicles
- Identify potential refinements to future NVTA SYP project selection process, in accordance with the recent update of TransAction

¹⁶⁷ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

¹⁶⁸ <https://thenovaaauthority.org/wp-content/uploads/2022/05/Northern-Virginia-Transportation-Authority-NVTA-2022-Legislative-Program-1.pdf>

¹⁶⁹ <https://thenovaaauthority.org/wp-content/uploads/2023/01/2023-Legislative-Priorities.pdf>

NVTA Transportation Technology Strategic Plan: Action Plan

Action Plan

- Funding commitments could be made to be contingent on TTSP related criteria, to be identified and approved through the [process laid out in the Action Plan](#).
- Projects selected for future funding could be required to participate in standardization of things like transit signal priority communications
- Funding
 - TransAction Project List is the first filter for projects that can be funded using NVTA regional revenues
 - NVTA staff is currently coordinating with jurisdiction/agency staff to create the projects list(s)
- Establish a process and prioritization for developing White Papers* for future regional transportation policy, potentially on the following topics:
 - Shared mobility devices
 - Autonomous transit shuttles
 - Zero Occupancy passenger Vehicles
 - Human Services transportation

** As NVTA has not previously developed regional transportation policies, any such policies (whether they are in response to the TTSP or any other factor) will first require broad agreement on a collaborative process for policy development. As part of this policy development process, consideration will be given to a prioritized list of potential policy topics. Detailed regional transportation policy development will not commence prior to agreement on both a process and a list of prioritized topics.*

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #1: Reduce Congestion and increase throughput

5.2 Strategy #1: Reduce Congestion and increase throughput

5.2.1 Overview

The population and economy in the region are expected to continue to grow¹⁷⁰ through the year 2045, which may, despite an expected decrease in VMT per capita¹⁷¹, not alleviate congestion. NVTA is, by law, committed to prioritizing congestion reduction in funding projects in the region, and the inclusion of some transportation technologies in projects may contribute to this goal. This Plan identifies several potential roles NVTA can pursue to facilitate and encourage inclusion of innovative measures, most of which can begin immediately or in the near future and be maintained for the long term. These range from funding physical components/projects to advocating for local policy change and state legislation.

5.2.1.1 Assumptions Made

- The population and economy of this region will continue to grow through the year 2045, in keeping with the Metropolitan Washington Council of Government's (MWCOC) projections, despite the impacts of the COVID-19 pandemic. This will likely perpetuate congestion, even if reductions in VMT per capita are achieved.
- The COVID-19 pandemic may create temporary or lasting cultural hesitation to share rides or use transit. Regardless of the longevity of these impacts, they have the potential to exasperate congestion, as preference is given to SOVs.
- Telework has risen in prevalence during the COVID-19 pandemic and will likely continue to constitute a larger percentage of commuter behavior, even after the pandemic has been mitigated.
- Making alternatives to SOV travel easier, cost effective and enjoyable will encourage mode shift and other desirable travel behavior changes. Technology can be used to achieve these goals, but parameters should be in place to both maximize benefits and minimize any negative side effects.

¹⁷⁰ <https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/>

¹⁷¹ <https://www.mwcog.org/file.aspx?D=PXVsN0kMkgXNwvPyDMX1kLIQFFp2OJN0YoTa%2bUimA%3d&A=7xHcSpkGbtnCMhK%2fQTirVScizz%2flnwCEKleZaqWs3K0%3d>

NVTATransaction Technology Strategic Plan: Action Plan

Strategy #1: Reduce Congestion and increase throughput

5.2.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
1A	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ¹⁷² The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore “how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies.” ¹⁷³	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list. • An additional scoring metric could be added to the funding application process that is designed to evaluate consistency with the strategies included in the TTSP, where appropriate.	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of transportation technology.

¹⁷² <https://nvtatransaction.org/>

¹⁷³ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #1: Reduce Congestion and increase throughput

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
1B	Consider transportation technology and innovation in NVTA procurements	NVTA staff	Immediate - Any time NVTA initiates a procurement process or seeks funding from an external source	None currently in progress.	• Funding applications should be written in such a way as to facilitate and encourage innovation in fulfilling the need or goal that drove the application. • When the Authority seeks to purchase goods or services (i.e. modeling platforms, consultant services, data subscriptions or analysis software etc.) to support its mission, careful attention should be paid to approach the procurement process in such a way that balances the need to achieve certain predetermined goals with the need to allow for a flexibility in methodology that enables innovation.	• NVTA staff • Council of Counsels • Authority Members • Member jurisdictions and agencies	• Inclusion of selection criteria that consider TTSP goals and objectives.

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #1: Reduce Congestion and increase throughput

1C	Advocate for jurisdictional policies that leverage technology to reduce congestion and increase throughput	The Authority	Immediate - Initiation of a SYP process	Several member jurisdictions (Alexandria, Arlington, Loudoun County and Prince William County) have, or are developing components of their Comprehensive Plans that focus on transportation technology. Separately, two member jurisdictions are participating in technology pilot programs – the Relay Shuttle pilot in Fairfax County and Arlington County’s Performance Parking Pilot. See the “Related Initiatives” section for more information.	• The Authority may develop policies that encourage mass and microtransit and/or other forms of ride sharing. For example, a policy may encourage creation of transit stations (or coverage by demand-responsive transit) in predetermined target areas (to help make First-Mile/Last-Mile (FMLM) connections) or to allow microtransit in bus lanes (with the caveat that they do not interfere with the high-frequency service operating using those lanes.) • The Authority may encourage member jurisdictions to reduce parking minimums for residential and business land uses and/or policies that allow for exemptions from such minimums for parcels within specified distances from mass transit routes and/or in the occasion of the provision of robust microtransit service.	• NVTA staff • Authority Members • Member jurisdictions and agencies	• Increased knowledge and citations of other jurisdictions’ efforts in jurisdictional level plans and policies. • Increased prevalence of technology plans and policies at the jurisdictional level.
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NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #1: Reduce Congestion and increase throughput

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
1D	Consider transit technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT). ¹⁷⁴	• The goals and strategies of the TTSP should be considered in these planning efforts. • Low/Zero Emissions rolling stock and supportive infrastructure should be considered. • Interoperability and cybersecurity should be carefully considered, particularly as the planning initiative explores interjurisdictional connections. • Related innovations such as TSP, and synergistic technologies that can improve the resiliency of the transportation system, such as V2G, should be considered.	• NVTA staff • PDP BRT Consultant • BRT Working Group	TBD

Table 29 - Action Table, Strategy #1

¹⁷⁴ <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #2: Maximize Access to Jobs, Employees and Housing

5.3 Strategy #2: Maximize Access to Jobs, Employees and Housing

5.3.1 Overview

The population and economy in region are expected to continue to grow¹⁷⁵ through the year 2045, which may perpetuate congestion, despite an expected decrease in VMT per capita¹⁷⁶. NVTA is committed to maximizing access to jobs, employees and housing in the region, through transportation, and various technologies may contribute to this goal. This Plan identifies several potential roles NVTA can take on to facilitate and encourage inclusion of innovative measures, most of which can begin immediately or in the near future and be maintained for the long term. These range from providing letters of support for relevant projects to providing funding for physical components/projects directly.

5.3.1.1 Assumptions Made

- The population and economy of this region will continue to grow through the year 2045, in keeping with the Metropolitan Washington Council of Government's projections, despite the impacts of the COVID-19 pandemic. This will likely perpetuate congestion, even if reductions in VMT per capita are achieved.
- Telework has risen in prevalence during the COVID-19 pandemic and will likely continue to constitute a larger percentage of commute behavior, even after the pandemic has been mitigated.

5.3.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
2A	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of

¹⁷⁵ <https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/>

¹⁷⁶ <https://www.mwcog.org/file.aspx?D=PXVsN0KkMkgXNwvPyDMX1kLIQFFp2OJN0YoTa%2bUimA%3d&A=7xHcSpkGbtCMhK%2fQTirVScizz%2flnwCEKleZaqWs3K0%3d>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #2: Maximize Access to Jobs, Employees and Housing

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
				2017. ¹⁷⁷ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore “how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies.” ¹⁷⁸	in developing top-down TransAction project list. • An additional scoring metric could be added to the funding application process that is designed to evaluate consistency with the strategies included in the TTSP, where appropriate.		transportation technology.
2B	Consider transit technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT). ¹⁷⁹	• The goals and strategies of the TTSP should be considered in these planning efforts. • Low/Zero Emissions rolling stock and supportive infrastructure should be considered. • Interoperability and cybersecurity should be carefully considered, particularly as the planning initiative explores interjurisdictional connections. • Related innovations such as TSP, and synergistic technologies that can improve the resiliency of the transportation system,	• NVTA staff • PDP BRT Consultant • BRT Working Group	TBD

¹⁷⁷ <https://nvtatransaction.org/>

¹⁷⁸ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

¹⁷⁹ <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #2: Maximize Access to Jobs, Employees and Housing

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
					such as V2G, should be considered.		

Table 30 - Action Table, Strategy #2

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

5.4 Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

5.4.1 Overview

Technologies related to transportation are constantly evolving and creating possibilities for customization and optimization at the individual, corridor and even system levels. All these uses are, to some extent, dependent on the sharing of information which may be personal and/or integral to the effective functioning of critical networks. For these reasons it is imperative to incorporate cybersecurity and privacy measures into innovative projects. This Plan identifies several potential roles NVTA can take in regard to cyber security and privacy, most of which can begin immediately or in the near future and be maintained for the long term.

5.4.1.1 Assumptions Made

- Systems critical to the functioning of society will continue to (and perhaps increasingly) be considered “soft targets.”
- As adoption and reliance on connected technologies grows, continuity of said connectivity will be increasingly critical to operations and safety.
- Individual awareness and concern about privacy will continue to grow.

5.4.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
3A	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ¹⁸⁰ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore “how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies.” ¹⁸¹	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list. • An additional scoring metric could be added to the funding application process that is designed to evaluate	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of transportation technology.

¹⁸⁰ <https://nvtatransaction.org/>

¹⁸¹ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
					consistency with the strategies included in the TTSP, where appropriate.		
3B	Increase consideration of cyber security and privacy in NVTA procurements	NVTA staff	Immediate - Any time NVTA initiates a procurement process or seeks funding from an external source		- Funding applications should be written in such a way as to facilitate and encourage cyber security and protect privacy. - When the Authority seeks to purchase goods or services (i.e. modeling platforms, consultant services, data subscriptions or analysis software etc.) to support its mission, careful attention should be paid to approach the procurement process in such a way that prioritized cybersecurity and protection of privacy.	- NVTA staff - Council of Counsels - Authority Members - Member jurisdictions and agencies	Inclusion of selection criteria that consider TTSP cybersecurity and privacy.
3C	Consider technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT). ¹⁸²	- The goals and strategies of the TTSP should be considered in these planning efforts. - Low/Zero Emissions rolling stock and supportive infrastructure should be considered. - Interoperability and cybersecurity should be carefully considered, particularly as the planning initiative explores interjurisdictional connections. - Related innovations such as TSP, and synergistic technologies that can improve	- NVTA staff - PDP BRT Consultant - BRT Working Group	TBD

¹⁸² <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #3: Maximize Cybersecurity and Privacy for Members of the Public

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
					the resiliency of the transportation system, such as V2G, should be considered.		

Table 31 - Action Table, Strategy #3

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

5.5 Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

5.5.1 Overview

It is widely acknowledged that the development of fully autonomous vehicles will/is taking longer than initially projected, and that full market penetration will take some time yet.¹⁸³ That said, there are companies testing autonomous vehicles in real-world conditions now, with some promising to have fully autonomous robo-taxi fleets deployed in just a few years. This means that now is the time to proactively address the issue of Zero Occupancy passenger Vehicles (ZOV-p.) These efforts could and did begin in 2021, with NVTA staff exploring potential impacts of AVs and ZOV-ps in the TransAction modeling and scenario planning efforts, the results of which may, in the near to midterm, inform the Authority's consideration of AVs in developing legislative programs. Additionally, policies designed to prepare for the introduction of AVs should also aim to maximize the potential benefits of increased automation and connectivity in the interim. Finally, all action on automation and connectivity should address potential barriers to access to AVs before they become ubiquitous (such as cost of ownership, or ADA access)¹⁸⁴ that may create or exacerbate existing inequities.

5.5.1.1 Assumptions Made

- Fully autonomous Vehicles are feasible and will eventually become commonplace. This technology is likely to be used first for freight and delivery purposes (which are not the focus of this plan, as they may not accommodate or benefit from carrying passengers), then by transportation services (taxis, ride sharing companies, shuttles etc.), before reaching full market penetration for personal vehicle ownership.
- Shared Occupancy and, perhaps ownership (i.e. subscription bases use) of AVs will reduce the negative impacts on congestion and the environment.
- Privately owned AVs will have the greatest potential to generate Zero Occupancy Miles Traveled.
- Pricing has the potential to disproportionately impact some persons, and thus equity must be an integral consideration in discussion and development of related mechanisms. One method to mitigate potential inequities is to reinvest any revenues yielded into public transportation systems like transit, or programs designed to further equity in access to transportation. Other options may include fostering development of a market for used autonomous vehicles.
- Progress towards full automation will happen concurrently with development of connective technologies that will have intrinsic value. Additionally, the two types of innovation may be synergistic and inform iterative development of one another.

¹⁸³ <https://www.bloomberg.com/features/2020-self-driving-car-race/#:~:text=The%20State%20of%20the%20Self,more%20of%20our%20contactless%20needs.&text=It%20turns%20out%20self%2Ddriving,be%20ready%20for%20the%20road.>

¹⁸⁴ <https://www.vtpi.org/avip.pdf>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

5.5.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
4A	Facilitate inclusion of components and actions that proactively prepare for the introduction of connectivity and automation technologies in NVTA funded projects.	Authority Members and NVTA staff	Immediate - Initiation of Six Year Program funding cycles (recurring) and updates to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ¹⁸⁵ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore "how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies." ¹⁸⁶	- Conduct education and outreach efforts to inform jurisdictions, agencies and elected officials about the potential benefits of connectivity and automation. Additionally, convey the importance of proactive action to maximize these benefits. - Ensure discussion of these concepts and evaluation of funding applications include consideration of NVTA's Core Values.	- NVTA staff - NVTA Committees - Council of Counsels - Authority Members - NVTA Legislative Liaison - Member jurisdictions and agencies	- Provision of educational opportunities. - Development and continued evolution of guidance for funding applicants around these topics.
4B	Develop Policies that discourage ZOV-p Miles Traveled.	Authority Members	Near term - TBD	- The update of TransAction that was adopted in 2022 includes a Mobility Goal to "enhance quality of life of Northern Virginians by improving performance of the multimodal transportation system"¹⁸⁷ - Additionally, it contains other objectives relating to improve operation of the regional system and reduce emissions, both of which	- Seek input from member jurisdictions and partner agencies. - Draft policy(s) and process them through the NVTA Committee review cycle. - Seek review from the Council of Counsels and Legislative Liaison. - Seek adoption by the Authority.	- NVTA staff - NVTA Committees - Council of Counsels - Authority Members - NVTA Legislative Liaison - Member jurisdictions and agencies	- Initiation of a region-wide conversation about discouraging ZOV-p miles traveled. - Adoption of a policy(s) that discourages ZOV-p Miles traveled.

¹⁸⁵ <https://nvtatransaction.org/>

¹⁸⁶ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

¹⁸⁷ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
				would be detrimentally impacted by ZOV-ps.			
4C	Advocate for the Commonwealth to provide local jurisdictions the ability to levy fees on autonomous vehicles.	Authority Members	Near term - Initiation of development of NVTA's legislative program.	• The update of TransAction that was adopted in 2022 includes a Mobility Goal to "enhance quality of life of Northern Virginians by improving performance of the multimodal transportation system"¹⁸⁸ • Additionally, it contains other objectives relating to improve operation of the regional system and reduce emissions, both of which would be detrimentally impacted by ZOV-ps.	• Seek input from member jurisdictions and partner agencies. • Consult with the Legislative Liaison and the Council of Counsels. • Incorporate discussion of the ability of jurisdictions to levy fees on AVs in processes to draft and adopt a legislative program.	• NVTA staff • NVTA Committees • Council of Counsels • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	• Initiation of a region-wide, and perhaps state-wide conversation about fees for AVs. • Inclusion of support for jurisdictions to gain the ability to levy fees on AVs.
4D	Champion use of Shared Automated Vehicles	Authority Members and NVTA staff	Near term - Introduction of these technologies into the region.	A legislative priority to "Support use of effective transportation technology" was introduced into NVTA's State and Federal Legislative Program in 2022. ¹⁸⁹ The position was updated and continued in NVTA's 2023 Legislative Priorities. ¹⁹⁰	• Encourage any publicly available AVs and/or private use of SAVs be equitably accessible to all.	• NVTA Committees • NVTA Legislative Liaison • Member jurisdictions and	TBD

¹⁸⁸ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

¹⁸⁹ <https://thenovaauthority.org/wp-content/uploads/2022/05/Northern-Virginia-Transportation-Authority-NVTA-2022-Legislative-Program-1.pdf>

¹⁹⁰ <https://thenovaauthority.org/wp-content/uploads/2023/01/2023-Legislative-Priorities.pdf>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
4E	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ¹⁹¹ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore "how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies." ¹⁹²	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list.	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of transportation technology.
4F	Advocate for legislation that limits ZOV-p miles traveled.	Authority Members	Long term - Significant deployments of AV Fleets in the region or sister regions.	Objective 1.1 of the current iteration of TransAction is "Reduce congestion and crowding experienced by travelers in the region." ¹⁹³ Additionally, it contains other objectives relating to improve operation of the regional system and reduce emissions, both of which would be detrimentally impacted by ZOV-ps.	• Seek input from member jurisdictions and partner agencies. • Consult with the Legislative Liaison and the Council of Counsels. • Incorporate discussion of ZOV-p miles traveled in development of both state and federal legislative programs.	• NVTA staff • NVTA Committees • Council of Counsels • Authority Members • NVTA Legislative Liaison • Member jurisdictions	• Initiation of a region-wide, and perhaps state-wide conversation about fees for AVs. • Inclusion of support for jurisdictions to gain the ability to levy fees on AVs.

¹⁹¹ <https://nvtatransaction.org/>

¹⁹² https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

¹⁹³ https://nvtatransaction.org/wp-content/uploads/2018/11/TransAction_Technical-Report_Nov.-2018-FINAL-1.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
						and agencies	
4H	Advocate for state entities to continue to provide, and perhaps expand, funding for innovative pilot projects and/or research efforts.	Authority Members	Long term - National legislation and/or standards regarding AVs are passed/enacted.	Many states and localities have passed legislation related to AVs, however, there is no such legislation at the Federal level. There are voluntary guidelines included in "A Vision for Safety 2.0", as issued by the National Highway and Transportation Safety Administration, and there have been several failed attempts to pass AV-related Acts through the US Congress. ¹⁹⁴		• NVTA CEO • Member jurisdictions and agencies	• Initiation of a region-wide, and perhaps state-wide conversation about the value of AV pilot programs.
4F	Consider technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid	• The goals and strategies of the TTSP should be considered in these planning efforts. • Low/Zero Emissions rolling stock and supportive infrastructure should be considered. • Interoperability and cybersecurity should be carefully considered, particularly as the	• NVTA staff • PDP BRT Consultant • BRT Working Group	TBD

¹⁹⁴ <https://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #4: Enhance operations of the multimodal transportation system through connectivity and automation

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
				Transit System in Northern Virginia (PDP-BRT). ¹⁹⁵	planning initiative explores interjurisdictional connections. • Related innovations such as TSP, and synergistic technologies that can improve the resiliency of the transportation system, such as V2G, should be considered.		

Table 32 - Action Table, Strategy #4

¹⁹⁵ <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #5: Develop pricing mechanisms that manage travel demand and provide sustainable travel options

5.6 Strategy #5: Develop pricing mechanisms that manage travel demand and provide sustainable travel options

5.6.1 Overview

Northern Virginia is subject to National Ambient Air Quality Standards, as imposed by the Federal Highway Administration (Congestion Mitigation and Air Quality [CMAQ] is a funding mechanism that can be leveraged to comply with these.) In pursuit of attainment, the region has established a four-year target for Annual Peak Hour Excessive Delay (PHED) per capita, of 26.7 hours¹⁹⁶. This is indicative of significant congestion in the area, which necessitates immediate and ongoing action and policy to mitigate. This Plan identifies several technology-related roles for NVTA to take on, that could supplement and complement its existing efforts to minimize congestion. These range from developing policies internally to advocating for legislation at the Commonwealth level.

5.6.1.1 Assumptions Made

- The population and economy of this region will continue to grow through the year 2045, in keeping with the Metropolitan Washington Council of Government's projections, despite the impacts of the COVID-19 pandemic. This will likely perpetuate congestion, even if reductions in VMT per capita are achieved.
- Careful and effective pricing can help mitigate congestion by influencing travel behavior patterns.
- Making alternatives to SOV travel easier, cost effective and enjoyable will encourage mode shift and other desirable travel behavior changes. Technology can be used to achieve these goals, but parameters should be in place to both maximize benefits and minimize any negative side effects.
- Pricing has the potential to disproportionately impact some persons, and thus equity must be an integral consideration in discussion and development of related mechanisms. One method to mitigate potential inequities is to reinvest any revenues yielded into public transportation systems like transit, or programs designed to further equity in access to transportation.

¹⁹⁶ http://www.virginiadot.org/about/resources/stip/Appendix_E_-_PerformanceBasedPlanning-Performance_CMAQ-FINAL-4-30-19-Rev.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #5: Develop pricing mechanisms that manage travel demand and provide sustainable travel options

5.6.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
5A	Develop and support policy(s) that support technology-based pricing mechanisms	The Authority	Immediate - TBD	There are several pricing schemas deployed in the region, such as the 495 NEXT initiative. ¹⁹⁷ Additionally, NVTA is a co-sponsor of RM3P ¹⁹⁸ which will apply ICM concepts ¹⁹⁹ at a regional level.	• The Authority may consider pricing and incentive mechanisms to reduce congestion and encourage sustainable transportation options. • The Authority may develop policies that suggest ratios, ranges, or other types of comparisons for capping fees for microtransit services, relative to local mass transit fees. • The Authority may develop policies for ensuring consistent pricing schemes for micromobility services across member jurisdictions. • Advocate that the Commonwealth coordinate with the region to develop pricing and incentive measures, to optimize the transportation network in a sustainable manner.	• NVTA staff • Authority Members • NVTA Committees • Council of Counsels • Member jurisdictions and agencies	• Adoption of policy(s) to support pricing mechanisms • Reinvigoration of regional discussion on pricing mechanisms, particularly in terms of technologies.

¹⁹⁷ <https://www.495northernextension.org/>

¹⁹⁸ <https://rm3pvirginia.org/>

¹⁹⁹ <https://www.fampo.gwregion.org/wp-content/uploads/2011/06/Intgrated-Corridor-Management.pdf>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #5: Develop pricing mechanisms that manage travel demand and provide sustainable travel options

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
5B	Further integrate consideration of pricing mechanisms into planning efforts	NVTA staff	Mid term - Initiation of a TransAction update	There are several pricing schemas deployed in the region, such as the 495 NEXT initiative. ²⁰⁰ Additionally, NVTA is a co-sponsor of RM3P ²⁰¹ which will apply ICM concepts ²⁰² at a regional level.	• Staff should explore the potential impacts of the institution of various pricing mechanisms on other long-range planning goals and scenarios. • Staff should monitor actual impacts of the implementation of any policies. • Staff should consider pricing mechanisms in long-range planning efforts (in terms of project eligibility criteria, the reevaluation of project scoring metrics and scenario planning.)	• NVTA staff • NVTA Committees • Council of Counsels • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	• Reinvigoration of regional discussion on pricing mechanisms, particularly in terms of technologies.

Table 33 - Action Table, Strategy #5

²⁰⁰ <https://www.495northernextension.org/>

²⁰¹ <https://rm3pvirginia.org/>

²⁰² <https://www.fampo.gwregion.org/wp-content/uploads/2011/06/Intgrated-Corridor-Management.pdf>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

5.7 Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

5.7.1 Overview

Many of the most innovative transportation technologies will rely on existing types of infrastructure, either as a supplement²⁰³ or as a base to build upon. Due to the length of time typically needed to plan and construct a capital project, juxtaposed with the potential for unforeseen surges in the development and acceptance of technologies, it is pertinent to put concerted effort into preparing existing resources for the most feasible, modal agnostic innovations. This lays the ground for a smooth transition period and maximizes the potential for the region to reap benefits of novel technologies, while minimizing detriments. Potential NVTA roles in this range from beginning to consider how planning documents and project definitions can allow for/encourage forward thinking infrastructure, in the immediate, to taking considering updating project selection criteria for funding in the near future.

5.7.1.1 Assumptions Made

- Much of the current transportation network (particularly roadways, rail lines, lighting, parking lots, sidewalks and bike lanes) will remain relevant into the foreseeable future, including for emerging modes. However, some adjustments will be valuable and even integral in ensuring their usability.
- The benefits of including additional components (like larger communications cabinets) or increasing and standardizing requirements (for signage etc.) for capital projects may take time to come to fruition, but will ultimately yield a strong return on investment.
- Autonomous Vehicles (AVs) will rely on consistently paved surfaces, clear lane and road markings (and possibly signage) and would benefit from robust and consistent communication with infrastructure, as would the overall network in which they operate.
- Bicycle and pedestrian infrastructure types may be useful for additional, small personal vehicles such as electric scooters, however, care should be taken to ensure that infrastructure is designed/allocated in a way that encourages use by all ages and abilities.²⁰⁴
- Technologies (particularly apps and big data) can be used to optimize use of existing infrastructure, by existing modes, as is the case with Curbside Management and behavioral incentivization.

²⁰³ <https://omniride.com/omniride/assets/File/PRTC-Recommendations-Summary.pdf>

²⁰⁴ https://nacto.org/wp-content/uploads/2017/12/NACTO_Designing-for-All-Ages-Abilities.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

5.7.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
6A	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ²⁰⁵ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore “how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies.” ²⁰⁶	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list. • An additional scoring metric could be added to the funding application process that is designed to evaluate consistency with the strategies included in the TTSP, where appropriate.	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of transportation technology.

²⁰⁵ <https://nvtatransaction.org/>

²⁰⁶ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
6B	Consider preparations for emerging modes and innovations in NVTA procurements	NVTA staff	Immediate - Any time NVTA initiates a procurement process or seeks funding from an external source		When the Authority seeks to apply for funding from an external source (as was the case with the RM3P²⁰⁷ program), the application should be written in such a way as to encourage project components that minimize potential for obsolescence.	- NVTA staff - Council of Counsels - Authority Members - Member jurisdictions and agencies	Inclusion of selection criteria that concerns itself with contribution towards the goals of the TTSP.
6C	Consider technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT). ²⁰⁸	- The goals and strategies of the TTSP should be considered in these planning efforts. - Low/Zero Emissions rolling stock and supportive infrastructure should be considered. - Interoperability and cybersecurity should be carefully considered, particularly as the planning initiative explores interjurisdictional connections. - Related innovations such as TSP, and synergistic technologies that can	- NVTA staff - PDP BRT Consultant - BRT Working Group	TBD

²⁰⁷ <https://rm3pvirginia.org/>

²⁰⁸ <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #6: Maximize the Potential of Physical and Communication Infrastructure to Serve Existing and Emerging Modes

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
					improve the resiliency of the transportation system, such as V2G, should be considered.		

Table 34 - Action Table, Strategy #6

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #7: Enhance regional coordination and encourage interoperability in the transportation system

5.8 Strategy #7: Enhance regional coordination and encourage interoperability in the transportation system

5.8.1 Overview

Interoperability in regards to both infrastructure and data will be integral to the smooth and efficient operation of the transportation network in Northern Virginia, and the need for it will increase commensurately with the integration of technology, and thus should be supported by policy. Due to the length of time typically needed to plan transportation projects, juxtaposed with the potential for unforeseen surges in the development and acceptance of technologies, it is pertinent to put concerted effort into developing policies and precedence for interoperability in advance. This lays the ground for a smooth transition period and maximizes the potential for the region to reap benefits of novel technologies, while minimizing detriments.

5.8.1.1 Assumptions Made

- Standardizing infrastructure types across jurisdictional borders facilitates operations of interjurisdictional travel in some cases (TSP or other adaptive signal control) and necessary in the case of things like Road Side Unit (RSU) communications standards for AVs.
- Interoperability in electric vehicle charging infrastructure would help reduce range anxiety and further market penetration of the technology in fleet and private vehicle use.
- Interoperable policies in the region regarding emerging modes will help mitigate learning curves for the public and gives regional leadership a stronger negotiating position when working with vendors.
- Interoperable data standards facilitate data sharing, and thus system-wide optimization, by reducing the need for data fusion and cleaning.

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #7: Enhance regional coordination and encourage interoperability in the transportation system

5.8.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
7A	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ²⁰⁹ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore "how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies." ²¹⁰	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list. • An additional scoring metric could be added to the funding application process that is designed to evaluate consistency with the strategies included in the TTSP, where appropriate.	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of transportation technology.

²⁰⁹ <https://nvtatransaction.org/>

²¹⁰ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #7: Enhance regional coordination and encourage interoperability in the transportation system

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
7B	Consider the creation of a committee or panel of experts to review procurement documents	NVTA staff	Mid term - TBD		NVTA may consider the creation of a committee or panel of experts that can be convened to review member jurisdictions' (new or established) policies and/or procurement scoping documents and advise on potential for barriers or synergies for interoperability across the region. This body may consist of jurisdictional representatives and/or the members of the private sector (although care should be taken in establishing and/or convening this body to avoid any conflicts of interest in procurement processes.) The committee could be convened to review NVTA's own documents/processes or to review member jurisdiction documents/processes, at the request of said jurisdiction.	- NVTA staff - Council of Counsels - Member jurisdictions and agencies	- Creation of a committee or panel of experts. - Initiation of a regional conversation about preparations for emerging modes and innovation in the region.
7C	Consider technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid Transit	- The goals and strategies of the TTSP should be considered in these planning efforts. - Low/Zero Emissions rolling stock and supportive infrastructure should be considered. - Interoperability and cybersecurity should be carefully considered, particularly as the planning initiative explores interjurisdictional connections. - Related innovations such as TSP,	- NVTA staff - PDP BRT Consultant - BRT Working Group	TBD

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #7: Enhance regional coordination and encourage interoperability in the transportation system

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
				System in Northern Virginia (PDP-BRT). ²¹¹	and synergistic technologies that can improve the resiliency of the transportation system, such as V2G, should be considered.		

Table 35 - Action Table, Strategy #7

²¹¹ <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #8: Advance decarbonization of the transportation system

5.9 Strategy #8: Advance decarbonization of the transportation system

5.9.1 Overview

This plan aims to address many types of vehicle propulsion technology, such as electrification, hydrogen, and other Zero Emission Vehicle (ZEV) technologies. One of the most significant challenges to electric vehicle adoption is “range anxiety”, which stems from a fear that one will run out of charge in an Electric Vehicle, and/or not be able to find a place to charge it, during a trip. However, the incoming Presidential administration has set several goals to increase prevalence of EV usage, including a promise to build 550,000 EV charging stations, and creation of the National Electric Vehicle Infrastructure (NEVI) Program. The Commonwealth is participating in the NEVI program and Commonwealth has launched an “Electric School Bus Initiative”. Private sector support is also evident in Virginia, including through Electrify America’s selection of the Washington D.C. metro area as a target area for investment in EV charging infrastructure in its Cycle 2 investment plan. These are indicators of the prospects of EV usage in the country, as well as Northern Virginia specifically, which is further bolstered by recent progress in development of associated technology, some of which may enhance resiliency of the overall transportation system. Together these create an opportune environment for NVTA investment and policy development. Interest is also growing in other low/ Zero Emissions technologies, like hydrogen.

5.9.1.1 Assumptions Made

- “Range anxiety” will continue to be a major factor in EV market penetration for the foreseeable future and thus a robust charging network is necessary.
- EV battery technology will continue to improve and become more cost effective, and this will further market penetration.
- Both private and fleet EV usage will yield benefits to the overall transportation network. There are also opportunities for such use to enhance resiliency, through things like Vehicle to Grid (V2G) functionality.
- Substantial work (including but not limited to policy development and supply chain improvements) is needed to advance other low/zero emissions propulsion technologies. There is a strong possibility that said work could be worthwhile, due to some challenges faced by electrification.
- Decarbonization of the transportation system will rely on multiple approaches and propulsion technologies that are tailored to the mode of transportation and type/class of vehicle and even the geography and weather patterns in which they will be deployed.²¹²

²¹² <https://www.energy.gov/eere/us-national-blueprint-transportation-decarbonization-joint-strategy-transform-transportation>

NVTA Transportation Technology Strategic Plan: Action Plan
Strategy #8: Advance decarbonization of the transportation system

5.9.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
8A	Advocate for continued exploration of the feasibility of alternative propulsion technologies in the region	Authority Members	Immediate - Identification and confirmation of substantial technical challenges to use of a low/Zero Emissions technology in one or more recurring/regular use cases	• In June of 2022 Connected DMV released a Hydrogen "Greenprint".²¹³ • Several jurisdictions across Northern Virginia are working to electrify their transit fleets. However, there are still deployment challenges including, charge range and ability to operate in all weather and terrain, that need to be overcome.²¹⁴	• An additional scoring metric could be added to the funding application process that is designed to evaluate consistency with the strategies included in the TTSP, where appropriate.	• NVTA staff • Service operators • Utility providers • Intra-jurisdictional partners and regional entities	TBD
8B	Develop and adopt policies regarding low/Zero Emissions Vehicles and supporting infrastructure.	Authority Members	Near future - Adoption of Federal policy and/or enactment of Federal programs	The Commonwealth has undertaken an Electric Vehicle Readiness Study ²¹⁵ and has completed a Deployment Plan as part of the Federal NEVI program. ²¹⁶	• The Authority may develop a policy to establish regionally consistent pricing/charging schemes and payment options. • The Authority may develop a policy to address the interoperability of infrastructure to support low/Zero emissions vehicles.	• NVTA staff • Council of Counsels • Authority Members • Member jurisdictions and agencies	• Adoption of new policy(s) that address EV charging needs. • Reinvigoration of regional discussions of the value of EVs and EV charging infrastructure.

²¹³ <https://www.connecteddmv.org/post/connected-dmv-releases-hydrogen-greenprint>

²¹⁴ <https://wtop.com/alexandria/2021/11/new-electric-dash-buses-face-challenges-as-alexandria-eyes-2035-zero-emission-goal/>

²¹⁵ http://www.ctb.virginia.gov/resources/2021/march/pres/ev_readiness_study_ctb_presentation_03-17-21_final.pdf

²¹⁶ <https://publicinput.com/VirginiaNEVI>

NVTA Transportation Technology Strategic Plan: Action Plan
Strategy #8: Advance decarbonization of the transportation system

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
8C	Advocate for Commonwealth policies that contribute to/support creation of a network of infrastructure to support low/ Zero Emissions Vehicles	Authority Members	Ongoing - Initiation of development of NVTA's annual legislative programs.	The Commonwealth has undertaken an Electric Vehicle Readiness Study ²¹⁷ and has completed a Deployment Plan as part of the Federal NEVI program. ²¹⁸	• The Authority may advocate for the Commonwealth to adopt legislation to require at-station payment options, ensure equitable access and protect user privacy and cybersecurity. • The Authority may advocate for legislation that prohibits price gouging. • The Authority may advocate for legislation to regulate how Energy providers charge residential customers for EV charging. • The Authority may advocate for the creation of a statewide EV battery reclamation policy and reuse system (this may leverage or create Public Private Partnerships.) One use of this system may be repurposing vehicle batteries as a component of EV charging stations.²¹⁹	• NVTA staff • NVTA Committees • Council of Counsels • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	• Initiation of a region-wide, and perhaps state-wide conversation about low/Zero Emissions vehicles and supportive infrastructure. • Inclusion of support for jurisdictions to develop a network of infrastructure to support low/ Zero Emissions Vehicles.

²¹⁷ http://www.ctb.virginia.gov/resources/2021/march/pres/ev_readiness_study_ctb_presentation_03-17-21_final.pdf

²¹⁸ <https://publicinput.com/VirginiaNEVI>

²¹⁹ https://www.ey.com/en_us/automotive-transportation/why-the-ev-battery-life-cycle-is-more-important-than-the-battery-life

NVTA Transportation Technology Strategic Plan: Action Plan
Strategy #8: Advance decarbonization of the transportation system

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
8D	Continue to consider innovative technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ²²⁰ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore "how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies." ²²¹	• Discuss transportation technology and innovation in any TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list.	• NVTA staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Inclusion of technology or innovation focused project(s) in the top-down TransAction project list. • Continuation of a regional conversation about metrics for successful deployment of transportation technology.
8E	Consider technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary	• The goals and strategies of the TTSP should be considered in these planning efforts. • Low/Zero Emissions rolling stock and supportive infrastructure should be considered. • Interoperability and cybersecurity should be	• NVTA staff • PDP BRT Consultant • BRT Working Group	TBD

²²⁰ <https://nvtatransaction.org/>

²²¹ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan
Strategy #8: Advance decarbonization of the transportation system

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
				Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT). ²²²	carefully considered, particularly as the planning initiative explores interjurisdictional connections. • Related innovations such as TSP, and synergistic technologies that can improve the resiliency of the transportation system, such as V2G, should be considered.		

Table 36 - Action Table, Strategy #8

²²² <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #9: Enhance mobility in the region through innovation and emerging technologies in transit

5.10 Strategy #9: Enhance mobility in the region through innovation and emerging technologies in transit

5.10.1 Overview

Transit offers many opportunities to improve accessibility through transportation, in manners that are equitable, safe, and sustainable. Due in part to this immense potential, the mode is often the subject of innovation, with many new technologies having been developed recently and more expected. Two key examples are Bus Rapid Transit (BRT) which provides high-capacity transit service in dedicated lanes, and microtransit which enables on-demand scheduling of transit service on both fixed and flexible routes. These options further improve accessibility for riders, while other innovations regarding propulsion have created opportunities to enhance the sustainability of transit through electrification and other low/Zero Emissions propulsion options. Finally new methods of optimizing transit routes, such as Advanced Traffic Management Systems (ATMS) and adaptive signal optimization, allow for even greater reductions in congestion. All of these potential benefits are highly consistent with NVTA's goals and vision for the region.

5.10.1.1 Assumptions Made

- Transit will continue to be a critical component of the Northern Virginia transportation system, regardless of the advancement of new technologies for personal travel, such as autonomous vehicles, or changes in travel behaviors like those experienced during the height of the Covid-19 pandemic.
- Supporting multimodal trips that involve transit can be an effective means of balancing individual traveler needs (including but not limited to trip chaining) and the density, centralization, and infrastructure needs of effective transit networks.
- It is critical to incorporate employment opportunities as part of the equity considerations surrounding the provision of transit services.
- The existence of transit services is not sufficient to attract and retain ridership. The service must also be safe, reliable, and affordable.
- In a region as interconnected as Northern Virginia, multi-jurisdictional and agency partnerships are critical to creating seamless travel experiences for transit riders in the region.
- The most beneficial combination of transit technologies will be unique to each community and may indeed vary by route within a community.

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #9: Enhance mobility in the region through innovation and emerging technologies in transit

5.10.2 Actions

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
9A	Continue to consider technologies in long-range planning efforts	NVTA staff	Mid term - Initiation of an update to TransAction	The updated TransAction Plan was adopted on December 8, 2022. This TransAction Update replaces the version which was adopted in 2017. ²²³ The updated Plan includes 17 projects for which technology is a primary mode and 9 projects with technology as a secondary mode. Additionally, the Plan considered used scenario analysis to explore “how travel behavior and the operations of the transportation system might change with the adoption and integration of these emerging technologies.” ²²⁴	• Purchase of transit technologies, including rolling stock, supporting infrastructure and more, should continue to be supported via TransAction. • An additional scoring metric could be added to the funding application process that is designed to evaluate consistency with the strategies included in the TTSP, where appropriate. • Technologies that synergize with transit innovations to enhance resiliency (such as V2G) should also be considered.	• NVTA staff • TransAction Consultant	TBD

²²³ <https://nvtatransaction.org/>

²²⁴ https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf

NVTA Transportation Technology Strategic Plan: Action Plan

Strategy #9: Enhance mobility in the region through innovation and emerging technologies in transit

No.	Action	Resp. Party	Time Frame - Trigger Point	Current Status	Sub Actions	Partners	Metric(s) of Success
9B	Consider technologies in deployment planning efforts	NVTA staff	Immediate - Initiation of the Preliminary Deployment Plan for Bus Rapid Transit (PDP BRT)	The Authority unanimously adopted the FY2024 Operating Budget, FY2024 Local Distribution Fund Budget, and the FY2024 Regional Revenue Fund Budget. The FY2024 Regional Revenue Fund Budget most notably included a Preliminary Deployment Plan for a Regional Bus Rapid Transit System in Northern Virginia (PDP-BRT). ²²⁵	• The goals and strategies of the TTSP should be considered in these planning efforts. • Low/Zero Emissions rolling stock and supportive infrastructure should be considered. • Interoperability and cybersecurity should be carefully considered, particularly as the planning initiative explores interjurisdictional connections. • Related innovations such as TSP, and synergistic technologies that can improve the resiliency of the transportation system, such as V2G, should be considered.	• NVTA staff • PDP BRT Consultant • BRT Working Group	TBD

Table 37 - Action Table, Strategy #9

²²⁵ <https://mailchi.mp/b635b8554095/authority-recap-march-2023-6124808?e=97cf1a7fb9>

NVTA Transportation Technology Strategic Plan: Action Plan

Consolidated Actions Table

5.11 Consolidated Actions Table

Roles										Immediate				Near Term				Mid Term	Long Term		
										June - Sept, 2023	Oct - Dec, 2023	Jan - March, 2024	April - June, 2024	July - Sept, 2024	Oct - Dec, 2024	2025	2026	2027	2028 - 2032	2033 and Beyond	
Title	Applicable Strategies										•Work begins on PDP BRT •Development of legislative program			Authority anticipated to adopt the FY24-29 SYP	Development of legislative program	•Initiate process to update TransAction •Completion of PDP BRT					
	1	2	3	4	5	6	7	8	9												
Funding	1A, 1B	2A	3A, 3B			6A, 6B	7A	8A	9A												
Policy				4B	5A			8B													
Advocate	1C			4C, 4D, 4G	5A			8A, 8C	9A												
Champion	✔	✔		✔		✔	✔	✔	✔												
Facilitate	✔	✔		✔		✔	7B	✔	✔												
Stakeholder			✔		✔																
Planning	1A, 1D	2A, 2B	3A, 3C	4A, 4E, 4F	5B	6A, 6C	7A, 7C	8D, 8E	9A, 9B												
Outreach/ Education	✔	✔		✔	✔	✔	✔	✔	✔												
Observer			✔																		

Key				
Preparatory Action	Potential Direct Action	Direct Action	Follow Up Action	Continuous

Table 38 - Consolidated Actions Table

NVTA Transportation Technology Strategic Plan: Action Plan

Next Steps

5.12 Next Steps

NVTA's Transportation Technology Committee (TTC) championed development of the inaugural TTSP, which included 8 strategies and an Action Plan. The TTC, Planning Coordination and Advisory Committee (PCAC), Technical Advisory Committee (TAC), and Planning and Programming Committee (PPC) recommended these items for adoption in spring of 2021. The Authority unanimously voted for this adoption in May 2021. Since that time NVTA staff have been working to implement the TTSP, in accordance with ongoing guidance from the TTC. This has included informing the update of TransAction, the Long-Range Transportation Plan for Northern Virginia, the introduction of a new position into NVTA's legislative priorities, and development of new outreach and communications efforts. The first substantive updates to the TTSP, including expansion of two existing strategies and addition of one new strategy, were adopted by the Authority in November 2022. This is illustrative of the Plan's structure as a living document, designed to evolve over time, in keeping with the pace of innovation. Such a readily adaptable plan structure is only possible in the context of close coordination with decision makers, so the Authority receives brief monthly updates on implementation of the TTSP, along with larger updates every 6 months. In the near future, the following items could arise in such updates:

- Ongoing efforts to integrate the TTSP with major NVTA deliverables such as Six Year Programs and the Preliminary Deployment Plan for BRT (PDP BRT.)
- Potential policy development, in accordance with the TTSP Action Plan.
- Ongoing monitoring of transportation technology development.
- Ongoing monitoring of state and federal funding opportunities for innovative initiatives.

5.13 Monitoring Progress and Updating the TTSP

As a living document, NVTA staff will revise the TTSP to reflect changing circumstances. The CEO's monthly report to the Authority will outline such changes together with other progress updates such as:

- Integration of relevant strategies into the TransAction scenario analysis work
- Public engagement under the TransAction umbrella
- Ongoing monitoring of market trends and trigger points
- Development of a more comprehensive approach to outreach and education that builds upon the 'Driven by Innovation' eBlast
- Process and prioritization of white papers related to potential future regional transportation policy

No significant TTSP changes/additions, as determined by the NVTA CEO, will occur without prior Authority approval. Examples of significant changes include:

- Changes to the methodology for the project selection process associated with NVTA's Six Year Program
- Changes/additions to NVTA's annual legislative program
- Detailed development of regional transportation policies

NVTA Transportation Technology Strategic Plan: Action Plan

Monitoring Progress and Updating the TTSP

The TTSP will be regularly reviewed and updated if necessary. As noted above, significant changes will require Authority approval.

5.13.1 The review/update process

- NVTA staff will continually monitor developments in transportation technologies.
- TTC members may, at any time, inform NVTA staff of any developments in the realm of transportation technologies. Other NVTA Committees may also bring relevant developments to the attention of staff.
- The NVTA CEO will determine if any possible changes to the TTSP are significant or small.
 - The process to update the document with any significant changes will necessitate committee reviews and Authority approval.
 - Examples of significant changes include (but are not limited to): additions of new strategies or changes to the scope of existing strategies.
 - Small changes can be made by staff, without the need for Authority approval.
 - Examples of small changes include (but are not limited to): administrative/grammatical changes to text or descriptions; updates to reflect the change in status of a planning effort (i.e. adoption of TransAction); and addition of contextualizing information such as descriptions of new regional initiatives or introduction of Technology Timeline.

NVTA Transportation Technology Strategic Plan: Action Plan

Monitoring Progress and Updating the TTSP

5.13.2 Progress Log

Table 38 provides an overview of progress on implementation of the Transportation Technology Strategic Plan, as of August 2023.

Strategy		NVTA Roles								
		Authority Roles			Shared Roles			Staff Roles		
Number	Name	Funding	Policy	Advocate	Champion	Facilitate	Stakeholder	Planning	Outreach/ Education	Observer
1	Reduce congestion and increase throughput									
2	Maximize access to jobs, employees and housing									
3	Maximize cybersecurity and privacy for members of the public									
4	Enhance operations of the multimodal transportation system through connectivity and automation									
5	Develop pricing mechanisms that manage travel demand and provide sustainable travel options									
6	Maximize the potential of physical and communication infrastructure to serve existing and emerging modes									
7	Enhance regional coordination and encourage interoperability in the transportation system									
8	Advance decarbonization of the transportation system									
9	Enhance mobility in the region through innovation and emerging technologies in transit									

Key	
	No role identified for NVTA
	Role identified for NVTA
	Some progress has been made
	Moderate progress has been made
	Substantial progress has been made
	Task has been completed

Table 39 - TTSP Progress Report

NVTA Transportation Technology Strategic Plan: Action Plan

Monitoring Progress and Updating the TTSP

			Actions suggested in the TTSP																																
			1A	1B	1C	1D	2A	2B	3A	3B	3C	4A	4B	4C	4D	4E	4F	4G	4H	5A	5B	6A	6B	6C	7A	7B	7C	8A	8B	8C	8D	8E	9A	9B	
			Mid term	Immediate	Immediate	Immediate	Mid term	Immediate	Mid term	Immediate	Immediate	Immediate	Near term	Near term	Near term	Mid term	Long term	Long term	Immediate	Immediate	Mid term	Mid term	Immediate	Immediate	Mid term	Mid term	Immediate	Immediate	Near term	Ongoing	Mid term	Immediate	Mid term	Immediate	
			Continue to consider innovative technologies in long-range planning efforts	Consider transportation technology and innovation in NVTA procurements	Advocate for jurisdictional policies that leverage technology to reduce congestion and increase throughput	Consider transit technologies in deployment planning efforts	Continue to consider innovative technologies in long-range planning efforts	Consider transit technologies in deployment planning efforts	Continue to consider innovative technologies in long-range planning efforts	Increase consideration of cyber security and privacy in NVTA procurements	Consider technologies in deployment planning efforts	Facilitate inclusion of components and actions that proactively prepare for the introduction of connectivity and automation technologies in NVTA funded projects	Develop Policies that discourage ZOV-p Miles Traveled.	Advocate for the Commonwealth to provide local jurisdictions the ability to levy fees on autonomous vehicles.	Champion use of Shared Automated Vehicles	Continue to consider innovative technologies in long-range planning efforts	Advocate for legislation that limits ZOV-p miles traveled.	Advocate for state entities to continue to provide, and perhaps expand, funding for innovative pilot projects and/or research efforts.	Consider technologies in deployment planning efforts	Develop and support policy(s) that support technology-based pricing mechanisms	Further integrate consideration of pricing mechanisms into planning efforts	Continue to consider innovative technologies in long-range planning efforts	Consider preparations for emerging modes and innovations in NVTA procurements	Consider technologies in deployment planning efforts	Continue to consider innovative technologies in long-range planning efforts	Consider the creation of a committee or panel of experts to review procurement documents	Consider technologies in deployment planning efforts	Advocate for continued exploration of the feasibility of alternative propulsion technologies in the region	Develop and adopt policies regarding low/Zero Emissions Vehicles and supporting infrastructure.	Advocate for Commonwealth policies that contribute to/support creation of a network of infrastructure to support low/Zero Emissions Vehicles	Continue to consider innovative technologies in long-range planning efforts	Consider technologies in deployment planning efforts	Continue to consider technologies in long range planning efforts	Consider technologies in deployment planning efforts	
Relevant Roles	Funding		✓	✓			✓			✓										✓			✓	✓				✓					✓		
	Policy												✓							✓										✓					
	Advocate				✓							✓		✓	✓			✓		✓				✓	✓										
	Champion						✓	✓				✓	✓	✓	✓	✓	✓		✓				✓	✓	✓	✓				✓					
	Facilitate						✓	✓				✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓				✓					
	Stakeholder								✓	✓										✓		✓		✓	✓										
	Planning		✓			✓	✓	✓	✓		✓	✓			✓	✓	✓				✓	✓	✓	✓											
	Outreach/ Education						✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observer								✓	✓	✓																									
Actions Taken	2021	Introduction of a new position to "Support use of effective transportation technology" in NVTA's Legislative Program.			○								○	○			●		○								○		○				○		
		Creation of a home for TTSP content on the NVTA website.	Generally supports the Outreach/ Education role.																																
		Inclusion of technology-related topics in TransAction public engagement activities. Drafting internal white papers and technical memos, to reflect ongoing monitoring of trends and developments	●			●	●	●	●		●	●			●	●					●	●		●	●		●				●	●	●	●	
		Development of opportunities to feature TTSP content and implementation progress in the "Driven by Innovation" newsletter.	Generally supports the Outreach/ Education role.																																
	2022	The TTSP informed development of the technology scenario included in TransAction.	●			●	●	●	●		●	●			●	●					●	●		●	●		●					●	●	●	●
		The TTSP informed development of top-down projects included in TransAction and coordination with applicants to adjust project descriptions to incorporate flexibility to accommodate innovation.	●			●	●	●	●		●	●			●	●					●	●		●	●		●					●	●	●	●
		The position to "Support use of effective transportation technology" was continued in NVTA's 2023 Legislative Program.			○									○	○			●		○								○		○				●	
		Trial run of a series of InNoVation Lunch and Learn begins. There were three sessions, held in October, November, and December.	Generally supports the Outreach/ Education role.																																
		The Authority unanimously approved expansion of the scope of strategies 4 and 8, and addition of a 9th strategy.	●			●	●	●	●		●	●				●	●					●	●		●	●		●				●	●	●	●
	2023	First season of InNoVation Lunch and Learns begin. There were three sessions, held in May, June, and July. These sessions were promoted publicly, recorded, and posted on NVTA's YouTube page.	Generally supports the Outreach/ Education role.																																

Key	
○	Role identified for NVTA
○	Some progress has been made
○	Moderate progress has been made
○	Substantial progress has been made
●	Task has been completed

Table 40 - TTSP Action Tracker

Glossary

Term	Acronym	See also	Definition	Source
5G			The 5th Generation of wireless cellular technology. It promises faster speeds, lower latency, and the ability to handle more devices simultaneously.	https://www.pcmag.com/news/what-is-5g
5GHz		AV, CAV, C-V2X DSRC	This is a band of the radio spectrum. In 1999 75 megahertz of this spectrum was allocated for transportation purposes, using Dedicated Short-Range Communications (DSRC) which is a standard that could support AVs, and was subsequently referred to as the "Safety band" by the US Department of Transportation (USDOT.) In 2020 the Federal Communications Commission (FCC) reallocated 30 megahertz to Cellular Vehicle-to-Infrastructure (C-V2X) which could also support AVs but is not interoperable with DSRC, and the remainder to non-transportation purposes. This reallocation was challenged by USDOT and other entities but was ultimately upheld by a US Appeals Court in 2022.	https://www.transportation.gov/content/safety-band https://www.reuters.com/legal/us-court-upholds-fcc-reallocation-auto-safety-spectrum-2022-08-12/
Accessibility			NVTA will consider two definitions of the word accessibility in this document 1) "Accessibility (or just access) refers to the ease of reaching goods, services, activities and destinations, which together are called opportunities"	https://www.vtpi.org/access.pdf
Advanced Driver Assistance Systems	ADAS	CAV	Examples of ADAS include collision warning, collision intervention, driving control assistance, parking assistance and other driver assistance systems.	https://www.sae.org/binaries/content/assets/cm/content/miscellaneous/adas-nomenclature.pdf
Application Programming Interface	API		APIs enable computer programs to communicate with one another, by providing a standardized format for requests. APIs can be used to provide access to centralized databases.	https://www.britannica.com/technology/API
Artificial Intelligence	AI		"Artificial intelligence is the capability of a computer system to mimic human cognitive functions such as learning and problem-solving. Through AI, a computer system uses math and logic to simulate the reasoning that people use to learn from new information and make decisions." • General/ Strong AI: "Strong AI can perform a variety of functions, eventually teaching itself to solve for new problems. ... While human input accelerates the growth phase of Strong AI, it is not required, and over time, it	https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/artificial-intelligence-vs-machine-learning/#introduction https://www.ibm.com/topics/strong-ai#:~:text=Weak%20AI%2C%20also%20known%20as,t%20solve%20for%20new%20problems.

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			develops a human-like consciousness instead of simulating it" • Narrow/ Weak AI: "Weak AI, also known as narrow AI, focuses on performing a specific task, such as answering questions based on user input or playing chess. It can perform one type of task, but not both" and "Self-driving cars and virtual assistants, like Siri, are examples of Weak AI."	
Automated Traffic Enforcement	ATE		Automated Traffic Enforcement (ATE), such as red-light cameras and speed cameras, permits law enforcement agencies and local or state governments to automatically detect and capture images of vehicles violating traffic laws, including speeding, red-light running, and illegal passing and subsequently give citations to those drivers. This method of enforcement serves as a means to uphold traffic laws with reduced law enforcement staff.	https://www.iihs.org/news/detail/safety-groups-create-automated-enforcement-checklist-to-encourage-well-designed-programs
Automated Vehicles	AV	CAV	Modern personal vehicles include many features that assist drivers by automating some functions. Examples of this include automatic headlines, emergency braking, lane departure warnings and blind spot detection. Despite the presence of one or more of these driver assistive technologies, a person is still required to operate and drive the vehicle.	https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety
Autonomous Vehicles	AV	CAV	Fully autonomous vehicles will be able to drive themselves without human intervention. No such vehicle currently exists but progress is being made towards achieving this. The Society of Automotive Engineers (SAE) recognizes five levels of automation, starting with 0 - No Automation ("the driver performs all driving tasks"), to 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.")	https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety
Big Data			"Big Data" is a term that originated in the late 1990s to describe databases that are characterized by "The Three Vs"; Variety (data included has varying degrees of structure and type); Velocity (the data is generated/compiled quickly) and Volume (the data is abundant.) The term can create the misconception that the volume of data directly correlates to its value.	https://datascience.berkeley.edu/blog/what-is-big-data/
Blockchain			"A digital database containing information (such as records of financial transactions) that can be	https://www.merriam-webster.com/dictionary/blockchain

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			simultaneously used and shared within a large decentralized, publicly accessible network"	
Bus Rapid Transit	BRT		"Bus Rapid Transit (BRT) is a high-quality public transportation system designed to be fast, reliable, and more convenient than traditional bus routes. It operates much like rail service but uses rubber tire bus vehicles. "Key components/features of a BRT system include frequent and efficient service, dedicated lanes and traffic signal priority, information technology systems (like real-time bus tracking and innovative fare collection methods), enhanced stations and specially designed, high-capacity buses.	https://www.fairfaxcounty.gov/transportation/richmond-hwy-brt/what-is-brt
Cellular Vehicle to Everything	C-V2X	AV, CAV, 5GHz	C-V2X is one of two technologies, which are not interoperable, that could have potentially provided Autonomous Vehicles with the capacity to communicate with one another and the infrastructure around them This technology relies on cellular chips and may use the 5th generation of wireless cellular technology. The FCC has shifted the 30 MHz of the 5.9 GHz band available for transportation safety purposes from DSRC to C-V2X.	• https://www.consumerreports.org/car-safety/fcc-plan-could-stall-v2x-car-safety-revolution/ • https://www.reuters.com/legal/us-court-upholds-fcc-reallocation-auto-safety-spectrum-2022-08-12/
Connected and Autonomous Vehicles	CAV	AV, CAV	"Connected and automated vehicles (CAVs) are two separate but related advancements in transportation technology. A vehicle can be connected but not automated, automated but not connected, neither or both."	https://www.naco.org/resources/featured/connected-autonomous-vehicles-toolkit
Connected Vehicles		AV, CAV	"Connected vehicles (CV) are those that can communicate with other vehicles, infrastructure and devices through wireless network technology, such as Wi-Fi and radio frequencies. Vehicles equipped with CV technology can alert drivers to nearby incidents, diversions or heavy traffic, thereby improving transportation safety and mobility."	https://www.naco.org/resources/featured/connected-autonomous-vehicles-toolkit
Corporate Average Fuel Economy standards	CAFÉ standards		These standards, set by the National Highway Traffic Safety Administration, regulate how far passenger cars and light duty trucks must be able to travel on a gallon of fuel.	https://www.nhtsa.gov/laws-regulations/corporate-average-fuel-economy
Curbside Management			"Curbside Management seeks to inventory, optimize, allocate, and manage curb spaces to maximize mobility and access for the wide variety of curb demands." Curb demands may include drop offs and pick-ups (of both persons and goods); Electric Vehicle charging, bicycle and pedestrian infrastructure; transit and transit infrastructure; ADA access points; emergency services; parklets and mobile vendors.	https://www.ite.org/technical-resources/topics/complete-streets/curbside-management-resources/

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Cybersecurity			"Prevention of damage to, protection of, and restoration of computers, electronic communications systems, electronic communications services, wire communication, and electronic communication, including information contained therein, to ensure its availability, integrity, authentication, confidentiality, and nonrepudiation."	https://csrc.nist.gov/glossary/term/cybersecurity
Dedicated Short Range Communications	DSRC	AV, CAV, 5GHz	DSRC is one of two technologies, which are not interoperable, that could have potentially provided Autonomous Vehicles with the capacity to communicate with one another and the infrastructure around them. This technology relies on short-wave signals and the G.9 GHz portion of the radio spectrum.	https://www.consumerreports.org/car-safety/fcc-plan-could-stall-v2x-car-safety-revolution/
Deep Learning		AI, ML	"Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to “learn” from large amounts of data.” (Whereas Machine Learning requires structured/ labeled data sets, Deep Learning can learn from unstructured data of multiple forms. It needs less pre-processing.)	https://www.ibm.com/topics/deep-learning
Equity/ Equitable			"Equity is giving attention to the advantages and disadvantages that exist among groups and individuals, correction of the inequities identified, and provision of access to resources and opportunities needed."	https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/PASMEMO-2019-05-06.pdf
First-Mile/Last-Mile	FMLM		Facilitating easy, multimodal access to transit stops and stations, from the surrounding area, increases the likelihood that travelers will be willing and able to incorporate transit into their travel plans.	
Gamification			“Gamification is often defined as “the use of game design elements in non-game contexts’. Nowadays, gamification is leveraged to stimulate specific usage patterns by users or customers of an ICT [Information and Communications Technologies] system in some business domain, by injecting mechanisms and concepts typical of games within the system, even if it was not originally designed with playful intentions in mind. Among the most commonly used gamification elements there are points, badges and leaderboards; more advanced ones include levels, paths, challenges, missions, feedback, and user powers.”	https://www.researchgate.net/publication/281377423_Using_Gamification_to_Incentivize_Sustainable_Urban_Mobility

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General Transit Feed Specification and GTFS Realtime	GTFS and GTFS-R	"The General Transit Feed Specification (GTFS) is an Open Standard used to distribute relevant information about transit systems to riders. It allows public transit agencies to publish their transit data in a format that can be consumed by a wide variety of software applications. ... GTFS consists of two main parts: GTFS Schedule and GTFS Realtime. GTFS Schedule contains information about routes, schedules, fares, and geographic transit details, and it is presented in simple text files. ... GTFS Realtime contains trip updates, vehicle positions, and service alerts. It is based on Protocol Buffers, which are a language (and platform) neutral mechanism for serializing structured data."	https://gtfs.org/
Gig Economy		"The gig economy is based on flexible, temporary, or freelance jobs, often involving connecting with clients or customers through an online platform."	https://www.investopedia.com/terms/g/gig-economy.asp
Global Positioning System	GPS	GPS is system of 32 satellites and a series of stations on the ground that uses radio waves to provide location information. The system is owned and operated by the US Department of Defense but is available for free use by the international community and is the base of many navigation services.	https://www.epa.gov/ghg-emissions/overview-greenhouse-gases
Greenhouse Gas	GHG	Greenhouse gases (Carbon Dioxide; Methane; Nitrous Oxide and Fluorinated gases) trap heat in the atmosphere. The transportation sector generates the most Greenhouse Gas emissions in the United States, accounting for approximately 28% of GHG emissions in 2018.	https://www.epa.gov/ghg-emissions/overview-greenhouse-gases
Incentivization		The act of providing incentives (either tangible or psychological) to encourage and/or sustain desirable behavior change. Examples of transportation-related incentives may include things like discounted fares; free passes; comparisons to peers (i.e., leader boards); or the ability to earn increases in status in a social context (i.e., badges/tokens etc.)	
Intelligent Transportation System	ITS	"ITS refers to a system of technologies and operational advancements that, when combined and managed, improve the capabilities of the overall transportation system." Examples of ITS include Autonomous Vehicles (AV) and Artificial Intelligence (AI), as well as advances in cybersecurity.	https://www.its.dot.gov/stratplan2020/ITSJPO_StrategicPlan_2020-2025.pdf
Internet of Things	IOT	"The Internet of Things is enabling devices in our everyday environment to talk to each other and share contextual information gathered through the use of embedded sensors, actuators, and other devices that can collect or transmit information about the objects. The data amassed from these devices can then be	https://innovationatwork.ieee.org/internet-of-things/?utm_source=iaw&utm_medium=20190207post&utm_campaign=iot_transportation&utm_content=text_link

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			analyzed to optimize products, services, and operations."	
Machine Learning	ML	AI	"Machine learning is an application of AI. It's the process of using mathematical models of data to help a computer learn without direct instruction. This enables a computer system to continue learning and improving on its own, based on experience."	https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/artificial-intelligence-vs-machine-learning/#introduction
Micromobility			Micromobility "refers to a range of small, lightweight devices operating at speeds typically below 15 mph, and is ideal for trips up to [approximately 6 miles.]" These devices can be human-powered or electric and can be privately owned or shared. Examples include bikes, scooters and skateboards.	https://www.itdp.org/multimedia/defining-micromobility/
Microtransit			"A privately owned and operated shared transportation system that can offer fixed routes and schedules, as well as flexible routes and on-demand scheduling. The vehicles generally include vans and buses." An example of a company that provides microtransit services is Via. It may also be possible to have publicly offered microtransit.	https://ops.fhwa.dot.gov/publications/fhwahop16022/apb.htm
Mobility As A Service	MaaS		"A full range of mobility options in a single digital mobility platform, leveraging public transportation as the network backbone."	https://www.apta.com/wp-content/uploads/MaaS_European_Study_Mission-Final-Report_10-2019.pdf
Original Equipment Manufacturer	OEM		"A company whose goods are used as components in the products of another company, which then sells the finished item to users."	https://www.investopedia.com/terms/o/oem.asp#:~:text=An%20original%20equipment%20manufacturer%20(OEM,the%20finished%20item%20to%20users.
Resilience			A resilient transportation network aims to "[i]mprove the transportation system's ability to anticipate, prepare for and adapt to changing conditions and withstand, respond to and recover rapidly from disruptions."	https://nvtatransaction.org/wp-content/uploads/2022/12/NVTATransActionPlanSummary_DEC22_Final.pdf
Sandbox		API	"A sandbox is a type of software testing environment that enables the isolated execution of software or programs for independent evaluation, monitoring or testing. It is used for many purposes, such as developing new features, testing patches, identifying and squashing bugs, or detecting cybersecurity vulnerabilities."	https://www.techopedia.com/definition/27681/sandbox-software-testing
Shared Mobility Devices	SMDs		"Shared-use fleets of small, fully or partially human-powered vehicles such as bikes, e-bikes and e-scooters. These vehicles are generally rented through a mobile app or kiosk, are picked up and dropped off in the	https://nacto.org/wp-content/uploads/2019/09/NACTO_Shared_Micromobility_Guidelines_Web.pdf

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			public right-of-way and are meant for short point-to-point trips."	
Smart cities and/or technologies			"Smart" transportation systems use data, applications and technology to "help people and goods move faster, cheaper, and more efficiently."	https://www.transportation.gov/sites/dot.gov/files/docs/Smart%20City%20Challenge%20Lessons%20Learned.pdf
Telematics			"Telematics is technology that combines telecommunications (i.e., the transmission of data from on-board vehicle sensors) and global positioning system (GPS) information (i.e., time and location) to monitor driver and vehicle performance."	https://www.fmcsa.dot.gov/research-and-analysis/technology/study-impact-telematics-system-safe-and-fuel-efficient-driving
Transactional Data Specification	TDS		"DRT [Demand Responsive Transit] produces two types of data: discovery data and transactional data. Discovery data is the information made available to potential customers so they may "discover" their travel options. For instance, trip-planning apps that consume the GTFS or GTFS-Flex specification enable customers to "discover" information about the next bus or train. But neither GTFS nor GTFS-Flex allow customers to schedule a trip. Transactional data are the information that needs to be exchanged so the customer can book and pay for a ride on a demand-responsive service, and for DRT providers to schedule and complete the trip."	https://www.aarp.org/content/dam/aarp/ppi/2020/12/modernizing-demand-responsive-transportation.doi.10.26419-2Fppi.00121.001.pdf
Transit Desert			Census block groups that have insufficient transportation services, compared to demand.	https://www.smithsonianmag.com/innovation/dozens-us-cities-have-transit-deserts-where-people-get-stranded-180968463/
Transit Signal Priority	TSP	ITS	"Transit Signal Priority (TSP) tools modify traffic signal timing or phasing when transit vehicles are present either conditionally for late runs or unconditionally for all arriving transit. TSP can be a powerful tool to improve both reliability and travel time, especially on corridor streets with long signal cycles and distances between signals."	https://nacto.org/publication/transit-street-design-guide/intersections/signals-operations/active-transit-signal-priority/
Transportation Demand Management	TDM		"Transportation Demand Management (TDM) means the acts of creating a most efficient multimodal transportation system that moves people with the goal of reducing congestion, improving air quality, and stimulating economic activity."	https://www.actweb.org/i4a/pages/index.cfm?pageID=3473
Transportation Network Companies	TNCs		"A transportation network company (TNC) provides prearranged rides for compensation using a digital platform that connects passengers with drivers using a personal vehicle." Examples include Lyft and Uber.	https://www.dmv.virginia.gov/commercial/#tnc/intr_o.asp

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Turing Test		AI	"[A] test proposed (1950) by the English mathematician Alan M. Turing to determine whether a computer can 'think.' And 'a remote human interrogator, within a fixed time frame, must distinguish between a computer and a human subject based on their replies to various questions posed by the interrogator.'"	https://www.britannica.com/technology/Turing-test
Vehicle to Everything	V2X	AV, CAV	V2X is an umbrella term that typically encompasses V2V, V2I and V2P technologies.	https://www.transportation.gov/v2x
Vehicle to Infrastructure	V2I	AV, CAV	"V2I technologies capture vehicle-generated traffic data, wirelessly providing information such as advisories from the infrastructure to the vehicle that inform the driver of safety, mobility, or environment-related conditions."	https://www.its.dot.gov/v2i/index.htm#:~:text=Vehicle%2Dto%2DInfrastructure%20(V2I)%20Resources&text=V2I%20technologies%20capture%20vehicle%2Dgenerated,%2C%20or%20environment%2Drelated%20conditions.
Vehicle to Pedestrian	V2P	AV, CAV	"Pedestrian detection systems can be implemented in vehicles, in the infrastructure, or with pedestrians themselves to provide warnings to drivers, pedestrians, or both. ... Some of the V2P applications in development include" mobile accessible pedestrian signal system; pedestrian in signalized crosswalk warning (transit) and automatic braking of personal vehicles.	https://www.its.dot.gov/factsheets/pdf/CV_V2Pcomms.pdf
Vehicle to Vehicle	V2V	AV, CAV	"Vehicle-to-vehicle (V2V) communication enables vehicles to wirelessly exchange information about their speed, location, and heading."	https://www.nhtsa.gov/technology-innovation/vehicle-vehicle-communication
Vulnerable Road Users	VRUs		VRU is a term used to describe those persons who are most at risk in traffic, including people walking, biking or riding a motorcycle.	https://safety.nsc.org/road-to-zero-safety-priority-statements-vulnerable-road-users

Appendix – Related Initiatives

Planning Initiatives

Member Jurisdictions Initiatives

- Alexandria Smart Mobility Plan
 - *“Smart Mobility is the concept of applying information technologies to roads, traffic signals, transit vehicles, and other transportation infrastructure to help us better understand how our roadway network operates. This data can be leveraged to improve quality of life in Alexandria in a variety of ways – from managing traffic to improving transit to enhancing safety to optimizing parking to streamlining emergency management.”*
 - The Smart Mobility Plan has four key goals: to improve safety; improve travel times and transit options; improve air quality; and, to position Alexandria to embrace innovation use future transportation technologies. It will apply six guiding principles in pursuit of these goals: safety; mobility; forward-looking; sustainability; traffic management; and transparency. Learn more here: <https://www.alexandriava.gov/SmartMobility>
- Arlington County Master Transportation Plan’s Demand and System Management Element
 - *“The Master Transportation Plan Goals and Policies document specifies three general policies that form the foundation of the Master Transportation Plan (MTP) and, therefore, transportation in Arlington in the years ahead:*
 - *integrating transportation with land use,*
 - *supporting the design and operation of complete streets, and*
 - *managing travel demand and transportation systems.**Integrating land use and transportation is the cornerstone of managing travel demand because focusing mixed-use development on major transportation corridors results in shorter trips, and shorter trips are more conducive to walking, biking and transit than are longer trips. This element of the MTP reinforces the first general policy of integrating transportation and land use and focuses on the third general policy of managing travel demand and transportation systems.”*

The Demand and System Management Element of the Arlington County Master Transportation Plan focuses on Transportation Demand Management (TDM) and Transportation System Management (TSM) strategies.
 - Learn more here: <https://arlingtonva.s3.dualstack.us-east-1.amazonaws.com/wp-content/uploads/sites/31/2014/02/DES-MTP-Demand-and-System-Management-Element.pdf>
 -
- Fairfax County Pitch and Pilot: Fairfax County Innovation Challenge - Bicycle and Pedestrian Safety
 - *“In partnership with Fairfax County Department of Economic Initiatives, Smart City Works will hold a regionally focused Pitch and Pilot to find the best safety solutions to support Fairfax County’s goals, including increasing bike and pedestrian safety,*

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Appendix – Related Initiatives

promoting active living, and sustainability. Fairfax County hopes this process will result in a viable pilot project. The County is agreeable to partnering with participants who offer innovative safety solutions that are aligned with County goals and policies. There are no preconceived notions about the incorporation of any specific technologies, but we do ask that the solution further the County's goal of being a leader in smart community innovation.

At least eight teams from around the world will present their solutions to an audience of Fairfax government officials and other safety, innovation, and community stakeholders from around the region."

- Learn more here: <https://www.smartcityworks.org/fairfax-innovation-challenge/> Loudoun County 2019 Transportation Plan
 - *"The Loudoun County 2019 Countywide Transportation Plan (2019 CTP) is guided by a set of goals developed based upon public input and affirmed by the Board of Supervisors, providing the foundation for the entire document and ensuring that the public is the guiding force behind this vision. From those goals, the 2019 CTP identifies the overarching objectives that the County will seek to meet through implementation of the planned transportation network and policies."*
 - Learn more here: <https://www.loudoun.gov/DocumentCenter/View/152287/CTP---Combined-with-small-maps-bookmarked>
- Prince William County Technology and Connectivity Plan
 - *"In Prince William County, ICT [Information and Communications Technology] will help accelerate enhancements in quality of life detailed in the Strategic Plan by enabling and supporting a Robust Economy, Mobility, Wellbeing, Safe and Secure Communities, and Quality Education and Workforce Development."*
 - *"ICT will help enable and support Mobility by: Understanding mobility behaviors, trends, and desires throughout the County... Enabling new-mobility options... [and,] Preserving capacity to adapt to new technologies."*
 - Learn more here: https://www.pwcva.gov/assets/documents/planning/MasterDocument_TechConn.pdf

Larger DMV Initiatives

- Regional Multimodal Mobility Program (RM3P)
 - *"The RM3P's mission is to leverage the collaborative use of real-time data by Virginia's public and private sectors to improve travel safety, reliability, and mobility, and to give the public the tools to make more informed travel choices."*
 - RM3P is comprised of five program elements: Data Exchange Platform; AI-Based Decision Support System; Commuter Parking Information System; Multi-Modal Analytical Planner and Dynamic Incentivization.
 - The program represents a partnership between the Virginia Department of Transportation's (VDOT) Office of the Secretary of Transportation, the NVTA, and the Department of Rail and Public Transportation (DRPT).
 - Learn more here: <https://rm3pvirginia.org/>
- I-95 project (Stafford)

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Appendix – Related Initiatives

- This is a Public Private Partnership to make downtown Stafford the Commonwealth's first standalone "smart community." The Center for Innovative Technology (CIT) has developed a plan for this effort and is working with a Tysons Corner based technology firm called Optimal Solutions and Technologies (OST) and other contractors, to test concepts. Some ideas include experiential shopping, connected traffic signals, energy monitoring sensors, pollution monitoring and incident mitigation information sharing in the nearby I-95 corridor.
- Learn more here: https://fredericksburg.com/news/local/stafford-targeted-to-become-virginias-first-smart-community/article_c66aabb2-6419-5bb2-baed-6c3f10816501.html
- Greater Washington Partnership's Capital Region Blueprint for Regional Mobility
 - *"The Capital Region's Blueprint for Regional Mobility lays out an agenda for working together to make tangible progress on these [four] priorities, with specific actions our region's public leaders and private employers can take to address the unique challenges facing our region. Only through collective action can we ensure that when one wins, we all win."*
 - The four priorities of the Blueprint are connecting the super-region; improving consumer experience; ensuring equitable access; and integrating innovation.
 - Learn more here:
<https://www.greaterwashingtonpartnership.com/blueprint/index.html#solutions-and-action>
- DDOT Mobility Wallet
 - In 2019, the District of Columbia's Department of Transportation (DDOT) posted a Request for Qualifications (RFQ) for a consultant firm to assist in scoping, and preparing an RFP (Request For Proposal) for a regional, multimodal payment & data aggregator/ Mobility Wallet.
 - Learn more here:
<https://wiki.ddot.dc.gov/download/attachments/35160942/Request%20for%20Qualifications%20-%20Mobility%20Wallet.pdf?version=1&modificationDate=1562614607227&api=v2>
- IncenTrip
 - *"The [IncenTrip] app was a joint project between Commuter Connections and the University of Maryland. The idea is to use something called "gamification" to incentivize choosing to walk, bike, use transit, or carpool to influence commuters to choose alternatives to driving alone. Gamification uses human psychology to reward more desirable behaviors and make it fun in the process. IncenTrip rewards users by awarding points when they log their trips in the app. When users choose non-driving modes, they get more points. People can also get points from choosing a less congested time to make a trip. The points can be traded for gift cards and cash prizes. The cash incentives are only available through Commuter Connections during peak hour rush periods".*
 - Learn more here: <https://www.mwcog.org/newsroom/2019/09/10/a-new-app-can-help-our-region-reach-its-transportation-goals/> and here https://www.mwcog.org/assets/1/28/07102020_-_Item_12_-_ATCMTD_Memo.pdf
- NVTC

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Appendix – Related Initiatives

- Regional Fare Collection Strategic Plan
 - *“This [P]lan serves as a roadmap for supporting the study, development and implementation these upgrades. This plan was developed as a collaborative effort with regional partners, and the process included regional partner surveys and work sessions, as well as an extensive industry review. It establishes the vision, needs, and actions of NVTC’s Regional Fare Collection Program. The actions of the plan will support and promote the enhancement of the fare collection systems used by the seven Northern Virginia transit systems and the Washington Metropolitan Area Transit Authority (WMATA). The following vision statement was developed by NVTC and the transit systems as a guide for decision-making in alignment with regional fare collection goals.”*
 - Learn more here: <https://novatransit.org/programs/transit-technology/>
- Zero-Emission Bus Research
 - *“The Commission, with support from the Virginia Department of Rail and Public Transportation (DRPT), launched its Northern Virginia zero-emission bus (ZEB) strategic planning process in January 2023. The goals of the Strategic Plan are to:
Identify regional zero-emission strategic goals and objectives;
Document strategies and priorities to achieve the goals and objectives, including how to implement ZEB to align with regional and agency goals;
Identify key tasks for NVTC to coordinate its activities with regional partners;
and
Identify regional, state and federal funding to accomplish the goals in the Strategic Plan.”*
 - Learn more here: <https://novatransit.org/programs/transit-technology/>
- CIT Unmanned Systems Center
 - *“As a major part of Governor Ralph Northam's "Comprehensive Economic Development Policy for the Commonwealth", Virginia is actively seeking to expand and diversify industries in Virginia - with special attention to the UAV and Unmanned Systems industry.
On May 11, 2017, CIT launched their UxS initiative named Virginia Unmanned Systems Center at CIT. The Center serves as a unified voice and central source for information and assistance related to the unmanned systems landscape in Virginia. The Virginia Unmanned Systems Center at CIT team members are charged with building on the rich assets and business climate to make Virginia "THE" state for unmanned systems.”*
 - Learn more here: <https://www.cit.org/unmanned-systems.html>
- MDOT CAV Strategic Framework
 - *“Maryland’s Vision for Connected and Automated Vehicles (CAV) is to uphold and enhance a Safe, Efficient, and Equitable transportation future by delivering collaborative and leading-edge CAV solutions. Maryland is open for business and eager to realize the life-saving and economic benefits of CAV technology, while ensuring safety for all. We are embracing CAV technology and innovation through continuing collaboration with partners interested in researching, testing, and implementing CAVs in Maryland.”*

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Appendix – Related Initiatives

- Maryland's CAV efforts include a CAV Strategic Framework, collaboration on research, testing and implementation in their state, creation of Locations to Enable Testing Sites (LETS) and, establishment of a CAV Working Group.
- Learn more here: <https://mva.maryland.gov/safety/Pages/MarylandCAV.aspx>
- DDOT Bus Priority Program Toolbox
 - *"The District Department of Transportation (DDOT) Bus Priority Program (BPP) is working to streamline delivery of projects that improve bus service in the District of Columbia ("the District"), with a goal of faster delivery timelines and improved coordination. To support those efforts, DDOT developed a Toolbox of potential bus priority treatments that can be consistently applied to future efforts to improve the speed and reliability of bus service or create safer interactions with other modes."*
 - The Toolbox includes five categories of treatments: Bus Operations; Traffic Control (includes Transit Signal Priority or TSP); Bus Stop Infrastructure; Bus Lane (includes Automated Bus Lane Enforcement) and; Bike and Bus.
 - Learn more here:
https://ddot.dc.gov/sites/default/files/dc/sites/ddot/page_content/attachments/DDOT%20Bus%20Priority%20Toolbox.pdf

Commonwealth Initiatives

- Transportation Climate Initiatives
 - *"The Transportation and Climate Initiative (TCI) is a regional collaboration of 12 Northeast and Mid-Atlantic states and the District of Columbia that seeks to improve transportation, develop the clean energy economy and reduce carbon emissions from the transportation sector. The participating states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia."*
 - TCI focuses its work on clean vehicles and fuels; sustainable communities; information and communication technology; freight efficiency and exploring regional policies to reduce emissions.
 - Learn more here: <https://www.transportationandclimate.org/>
- Eastern Transportation Coalition's Mileage-Based User Fees (MBUFs)
 - *"The Eastern Transportation Coalition, formerly known as the I-95 Corridor Coalition, is a partnership of 17 states and the District of Columbia focused on connecting for solutions to support the economic engine of the U.S. The Coalition represents 40% of the U.S. population and GDP.
The Coalition is dedicated to advancing the national conversation around mileage-based user fees through real-world pilots, education, and outreach. The unique characteristics of the Eastern Seaboard – such as significant cross-state travel, numerous toll facilities, and several major truck corridors – make it a natural testing ground for the potential challenges of implementing a mileage-based user fee (MBUF) system nationally.
The Coalition is neutral regarding MBUF as the ultimate solution for transportation funding but wants to ensure the voices of citizens along the Eastern Seaboard are part of the national discussion. Results from studies across the country will help policymakers decide on next steps."*

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- Learn more here: <https://tetcoalitionmbuf.org/>
- VTTI Mixed Fleet Integration project
 - The Virginia Tech Transportation Institute recently earned two grants, each for 7.5 million dollars, and will use one of these to test Autonomous Vehicle (AV) technology and its interaction with work zones and incident response scenarios. The funding will be used to develop level 4 AVs (see the SAE AV classification scale²²⁶ for more information) and the connected infrastructure needed to support them, in pursuit of conducting three demonstrations of the AV navigating challenging scenarios. The demonstrations, anticipated to take place in 2022, will be conducted in partnership with TransUrban, on the I-95 corridor in the Greater Washington D.C. region.
 - Learn more here: <https://vtnews.vt.edu/articles/2020/03/031720-vtti-usdottruckgrant.html>
- 2020 Virginia CAV Strategic Plan and Program
 - *“The Virginia Department of Transportation’s (VDOT) Connected and Automated Vehicle (CAV) program helps guide the department in the deployment and sustainment of related technologies and initiatives.”*
 - The CAV program has several goals including to: reduce crashes and fatalities on Virginia roadways by improving safety measures; improve mobility to reduce delay, increase system reliability, and provide a more efficient use of physical infrastructure; reduce infrastructure investments through efficiencies enabled by the conversion of vehicles that are connected and automated; and to enhance traveler information.
 - VDOT’s CAV efforts include a Connected and Automated Vehicle Program Plan; test bed facilities; and a data portal called [SmarterRoads](#).
 - Learn more here:
https://www.virginiadot.org/programs/connected_and_automated_vehicles.asp and here
<https://www.mwcog.org/file.aspx?&A=3FvjGRYdXSYnYFkJtcJwIDmXvQGhUu9IIHYyKBYKhI%3D>
- Virginia Connected Corridor
 - *“To facilitate the understanding of CV deployment, the Virginia Department of Transportation (VDOT) has partnered with the Virginia Tech Transportation Institute (VTTI) to create the Virginia Connected Corridors (VCC). The VCC is a CV environment that enables the development and assessment of early stage connected and automated vehicle (CAV) applications. The VCC comprises more than 60 roadside units (RSUs) which are connected to a low-latency backhaul network via dedicated short-range communications (DSRC) and cellular technology. The VCC strives to provide an open application development environment where third party developers may bring their applications and tap into existing infrastructure resources and systems to minimize time to demonstration and deployment. Developers may create applications that run directly on the VCC Cloud computing environment or access VCC data through a Public API depending on which is most appropriate.”*

²²⁶ <https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%99Clevels-of-driving-automation%E2%80%99D-standard-for-self-driving-vehicles>

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- *“Since 2012, VTTI has been working in partnership with VDOT to develop, test, and demonstrate connected vehicle solution components that can improve work zone safety.”*
- Learn more here: <https://www.vtti.vt.edu/vcc/>
- Connected Vehicle Pooled Fund Study
 - *“[T]he pooled fund study entitled “Program to Support the Development and Deployment of Connected Vehicle Applications” was created by a group of state, local, and international transportation agencies and Federal Highway Administration (FHWA) in order to provide a means to conduct the work necessary for infrastructure providers to play a leading role in advancing the Connected Vehicle systems. Participating agencies include Alaska Department of Transportation (DOT), Arizona DOT, Caltrans, Colorado DOT, Connecticut DOT, Delaware DOT, FHWA, Florida DOT, Georgia DOT, Idaho DOT, Illinois DOT, Maricopa County DOT in Arizona, Maryland DOT, Michigan DOT, Minnesota DOT, Mississippi DOT, New Hampshire DOT, New Jersey DOT, New York State DOT, Ohio DOT, Pennsylvania DOT, Tennessee DOT, Texas DOT, Transport Canada, Utah DOT, Washington State DOT, and Wisconsin DOT with the Virginia DOT as lead agency and the University of Virginia Center for Transportation Studies as technical leadership provider.”*
 - Learn more here: <http://www.cts.virginia.edu/cvpfs/>
- Northern Virginia Park and Ride Assessment
 - *“This study, conducted for VDOT with funding from the National Capital Region Transportation Planning Board Unified Planning Work Program Technical Assistance Program, assessed Northern Virginia's existing park and ride facilities and future park and ride needs with input from localities and regional stakeholders between June 2020 and June 2021. There are over 100 park and ride facilities in Northern Virginia, 22 of which are VDOT owned or operated. The final report was issued in June 2021 and contains findings on the stakeholder survey results and workshop meeting, previous related studies, park and ride facility information for Northern Virginia, an assessment of current needs, future technology and mobility vision, and overview of planning and funding processes.”*
 - Learn more here:
https://www.virginiadot.org/projects/northernvirginia/nova_park_and_ride.asp
- Virginia Code 46.2-908.1:1. Personal delivery devices, updated per SB 758 (2020)
 - Current Code: <https://law.lis.virginia.gov/vacode/title46.2/chapter8/section46.2-908.1:1/#:~:text=Personal%20delivery%20devices,or%20town%20in%20the%20Commonwealth.>
 - *“[S]everal changes related to electric personal delivery devices, including changing the term used to refer to such devices to “personal delivery devices” and changing the weight limit of such devices from 50 to 500 pounds. The bill allows localities to regulate the use of personal delivery devices on sidewalks, crosswalks, or roadways but requires a locality to allow a personal delivery device to operate on the side of a roadway with a speed limit of 25 miles per hour or less if a sidewalk is not available.”*
 - Learn more here: <https://lis.virginia.gov/cgi-bin/legp604.exe?201+sum+SB758>

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- Transit Ridership Incentive Program (TRIP)
 - *“The Transit Ridership Incentive Program is a statewide grant program from DRPT dedicated to improving transit’s regional connectivity in urban areas with a population in excess of 100,000 and reducing barriers to transit use by supporting low-income and zero-fare programming.*
 - The Transit Ridership Incentive Program’s regional connectivity component promotes improved public transportation services in urban areas with a population greater than 100,000. The program’s goal is the identification and establishment of routes of regional significance, the development and implementation of a regional subsidy allocation model, implementation of integrated fare collection, establishment of bus-only lanes on routes of regional significance, and other actions and service determined by the Commonwealth Transportation Board to improve transit service.”*
 - Learn more here: <https://www.drpt.virginia.gov/ongoing-grant-programs/trip/>
- Statewide Integrated Mobility Initiative
 - *“DRPT’s Statewide Integrated Mobility Initiative assists the department and its partners in navigating the rapidly changing shared mobility landscape. This initiative developed recommendations for integrated technologies and shared mobility devices/services rooted in stakeholder input from DRPT’s staff, transit agencies, and research.”*
 - Goals of the initiative include:
 - Identify what is happening in Virginia in terms of integrating shared mobility and transit and utilizing transit technology to assess operations and tailor service in evolving mobility landscapes
 - Document current and planned technology deployments of Virginia transit agencies, including planned partnerships or pilots involving shared mobility providers
 - Develop recommendations for DRPT and its partner agencies for what needs to be done in light of the changing mobility industry — for example, roles, investment needs, and projects
 - Learn more here: <https://drpt.virginia.gov/work/transit-technology-and-innovation/>

Federal Initiatives

- United States Department of Transportation (USDOT)’s Automated Vehicles Comprehensive Plan” (AVCP)
 - *“Building upon the principles stated in AV 4.0, the Automated Vehicles Comprehensive Plan defines three goals to achieve USDOT’s vision for Automated Driving Systems (ADS).*
 - 1. Promote Collaboration and Transparency – USDOT will promote access to clear and reliable information to its partners and stakeholders, including the public, regarding the capabilities and limitations of ADS.*
 - 2. Modernize the Regulatory Environment – USDOT will modernize regulations to remove unintended and unnecessary barriers to innovative vehicle designs, features, and operational models, and will develop safety focused frameworks and tools to assess the safe performance of ADS technologies.*

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3. *Prepare the Transportation System – USDOT will conduct, in partnership with stakeholders, the foundational research and demonstration activities needed to safely evaluate and integrate ADS, while working to improve the safety, efficiency, and accessibility of the transportation system.”*

- Learn more here: <https://www.transportation.gov/av/avcp>
- U.S. Access Board's Inclusive Design of Autonomous Vehicles: A Public Dialogue
 - *“Self-driving or “autonomous” vehicles stand to revolutionize road transportation in the U.S. and around the world. Their cutting-edge technologies and engineering innovations have the potential to significantly expand transit options for many people, including those with disabilities. It is important that autonomous vehicles (AVs) are designed to be inclusive of everyone.*

This spring, the U.S. Access Board will host a four-part series of virtual meetings on making AVs accessible to passengers with disabilities. The Board will provide an open forum where members of the public and stakeholders can discuss considerations, challenges, and solutions in designing accessible AVs. The sessions will cover accessibility for passengers with mobility, sensory, or cognitive disabilities. The sessions are free and open to the public. Attendees will be able to pose questions and share comments, suggestions, and information.

The Board is undertaking this initiative jointly with other agencies, including the Department of Labor’s Office of Disability Employment Policy (ODEP) and the Department of Health and Human Service’s Administration for Community Living.”

- Learn more here: <https://www.access-board.gov/av/>
- FTA’s Low or No Emission Vehicle Program
 - *“The Low or No Emission competitive program provides funding to state and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required supporting facilities.”*
 - Eligible activities include (but are not limited to): purchasing/leasing low- or no-emission buses, constructing or leasing facilities and related equipment (including intelligent technology and software) for low- or no-emission buses, constructing new facilities to accommodate low- or no-emission buses, and rehabilitating existing facilities to accommodate low- or no-emission buses.
 - Learn more here: <https://www.transit.dot.gov/lowno>
- Federal Motor Carrier Safety Administration’s High Priority Program – Innovative Technology Deployment (HP-ITD)
 - *“The HP grant program is a discretionary (competitive) grant program designed to provide Federal financial assistance to enhance MCSAP commercial vehicle safety plan (CVSP) activities, maintain innovative technology and/or new project(s) not included in the CVSP that will have a positive impact on commercial motor vehicle (CMV) safety. Other applicants are also eligible for HP grants that improve CMV safety. HP now includes two major purposes: Innovative Technology Deployment (ITD), and CMV safety*

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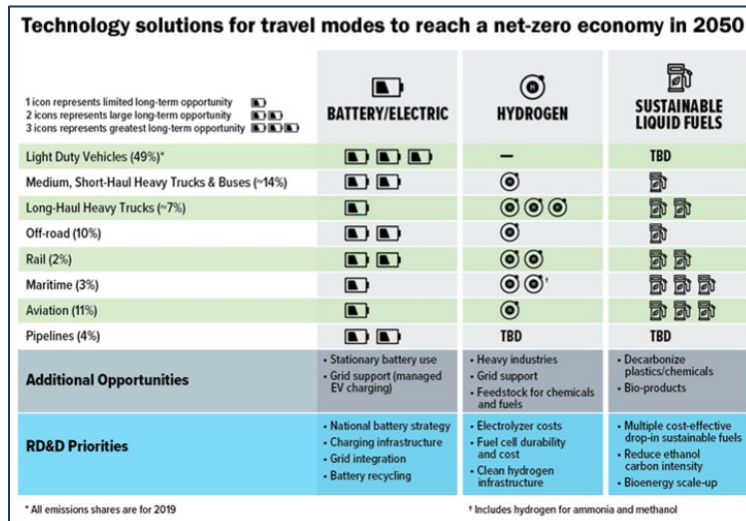
related activities and projects. Although ITD resides within HP, the ITD grant program purpose and program eligibility requirements are separate and distinct from CMV safety related activities and projects.”

- The HP program provides financial assistance to carry out activities that augment motor carrier safety. The ITD program provides assistance to advance the technological capability and promote the deployment of intelligent transportation system applications for CMV operations, including commercial driver and carrier specific information systems and networks.
- Learn more here: <https://www.fmcsa.dot.gov/grants/mcsap-high-priority-grant/motor-carrier-safety-assistance-program-mcsap-high-priority-grant>
- Federal Highway Administration’s Carbon Reduction Program
 - The Infrastructure Investment and Jobs Act (IIJA) (Public Law 117-58, also known as the “Bipartisan Infrastructure Law (BIL)”) is a 5-year investment in our infrastructure that will help grow the economy, enhance U.S. competitiveness, create good jobs, and build our safe, resilient, and equitable transportation future. Through BIL funding, FHWA has launched the Carbon Reduction Program to provide \$6.4B for states and local governments over five years to develop carbon reduction strategies and address climate crisis. Virginia’s funding is estimated at \$165M for local governments and the state to develop a Carbon Reduction Strategy which will address the current climate crisis.
 - Learn more here: https://www.fhwa.dot.gov/bipartisan-infrastructure-law/crp_fact_sheet.cfm
- National Electric Vehicle Infrastructure (NEVI) program
 - “The BIL [Bipartisan Infrastructure Law] establishes a National Electric Vehicle Infrastructure Formula Program (“NEVI Formula”) to provide funding to States to strategically deploy electric vehicle (EV) charging infrastructure and to establish an interconnected network to facilitate data collection, access, and reliability.”
 - Learn more here: https://www.fhwa.dot.gov/bipartisan-infrastructure-law/nevi_formula_program.cfm
 - See Virginia’s NEVI plan here: <https://publicinput.com/M5232>
- The Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law (BIL), also includes several other funding opportunities that can be utilized to advance innovation going forward. These include but are not limited to the Charging and Fueling Infrastructure Grants Programs and Advanced Transportation Technologies and Innovative Mobility Deployment.
 - Learn more here: https://www.fhwa.dot.gov/bipartisan-infrastructure-law/grant_programs.cfm
 - A summary is provided here: <https://thenovaauthority.org/wp-content/uploads/2023/03/8th-Annual-NoVA-Transpo-Roundtable-Slides-Anthony-Bedell.pdf>
- U.S. National Blueprint for Transportation Decarbonization
 - “The U.S. National Blueprint for Transportation Decarbonization (Blueprint) is a landmark strategy for cutting all greenhouse gas (GHG) emissions from the transportation sector by 2050. The Blueprint was developed by the EPA, along with

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Department of Energy (DOE), Department of Transportation (DOT), and Housing and Urban Development (HUD). It exemplifies a whole-of-government approach to addressing the climate crisis and will help reach net-zero carbon emissions by 2050. The Blueprint lays the groundwork for us to build a safer and more sustainable transportation system.”



- Learn more here: [https://www.epa.gov/greenvehicles/us-national-blueprint-transportation-decarbonization#:~:text=The%20U.S.%20National%20Blueprint%20for%20Transportation%20Decarbonization%20\(Blueprint\)%20is%20a,the%20transportation%20sector%20by%202050.](https://www.epa.gov/greenvehicles/us-national-blueprint-transportation-decarbonization#:~:text=The%20U.S.%20National%20Blueprint%20for%20Transportation%20Decarbonization%20(Blueprint)%20is%20a,the%20transportation%20sector%20by%202050.)

Pilot Programs

General

- Arlington County's Performance Parking Pilot
 - Arlington County has earned support for a “performance parking” concept from the Virginia Department of Transportation (VDOT), in the form of an Innovation and Technology Transportation Fund (ITTF) grant. The funds will support a pilot that would dynamically adjust the price of parking on Metro corridors and provide information about costs and availability to the public. The hope is that this initiative will reduce congestion resulting from circling, buy encouraging turnover and informing would-be parkers. If the program is successful, it could be used as precedence for expansion elsewhere in the Commonwealth.
 - Learn more here: <https://www.arlnow.com/2020/12/17/county-approves-performance-parking-pilot-after-hashing-out-equity-concerns/>
- Audi/Qualcomm/VTI (DSRC/C2V RSUs)- “CV2X Pilot”
 - Audi of America, the Virginia Department of Transportation and Qualcomm have joined forces to deploy Cellular Vehicle-to-Everything (C-V2X) technologies in Northern Virginia, using software to be developed by the Virginia Tech Transportation Institute. This partnership will aim to improve road safety through two use cases: work zone

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warning and increased communications between vehicles and traffic signals. The deployment was authorized via an experimental license, which allows use of the 5.9 GHz bandwidth.

- Learn more here: <https://www.qualcomm.com/news/releases/2020/01/22/audi-america-virginia-dot-and-qualcomm-announce-initial-c-v2x-deployment>
- Falls Church Proposed Smart City Connected Infrastructure Pilot Project
 - *“The city is delighted to partner with Virginia Tech on the Smart City technology program that will bring cutting-edge transportation solutions to Falls Church, including support for autonomous vehicles, adaptive lighting, and parking garage utilization indicators. These solutions will reduce pollution and traffic congestion and improve public safety”*
 - Learn more here: <https://vtnews.vt.edu/articles/2021/03/vtti-falls-church-test-bed.html>
- Northern Virginia Smart Region initiative: Investment and Growth
 - *“Smart City Works, with partners Washington DC ArchAngels and VA Center for Innovative Technology (CIT), announced a new grant award supporting the Northern Virginia Smart Region Initiative. The \$1.9 million grant was approved by the Virginia Growth and Opportunity State Board. With the Go Northern Virginia grant, Smart City Works will fill a much-needed gap supporting high-growth, technology start-ups and SMEs in Northern Virginia; accelerating their growth; and creating commercialization pathways to spur sustained near- and long-term economic development.”*
 - Learn more here: <https://www.smartcityworks.org/smart-region-initiative/>
- Virginia CAV Testing
 - Daimler
 - *“Daimler Trucks and Torc Robotics are actively developing and testing automated trucks with SAE Level 4 intent technology on public roads. The initial routes are on highways in southwest Virginia, where Torc Robotics is headquartered. All automated runs require both an engineer overseeing the system and a highly trained safety driver certified by Daimler Trucks and Torc Robotics. All safety drivers hold a commercial driver’s license and are specially trained in vehicle dynamics and automated systems. The deployment on public roads takes place after months of extensive testing and safety validation on a closed loop track.”*
 - Learn more here: <https://media.daimler.com/marsMediaSite/en/instance/ko/Daimler-Trucks-begins-testing-automated-trucks-on-public-roads.xhtml?oid=44348018>
 - CARMA
 - *“With a multimodal approach, CARMASM was developed by the Federal Highway Administration (FHWA) to encourage collaboration and to improve transportation safety, efficiency, and mobility. Automation is transforming the transportation system and enhancing the mobility of millions of Americans. FHWA’s focus is on how infrastructure can move traffic more efficiently by advancing transportation systems management and operations (TSMO) strategies.*

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Cooperative driving automation (CDA) enables automated vehicles (AVs) to communicate between vehicles, infrastructure devices, and road users such as pedestrians and cyclists. CDA has the potential to advance transportation efficiency, facilitate freight movement, increase productivity, and reduce the need for roadway facilities, therefore, saving billions of dollars. CDA also has the potential to reduce crashes caused by human error and save lives. The CDA research focuses on AVs working together and with roadway infrastructure will increase safety and improve operational efficiency by: reducing fuel consumption at intersections by 20 percent; doubling capacity of existing lanes [; and,] saving fuel by 10 percent.”

- *“FHWA’s CARMA platform (which focuses on testing automated vehicle features and cooperative automated vehicle features) effort is based out of McLean, VA where they test their research vehicles and applications.”*
- Learn more here: <https://highways.dot.gov/research/operations/Cooperative-Driving-Automation> and here <https://www.mwcog.org/file.aspx?&A=3FvjGRYdXSYnYFkJtcJwIDmXvQGhUu9IHYYKBYKhI%3D>
- Virginia Rural Microtransit Deployment (Bay Transit in Gloucester County and Town of UVA at Wise Campus)
 - *“The collaborators are seeking a microtransit vendor to provide a turnkey Software-as-a-Service solution for deploying microtransit services on two rural transit routes in the Commonwealth of Virginia. The partners are looking to augment existing deviated fixed route and demand responsive service with microtransit technologies. The goal of deploying microtransit is to enhance the rider experience by providing enhanced real-time vehicle routing real-time trip booking via app, website, and call center; and arrival information. The project is being funded in part by a Federal Transit Administration Integrated Mobility Innovation Grant and will require 1-year of initial microtransit service along with all necessary planning and preparation to launch the 1-year of service. If successful, the intent would be to extend service beyond the 1-year demonstration period, if funding is available. Further, there may be opportunities for microtransit deployments in additional locations within the Commonwealth.”*
 - Learn more here: <https://cn5.778.myftpupload.com/wp-content/uploads/2020/11/Microtransit-Scope-Requirements-Final-11172020.pdf>
- DDOT’s Pedestrian and Cyclist Intersection Safety Sandbox
 - *“The research is intended to implement a sandbox for one or more pilot or demonstration projects that use emerging technology solutions to improve pedestrian and/or cyclist safety in intersections. The sandbox will encompass a single intersection or corridor within the District. Envisioned solutions include:*
 - *Technology that enhances DDOT’s situational awareness of intersection activity to inform safety improvements*
 - *Technology that provides auditory or visual alerts for pedestrians, cyclists, and/or drivers approaching crosswalks based on real-time activity in the intersection.”*

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- Learn more here:
<https://wiki.ddot.dc.gov/display/RL/Pedestrian+and+Cyclist+Intersection+Safety+Sandbox>
- Uber Green
 - *“We’re launching Uber Green, a low-emission ride option that connects riders with drivers using hybrid and fully electric vehicles. Eligible drivers of low-emission vehicles automatically get \$0.50 extra directly from riders in each Uber Green trip.”*
 - *“Drivers are leading the way toward a greener future, and Uber is committed to supporting them. Our Green Future program provides access to resources valued at \$800 million to help hundreds of thousands of drivers transition to battery EVs by 2025 in Canada, Europe, and the US.”*
 - Learn more here: <https://www.uber.com/us/en/drive/services/electric/>
- Loudoun County’s Shared Mobility Devices Pilot Program
 - *“Loudoun County is conducting a Shared Mobility Devices Pilot (SMD) program to facilitate the operation and use of SMDs (motorized skateboards and scooters, electric assist bikes and pedal bikes for hire) within the county and to evaluate their impact. During the pilot program, the Department of Transportation and Capital Infrastructure will monitor SMD operations, operator performance and engage the public in developing regulatory recommendations for the Board of Supervisors to Consider.”*
 - The program is designed to test how SMDs as a mobility option can support providing transportation choices that connect people to their communities, jobs, schools, activity centers and other amenities and evaluate the impact of this technology on the county. In 2020, the pilot project was initially poised to last at least 6 months after the opening of the Silver Line Extension.
 - Learn more here: <https://www.loudoun.gov/5292/Shared-Mobility-Devices>
- Fairfax County’s Speed Camera Pilot Program
 - *“Slowing down drivers and improving traffic safety are the objectives of a new Speed Camera Pilot Program that will include the installation of photo monitoring devices (speed cameras) in eight school zones. Data suggests that school zone speeding is prevalent and cameras are effective. In the five school zones surveyed last year, thousands of drivers exceeded the speed limit by more than 10 mph during the sample period. Ultimately, it is expected that the pilot program will change driver behaviors to keep Fairfax County residents safe.”*
 - The pilot program will implement speed cameras at eight school zones throughout the county and operate during school zone hours only. Speed cameras have been shown to reduce traffic related injuries and accidents and ultimately save lives. The purpose of the project is to improve the safety of roads for all residents
 - Learn more here: <https://www.fairfaxcounty.gov/news/speed-camera-pilot-program-launches-feb-10>

5.13.2.1 Autonomous Shuttle Pilots

- Relay shuttle in Merrifield (Fairfax County, Virginia)

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- *“The first publicly funded autonomous electric shuttle and test of driverless technology in public transportation in the Commonwealth of Virginia is now in operation. This pilot project is a public-private partnership between Fairfax County, Dominion Energy, EDENS (Mosaic District developer), Virginia Department of Rail and Public Transportation (VDRPT), Virginia Department of Transportation (VDOT), Virginia Tech Transportation Institute (VTI), and George Mason University (GMU).”*
- The Relay shuttle operated for three years on a fixed route between the Dunn Loring Metrorail Station and the Mosaic District, in Merrifield, Virginia. A safety steward was always on-board to monitor operations of the shuttle, which traveled at a maximum of 10mph. Passengers were required to wear safety belts and additional safety precautions were in place, due to the COVID-19 pandemic.
- Learn more here: <https://www.fairfaxcounty.gov/transportation/autonomous-shuttle-pilot>
- Optimus Ride shuttle at the Halley Rise development (Reston, Virginia)
 - In 2019, Brookfield Properties announced a partnership with Optimus Ride, to bring self-driving shuttles to the Halley Rise development in Reston, Virginia. Shuttle routes were to be completely contained within the development site.
 - Learn more here: <https://www.restonnow.com/2019/02/07/self-driving-vehicles-to-hit-the-roads-at-halley-rise-this-spring/> and <https://www.fairfaxcountyped.org/ride-of-future-happening-in-fairfax-county/>
- Olli Fleet Challenge – autonomous vehicles on Joint Base Meyer-Henderson Hall (Arlington County, Virginia)
 - *“[The Northern Virginia Regional Commission] was pleased to be part of the winning team that won the Olli Fleet Challenge that resulted in two autonomous vehicles on Joint Base Meyer-Henderson Hall in Arlington from June through September. This partnership is a collaboration among the Army, Marine Corps, federal and state DOTs, NVRC and local communities, academic institutions, and private sector. The demonstration evaluates Connected and Autonomous Vehicles (CAVs) for the potential to reduce base operating costs, improve mobility and safety, and contribute to the quality of life for military service members and their families. The CAV demonstration operates with six lines of effort that include: Infrastructure and Safety; Energy and Economy; Data Architecture and Cyber Security; Data Analytics; Human Factors; Planning and Policy; and Integration.”*
 - Learn more here: <https://www.novaregion.org/DocumentCenter/View/12284/NVRC-2019-Year-in-Review-PDF>
- Olli shuttle, National Harbor (Maryland)
 - *“Local Motors by LM Industries Inc., in partnership with the Maryland Department of Transportation (MDOT), [in 2019] expanded the testing of Olli, its low-speed, connected, self-driving shuttle, to public roads in National Harbor. Due to a landmark local permit, Olli will collect imperative insights to help solve Maryland’s most pressing transportation challenges such as traffic congestion, accessibility, and environmental concerns like pollution.”*

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- Learn more here: <https://localmotors.com/press-release/self-driving-shuttle-olli-continues-testing-on-public-roads-in-maryland/>
- Autonomous Vehicle, Neighborhood Use shuttle (Crozet, Virginia)
 - The Autonomous Vehicle, Neighborhood Use (AVNU) service in Crozet, near Charlottesville, was the first public autonomous shuttle system to travel on public roads in Virginia. This pilot successfully concluded in October of 2019, with over 530 miles driven autonomously (with a safety monitor on board), carrying 750 passengers, with no interventions required.
 - Learn more here: <https://www.roboticsbusinessreview.com/unmanned/unmanned-ground/perrone-robotics-launches-public-autonomous-shuttle-service-in-virginia/> and here <https://www.perronerobotics.com/news/county-shuttle-report>
- Olli and MAGIC Shuttle (Westminster, Maryland)
 - The Mid-Atlantic Gigabit Innovation Collaboratory, or MAGIC, a technology nonprofit in Carroll County, is taking steps to develop an autonomous vehicle pilot that would connect a retirement community to downtown Westminster. MAGIC is also developing partnerships with STEM programs at local schools, creating opportunities to participate in the project. On May 20, 2021, MAGIC hosted a ribbon cutting ceremony to kick off its Autonomous Corridor project in the City of Westminster.
 - Learn more here: <https://technical.ly/civic-news/westminster-autonomous-corridor/>