Northern Virginia Transportation Authority
The Authority for Transportation in Northern Virginia

TECHNICAL ADVISORY COMMITTEE
~~Wednesday, April 21, 2021~~
Rescheduled - Tuesday, April 27, 2021
7:00 pm
(Virtual meeting and livestreaming via YouTube)

AGENDA

I. Call to Order/Welcome — Chairman Boice

Action

II. Resolution finding need to conduct meeting electronically — Chairman Boice
Recommended action: Adoption of resolution

III. Summary Notes of March 17, 2021 Meeting — Chairman Boice
Recommended action: Approval of meeting notes [with abstentions from those who were not present]

IV. Transportation Technology Strategic Plan & Action Plan
Mr. Jasper, Principal, Transportation Planning and Programming
Recommended action: Recommend the Authority adopt the eight strategies (in the Transportation Technology Strategic Plan) and Action Plan

Discussion/Information

V. TransAction Update — Mr. Jasper, Principal, Transportation Planning and Programming

VI. NVTA Update — Ms. Backmon, Executive Director

Adjournment

VII. Adjourn

Next Meeting (Virtual)
Wednesday, April 21, 2021
7:00 pm

NORTHERN VIRGINIA TRANSPORTATION AUTHORITY

TECHNICAL ADVISORY COMMITTEE

RESOLUTION FINDING NEED TO CONDUCT MEETING BY ELECTRONIC COMMUNICATION MEANS DURING GOVERNOR'S DECLARED STATE OF EMERGENCY DURING COVID – 19 PANDEMIC

APRIL 21, 2021 MEETING ELECTRONICALLY

April 21, 2021

WHEREAS, on March 12, 2020, the Governor of Virginia declared a state of emergency in Virginia in response to the spread of novel coronavirus, or COVID-19, a communicable disease of public health threat as so declared by the State Health Commissioner on February 7, 2020 ("COVID-19"); and

WHEREAS, in subsequent Executive Orders, particularly Executive Order Nos. 53 and 55, as amended, the Governor of Virginia, among other measures designed to ensure safe physical distancing between individuals, prohibited public and private in person gatherings of 10 or more individuals and ordered all individuals in Virginia to remain at their place of residence, with limited exceptions, to mitigate the impacts of COVID-19 and prevent its spread; and

WHEREAS, the Northern Virginia Transportation Authority (Authority) – Technical Advisory Committee (Committee) finds that it has a responsibility to demonstrate to the public, through the Authority's conduct, the importance of maintaining proper physical distance from others and to avoid gathering in public where the risks of infection are highest, and to take measures that promote physical distancing in order to protect the public health and mitigate the impacts and spread of COVID-19, including, among others, conducting meetings electronically whenever possible; and

WHEREAS, on April 22, 2020, the Virginia General Assembly adopted, and the Governor signed, budget bill amendments to HB 29 that expressly authorize "any public body, including any state, local, [or] regional body" to "meet by electronic communication means without a quorum of the public body . . . physically assembled at one location when the Governor has declared a state of emergency . . ., provided that (i) the nature of the declared emergency makes it impracticable or unsafe for the public body . . . to assemble in a single location; (ii) the purpose of the meeting is to discuss or transact the business statutorily required or necessary to continue operations of the public body . . . and the discharge of its lawful purposes, duties, and responsibilities" among other provisions; and

WHEREAS, member jurisdictions of the Northern Virginia Transportation Authority have adopted continuity of government ordinances pursuant to Va. Code Ann. § 15.2-1413 which ordinances, among other provisions, contemplate regional bodies of which the locality is a member meeting electronically to transact business to assure the continuity of government; and

NOW, THEREFORE, BE IT RESOLVED, that the Northern Virginia Transportation Authority Technical Advisory Committee hereby finds that meeting by electronic means is authorized because the nature of the declared emergency makes it both impracticable and unsafe for the Committee to assemble in a single location on April 21, 2021, to discuss and transact the business of the Authority listed on the April 21, 2021 Committee Meeting Agenda; and

BE IT FURTHER RESOLVED, that the Committee hereby finds that meeting by electronic means is authorized because the items on the April 21, 2021 Committee Meeting Agenda are statutorily required or necessary to continue operations of the Authority and the discharge of the Authority's lawful purposes, duties, and responsibilities; and

BE IT FURTHER RESOLVED, that the items on the April 21, 2021 Committee Meeting Agenda are encompassed within the continuity of operations ordinances adopted by member localities of the Northern Virginia Transportation Authority to assure the continued operation of the government during the disaster posed by the public health emergency resulting from COVID-19.

Adopted the 21st day of April, 2021.

Northern Virginia Transportation Authority
The Authority for Transportation in Northern Virginia

TECHNICAL ADVISORY COMMITTEE
Wednesday, March 17, 2021, 7:00 pm
Virtual meeting and live-streamed on YouTube

MEETING SUMMARY

I. Call to Order/Welcome

- Chairman Boice called the meeting to order at 7:00 pm.
- Attendees:
  - **Members:** Randy Boice, Karen Campblin, Armand Ciccarelli, Amy Morris, Frank Spielberg, Pat Turner, Dr. Shanjiang Zhu
  - **NVTA Staff:** Monica Backmon (Executive Director), Keith Jasper (Principal), Ria Kulkarni (Regional Transportation Planner), Mackenzie Love (Regional Transportation Planner), Sree Nampoothiri (Senior Transportation Planner)
  - **Others: On YouTube live stream.**

II. Resolution finding the need to conduct meetings electronically

- Chairman Boice noted that as a result of the COVID-19 and Governor Northam's declaration of a State of Emergency, the Authority's Technical Advisory Committee Meeting was held electronically. He noted that the passage of the amendments to HB 29 (the FOIA Bill) allowed regional bodies such as the Authority and their committees to conduct business meetings electronically. He added that the meeting by electronic means is authorized because the Committee Meeting Agenda items are statutorily required or necessary to continue operations of the Authority. The resolution moved by Ms. Turner and seconded by Mr. Spielberg was approved unanimously.

III. Summary of February 17, 2020 Meeting

- The motion to approve the meeting summary moved by Ms. Morris and seconded by Ms. Turner was approved unanimously.

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IV. Transportation Technology Action Plan (TTSP)

- Mr. Jasper revisited the TTSP and its pathway to approval. He emphasized that the TTSP comprises of eight strategies and nine identified roles for NVTA that are under the domain and align with core values of TransAction Vision, namely safety, equity and sustainability. Mr. Jasper introduced to the committee TTSP's Action Plan and sought feedback for the same.
- Ms. Love assured the Committee that an executive summary for the TTSP will be drafted as requested by the Committee.
    - The committee recommended rewording the titles of some Strategies included in the TTSP, as they could be perceived as "goals", rather than "strategies." The Committee also provided input on how values connect to strategies. It was also indicated that feedback provided by the Committee will be addressed and integrated into the Plan.
    - Chair Boice suggested clarifying language in the TTSP to avoid exclusion of updates to legacy systems from consideration via the TTSP, if emerging technologies may improve functioning. He also suggested elaborating on "underserved" which could be perceived as either "gentrified" or rural areas where there is sparse transit service.
        - Ms. Love provided an overview of the same and agreed to provide more clarity in the Plan.
- Ms. Love then provided the next steps to the TTSP Action Plan, which ties strategies to actions.
    - Ms. Love expanded on the Action Plan that will primarily focus of the roles of funding, policy, and advocacy for the Authority as defined by TTSP, which will have a time frame when action might be taken or have tangible outcomes. Other roles such as facilitating, stakeholder, outreach, and education will be undertaken continuously. She also gave an overview of strategies, their specific summaries, and showed templates of what their respective actions, components entailed, and how they would be structured/referenced. She added that actions have specific trigger points and timing that put strategies to actions.
- Mr. Jasper added that the TransAction update would include a series of scenario analyses that could define and prioritize the elements that might affect forecast for the region. Some of these scenarios could include incentivization/pricing mechanisms, Connected, Autonomous, Shared and Electric (CASE) Vehicles, or climate change. He also discussed other possible outcomes of the TTSP,

DRAFT

including outreach-education, impacts on NVTA legislative program(s), changes to future Six Year Program (SYP) funding and project evaluations and development of regional transportation policy.

- Mr. Jasper mentioned that electric vehicle and infrastructure have been the most recent topics of discussions at the General Assembly session.
- Mr. Jasper reiterated that the TTSP will be a "living" document and an executive summary of the plan will be shared with the Committee for recommendation to the Authority for approval in the future. He also emphasized that each action has a performance measure with the intent to monitor progress. Additionally, until TransAction is adopted in late 2022, the TTSP will be reviewed/updated every six months, incorporating feedback from the TransAction public engagement phases and relevant findings from TransAction analyses. Thereafter the TTSP will be reviewed/updated annually, typically around the anniversary of its adoption. He also noted that some of the action trigger elements (such as federal laws, Commonwealth actions, actions by member jurisdictions and other regional bodies, market factors) that fall outside the annual review cycle may also call for an update of the document.
- Mr. Jasper sought for Committee feedback on the Action Plan and requested committee members to share the plan and seek additional feedback on it as well.
- Dr. Zhu recommended revisiting the role of the document on whether it would serve as a high level guide, that guides the direction of NVTA in terms of planning (TransAction). Or perhaps serve as a detail document that promotes regional collaboration on a certain technology, facilitating coordination with counties to develop necessary EV charging infrastructure or Autonomous Vehicle Network.
    - He suggested perhaps opening it up to a broader spectrum to be inclusive of technology elements and infrastructure that is environmentally friendly, considering the pros and cons of dynamic and future technology – adaptation framework for alternative fuel technology such as hydrogen fuel cell technology that is gaining pace, for example.
    - Ms. Love responded that revisiting the executive summary should bring more clarity to the role of the document.

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V. NVTA Update

- Ms. Backmon noted that the FY2022 70% regional budget, 30% local budget and operating budget will be put forth to the Authority in April for adoption. She also added that the update to the Economic Impact Analysis of NVTA investments will be presented to the Authority.

VI. Adjournment

- The meeting adjourned at 8:07 pm. The next meeting date is April 21, 2021, at 7 pm.

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Transportation Technology Strategic Plan (TTSP): Recommendations

April 21, 2021

NVTA's Vision for 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**"

Approved by NVTA on December 17th, 2020

Three Core Values - Overarching Principles

1. Equity

- Fairness in mobility and accessibility to meet needs of the region/sub-regions/communities
- Facilitate social and economic opportunities by providing equitable levels of access to affordable and reliable transportation options to serve the needs of all and in particular underserved populations (low-income, minority, elderly, children, people with Limited English Proficiency (LEP), and/or people with disabilities)

2. Sustainability

- Focus on meeting the needs of the present without compromising the ability of future generations to meet their needs.
- Concept of sustainability is composed of three pillars: economic, environmental, and social

3. Safety

- Minimize transportation system fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all.

Timeline – Technology versus NVTA

2004/5 – Apple begins product development on a computer that uses a touch screen instead of a physical keyboard/mouse or stylus

January 2007 – Launch of iPhone 2G

January 2017 – 2.2M apps in App Store

October 2020 – Launch of iPhone 12

2035 – Which version of the iPhone?

July 2002 – NVTA created by General Assembly

September 2006 – TransAction 2030 adopted

November 2012 – TransAction 2040 adopted

July 2013 – NVTA revenue stream begins

October 2017 – TransAction update adopted

April 2021 – draft TTSP/Action Plan

2035 – Where should NVTA be?

What is the Transportation Technology Strategic Plan (TTSP)?

- Tool that will inform a proactive approach to adoption of transportation technology;
- TTSP considers how transportation technologies support the region's vision, i.e. needs-driven NOT technology-driven;
- Includes eight strategies, and up to nine NVTA roles for each strategy;
- TTSP is a living document that will be updated as transportation technologies evolve;
- TTSP Action Plan enables NVTA to think big, start small, and build momentum with respect to adoption of transportation technologies in the region.

Expected Benefits of the TTSP

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. TransAction scenario (sensitivity) analysis will support data-driven decision making by the Authority with respect to development of TransAction and subsequent project selection during future funding programs. While scenarios could reflect a range of external considerations, the TTSP will guide the development of technology-related scenarios;
3. Consistent approach to NVTA's transportation technology investments will increase synergies and maximize return on investments and taxpayer dollars;
4. 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;
5. 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.
6. Open and regular exchange of ideas between NVTA staff and jurisdiction/agency staff will strengthen the regional approach to transportation technologies.

Recommended Strategies

Recommended 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	Minimize potential for Zero Occupancy passenger Vehicles	Identify measures to address 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

TTSP Strategies and NVTA Roles

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	Minimize potential for Zero Occupancy passenger Vehicles		✓	✓	✓	✓		✓	✓	
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	✓	✓	✓	✓	✓		✓	✓	

Example 1: Electric, Autonomous Transit Shuttle

Features

- Not reliant on infrastructure type
- ADA accessible
- Can operate in inclement weather and in mixed traffic

Assumptions

- There have already been successful pilot(s) of the technology in the region
- Public acceptance of the technology is growing
- The shuttles have been determined to be a sound investment and/or market is nearing price parity

Ratings

Key		
(Red)	(Yellow)	(Green)
Intervention needed	Proceed with caution	Embrace



Electric, Autonomous Shuttles

Vision Statement		 (Green)	This type of shuttle has the potential to provide a **safe** first/last mile connection when **integrated** with transit. This would encourage use of **sustainable** mass transportation, and contribute to an **equitable** system through improved access.	
			Description	**Action**
Core Values	**Equity**	 (Green)	• Potential first/last mile connection • Improved access • Reduced congestion and more reliable travel times	• Encourage/conduct diverse public outreach that starts with needs identification through listening • Develop white paper(s) to analyze feedback received and research, and identify best practices and/or deployment guidance • Conduct public education initiatives, to dispel myths and encourage adoption
	Sustainability	 (Green)	• Reduce congestion and increase throughput through mass travel options. • Reduce tailpipe emissions.	• Identify potential additions to NVTA's Legislative Program
	Safety	 (Yellow)	• Fewer fallible drivers on the road • Potential reduction in crashes • Slow speeds may not be harmonious with traffic • Object detection/differentiation abilities are an important consideration	• Develop white paper(s) to analyze state of the field and research, and identify best practices and/or project/vendor selection guidance
			Sub-Actions	
Strategies	**1**	✓	• Increase consideration of EV, AV shuttles and pricing mechanisms in TransAction and/or SYP project selection process • Consider EV, AV shuttles and data/analysis needs and cybersecurity and/or privacy measures in NVTA procurements • Advocate for jurisdictional policies that support deployment of EV, AV shuttles • Develop and support policy(s) regarding EV charging infrastructure and/or support technology-based pricing mechanisms and investment of revenues • Advocate for Commonwealth policies that contribute to/support creation of a network of EV charging infrastructure	
	2	✓		
	3	✓		
	4			
	5	✓		
	6	✓		
	7	✓		
	8	✓		

Example 2: Personal, Electric Autonomous Autos

Features

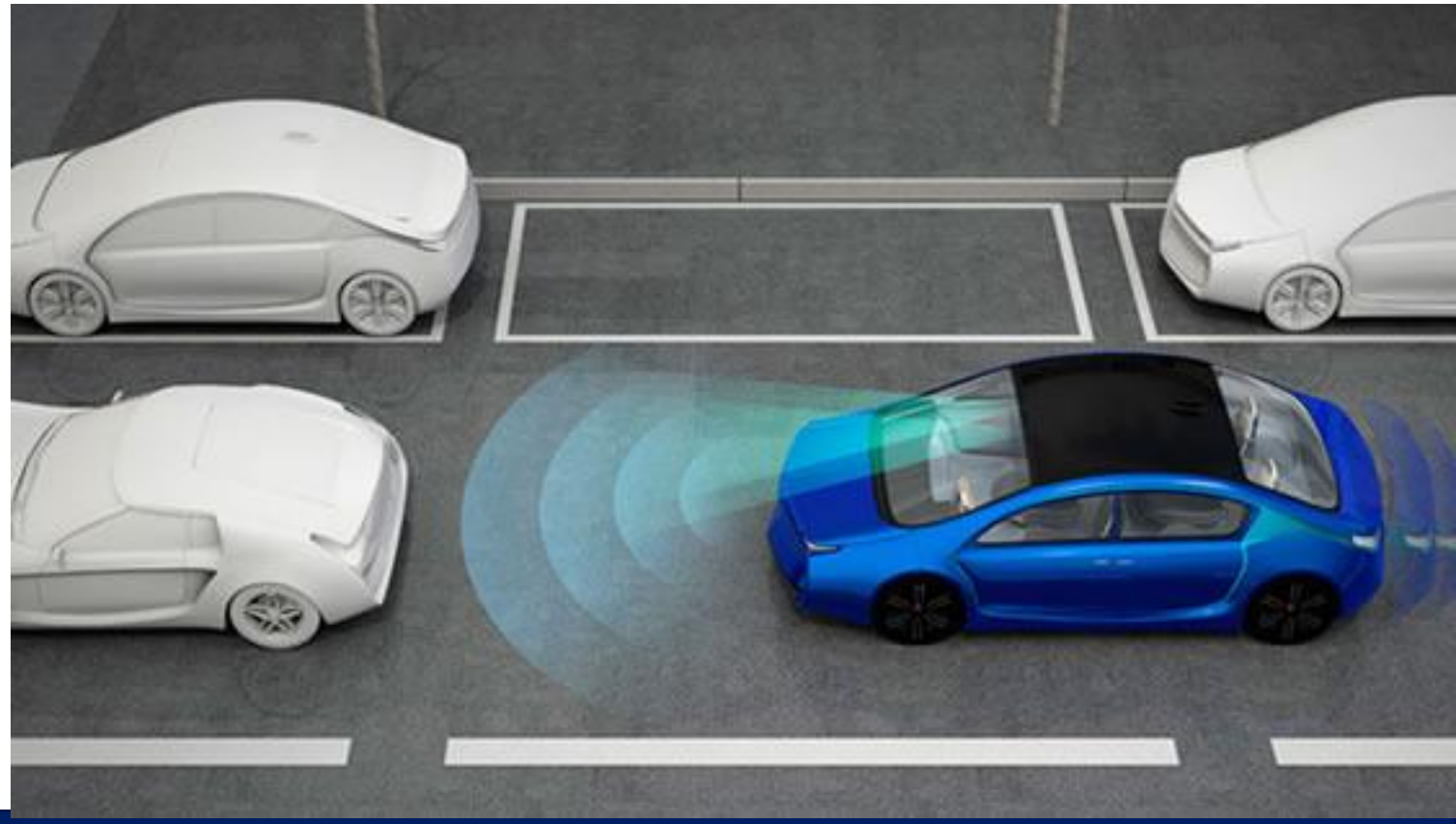
- SAE Level 5 vehicles can operate autonomously under all conditions
- May not have steering wheel or pedals

Assumptions

- Public acceptance of the technology is growing
- Fully autonomous vehicle have or are nearing entry to the public marketplace

Ratings

Key		
(Red)	(Yellow)	(Green)
Intervention needed	Proceed with caution	Embrace



Personal Electric, Autonomous Vehicles

Vision Statement		(Yellow)	Personal use of electric, autonomous vehicles have the potential to improve **safety,** and improve **sustainability** of the transportation system by reducing congestion. However, proactive steps will be necessary to ensure they are well integrated with existing modes and the cost of these vehicles **may create inequities,** if use is dependent on personal ownership.	
			Description	**Action**
Core Values	Equity	(Red)	• Shared ownership or subscription based usage could contribute to equitable access to personal electric, autonomous vehicles • Any revenues generated from personal use of EV AVs could be reinvested in programs, infrastructure or services that support equitable access to the transportation network • AVs may contribute to more reliable travel times in the region and increased safety	• Encourage/conduct diverse public outreach that starts with needs identification through listening • Develop white paper(s) to analyze feedback received and research, and identify best practices to accommodate this mode in a manner consistent with NVTA core values
	Sustainability	(Yellow)	• Reduce congestion and increase throughput through efficiencies of automation • Zero Occupancy passenger Vehicles may increase VMT and congestion • Reduce tailpipe emissions	• Identify potential additions to NVTA's Legislative Program • Conduct public education initiatives, to dispel myths and encourage shared usage and/or occupancy
	Safety	(Green)	• Fewer fallible drivers on the road • Potential reduction in crashes • Object detection/differentiation abilities are an important consideration	• Develop white paper(s) to analyze state of the field and research, and identify best practices to accommodate this mode in a manner consistent with NVTA core values
			Sub-Actions	
Strategies	1	✓	• Increase consideration of EV, AVs, pricing mechanisms and minimization of ZOV miles traveled in TransAction and/or SYP project selection process • Consider EV, AVs and data/analysis needs and cybersecurity and/or privacy measures in NVTA procurements • Advocate for jurisdictional policies that support equitable use of EV, AVs • Develop and support policy(s) regarding EV charging infrastructure, support technology-based pricing mechanisms and investment of revenues or discourage ZOV miles traveled • Advocate for Commonwealth policies that contribute to/support creation of a network of EV charging infrastructure • Advocate for state provision/funding of pilots and research efforts	
	2	✓		
	3	✓		
	4	✓		
	5	✓		
	6	✓		
	7	✓		
	8	✓		

Recommendations

1. Approve the eight TTSP strategies, as described in the TTSP document*
2. Approve the TTSP Action Plan, subject to:
   - No significant TTSP changes/additions, as determined by the NVTA Executive Director, 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
     - development of regional transportation policies

Note (*): NVTA staff is not seeking NVTA approval of the TTSP document (see next slide for details)

Recommendations – Note (*)

NVTA staff is not seeking NVTA approval of the TTSP document because:

- The TTSP will be maintained as a living document to reflect the continued evolution of transportation technologies;
- NVTA staff requires flexibility to update the TTSP and, where necessary, refine the strategies and action plan, as new technologies emerge or approach market thresholds that may trigger big shifts in travel demand or behavior; and
- New federal/state legislation, or initiatives undertaken by the federal/state government or the region and its partners, may also trigger refinements to the strategies and the action plan.

TTSP Action Plan: Possible Outcomes

- Development of technology-related scenarios for TransAction scenario (sensitivity) analysis, potentially on the following:
  - Incentives and pricing mechanisms to reduce car dependency
  - Climate change and resiliency of regional transportation system
  - Pandemic 'new normal' implications of increased work-from-home and e-commerce
- Technology-related outreach/education
  - Facts and Myths: Connected, Autonomous, Shared, and Electric (CASE) vehicles
- Identify potential technology-related additions to NVTA's Legislative Program, these may include:
  - Support EV infrastructure
  - Support Zero Emission Vehicles
  - Concern regarding Zero Occupancy passenger Vehicles

TTSP Action Plan: Possible Outcomes

- Identify potential technology-related refinements to TransAction and future NVTA SYP project selection process (post-TransAction update)
  - 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)
- Develop a process for, and White Papers to help prioritize, future regional transportation policy, potentially on the following topics:
  - Shared mobility devices
  - Autonomous transit shuttles
  - Zero Occupancy passenger Vehicles
- Human Services transportation

Planned Actions (May thru October 2021)

- Integration of technology-related 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 technology-related outreach and education that builds upon the 'Driven by Innovation' eblast
- Collaborate on a process for development of future regional transportation policies
- Develop White Papers to prioritize potential future regional transportation policies

Review and Reporting

Using the Executive Director's monthly report, summarize status on topics such as:

- Progress against specific measures;
- Citizen and stakeholder feedback;
- Trigger points observed or anticipated;
- Relevant TransAction analyses;
- Revisions to the TTSP living document to reflect changing circumstances;
- Upcoming TTSP-related activities; and
- Consideration of significant changes/additions to the strategies or Action Plan (requiring future Authority action).

Supplementary Slides

TTSP Draft Action Plan
Consolidated Actions Table

Roles									Immediate				Near Term					Mid Term	Long Term
									Jan - March, 2021	April - June, 2021	July - Sept, 2021	Oct - Dec, 2021	Jan - March, 2022	April - June, 2022	July - Sept, 2022	Oct - Dec, 2022	2023 - 2025	2026 - 2029	2030 and Beyond
Title	Applicable Strategies								TransAction kick-off			Completion of TransAction Phase 1		TransAction adoption		Development of legislative program			
	1	2	3	4	5	6	7	8				Development of legislative program	Six Year Program Update FY2022-2027						
Funding	1A, 1B	2A	3A, 3B			6A, 6B	7A	8A											
Policy				4B	5A			8B											
Advocate	1C			4C,4D, 4E	5A			8C											
Champion	✓	✓		✓		✓	✓	✓											
Facilitate	✓	✓		✓		✓	7B	✓											
Stakeholder			✓		✓														
Planning	1A	2A	3A	4A	5B	6A	7A	8A											
Outreach/ Education	✓	✓		✓	✓	✓	✓	✓											
Observer			✓																

Key				
Preparatory Action	Potential Direct Action	Direct Action	Follow Up Action	Continual/ Serendipitously

Bold text indicates this Role is a focus of the Strategy-Specific mini-action plans.

Technologies Mapped to TTSP Strategies

Strategies		Technologies										
Number	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
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	Minimize potential for Zero Occupancy passenger Vehicles	◑	◕	●	◑	◕	◑	◕	◕	●	●	◕
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	●	◑			◑						

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 Insuffecient Information Available	

NVTA DRAFT Transportation Technology Strategic Plan

Executive Summary

The Transportation Technology Strategic Plan (TTSP) is a first-of-a-kind initiative to take such a comprehensive and multi-modal position on how transportation technology can be leveraged to support the NVTA's vision for the NoVA transportation system in the coming years. Subject to Authority approval, this proactive initiative will be integrated with TransAction, the Long Range Transportation Plan for Northern Virginia[1]. As part of TransAction, the TTSP is one of many factors that may necessitate a review of, and possible enhancements to, NVTA's project selection process for future Six Year Program updates. Since NVTA's Six Year Program is based on the prevailing adopted version of TransAction, any changes would not come into effect until the FY2024-2029 Six Year Program at the earliest, which is the first update following the anticipated adoption of TransAction in November 2022. In addition, the TTSP will potentially support NVTA's Legislative Program, technology-related outreach/education, and development of regional transportation policy guidance.

The TTSP:

- **Is a tool 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.**

It is comprised of eight strategies, each of which has been evaluated in terms of NVTA's three core values; **safety**, **equity** and **sustainability**. (More information about the Core Values and their application can be found in Chapter 1.2 of the TTSP, and in the "Application of Core Goals" section for each of the eight strategies in Chapter 3 of the TTSP.) The strategies and NVTA roles were identified and defined with the guidance of the Executive Director's Transportation Technology Committee, 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).

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/

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NVTA DRAFT Transportation Technology Strategic Plan

Recommended 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	Minimize potential for zero occupancy passenger vehicles	Identify measures to address 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

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 nine possible NVTA roles proposed to address them. *Descriptions of the roles can be found in Chapter 1.4 of the TTSP.*

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	Minimize potential for Zero Occupancy passenger Vehicles		✓	✓	✓	✓		✓	✓	
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	✓	✓	✓	✓	✓		✓	✓	

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 (like the fare payment technologies, variable priced tolls on freeways or ride matching. However, dynamic vanpool matching may be revisited as relevant initiatives evolve) and will instead explore novel concepts. *See Chapter 2.1 of the TTSP, 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 eight 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 will detail a process for monitoring, review and update of the TTSP and its Action Plan.

No significant TTSP changes/additions, as determined by the NVTA Executive Director, 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
- Development of regional transportation policies

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 Executive Director'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

After Authority adoption of TransAction, the TTSP will be regularly reviewed, and updated if necessary. As noted above, significant changes will require Authority approval.

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

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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. TransAction scenario (sensitivity) analysis will support data-driven decision making by the Authority with respect to development of TransAction and subsequent project selection during future funding programs. While scenarios could reflect a range of external considerations, the TTSP will guide the development of technology-related scenarios;
3. Consistent approach to NVTA's transportation technology investments will increase synergies and maximize return on investments and taxpayer dollars;
4. 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;
5. 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.
6. Open and regular exchange of ideas between NVTA staff and jurisdiction/agency staff will strengthen the regional approach to transportation technologies.

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2021

NVTA Draft Transportation Technology Strategic Plan

NORTHERN VIRGINIA TRANSPORTATION AUTHORITY |
3040 Williams Drive, Suite 200, Fairfax, VA 22031

NVTA DRAFT Transportation Technology Strategic Plan

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List of Acronyms

ADAS	**Advanced Driver Assistance Systems**
AI	Artificial Intelligence
API	Application Program Interface
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
FLM	First/ Last Mile
GHG	Greenhouse Gas
GPS	Global Positioning System
HAV	Highly Autonomous Vehicles
IOT	Internet Of Things
ITS	Intelligent Transportation System
MaaS	Mobility as a Service
ML	Machine Learning
NVTA	Northern Virginia Transportation Authority
OEM	Original Equipment Manufacturer
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
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to Everything
VMT	Vehicle Miles Traveled
VR	Virtual Reality

NVTA DRAFT 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 multi-modal position on how transportation technology can be leveraged to support the NVTA's vision for the NoVA transportation system in the coming years. Subject to Authority approval, this proactive initiative will be integrated with TransAction, the Long Range Transportation Plan for Northern Virginia[1]. As part of TransAction, the TTSP is one of many factors that may necessitate a review of, and possible enhancements to, NVTA's project selection process for future Six Year Program updates. Since NVTA's Six Year Program is based on the prevailing adopted version of TransAction, any changes would not come into effect until the FY2024-2029 Six Year Program at the earliest, which is the first update following the anticipated adoption of TransAction in November 2022. In addition, the TTSP will potentially support NVTA's Legislative Program, technology-related outreach/education, and development of regional transportation policy guidance.

The TTSP:

- **Is a tool 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.**

It is comprised of eight strategies, each of which has been evaluated in terms of NVTA's three core values; **safety**, **equity** 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 eight strategies in Chapter 3.) The strategies and NVTA roles were identified and defined with the guidance of the Executive Director's Transportation Technology Committee, 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).

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/

Recommended 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	Minimize potential for zero occupancy passenger vehicles	Identify measures to address 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

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 nine 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	Minimize potential for Zero Occupancy passenger Vehicles		✓	✓	✓	✓		✓	✓	
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	✓	✓	✓	✓	✓		✓	✓	

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 (like the fare payment technologies, variable priced tolls on freeways or ride matching. However, dynamic vanpool matching may be revisited as 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 eight 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 will detail a process for monitoring, review and update of the TTSP and its Action Plan.

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

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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 Executive Director'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

After Authority adoption of TransAction, the TTSP will be regularly reviewed, and updated if necessary. As noted above, significant changes will require Authority approval.

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. TransAction scenario (sensitivity) analysis will support data-driven decision making by the Authority with respect to development of TransAction and subsequent project selection during future funding programs. While scenarios could reflect a range of external considerations, the TTSP will guide the development of technology-related scenarios;
3. Consistent approach to NVTA's transportation technology investments will increase synergies and maximize return on investments and taxpayer dollars;
4. 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;
5. 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.
6. Open and regular exchange of ideas between NVTA staff and jurisdiction/agency staff will strengthen the regional approach to transportation technologies.

Chapter 1

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1.4 NVTA Roles *5*

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1.1 Introduction

The TTSP will be a first-of-a-kind initiative to take such a comprehensive and multi-modal 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 eight strategies, which will each be evaluated in terms of three core values; safety, equity and sustainability. Additionally, the TTSP identifies nine roles NVTA may undertake to bring these strategies to fruition. This plan seeks to acknowledge the rapid pace and transformative of innovation, and to maximize its potential benefits while mitigating any negative impacts. When approved by the Authority, this proactive approach that will be integrated with TransAction and potentially support NVTA's Legislative Program, technology-related outreach/education, and development of regional transportation policy guidance.

1.1.1 Purpose and Scope

In 2019, the Executive Director of the Northern Virginia Transportation Authority (NVTA), Monica Backmon, established a Transportation Technology Committee[2] (TTC.) The TTC is tasked with keeping her 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 has been working closely with NVTA Staff to develop a Transportation Technology Strategic Plan (TTSP.)

The TTSP is a first-of-a-kind initiative that takes a comprehensive and multi-modal position on how technology can be leveraged to solve some of our most pressing problems. It identifies eight strategies that focus on mobility, accessibility, and resilience, while embracing core values of safety, equity, 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 looks forward to sharing 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.*

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[2] https://thenovaauthority.org/about/committees/transportation-technology-committee-2/

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 regards to project selection, policy development and process.

Core Values			
	Safety	**Equity**	**Sustainability**
Description	Safety is understood as a goal of any transportation project, but the rapid development of new technologies creates new opportunities and challenges that have not existed before. It will be critically important to evaluate the safety ramifications for all projects, in the then current scenario, during the transition period to adoption of new technologies and after full adoption has occurred.	New technologies create opportunities to improve transportation system coordination, accessibility, optimize travel systems overall. These outcomes have the potential to benefit all persons but there are also barriers to access, which may affect groups of the population differently. The FHWA advises that an equitable transportation system "seeks fairness in mobility and accessibility to meet the needs of all community members" and may not necessarily be achieved by an equally distributed approach. For this reason, it is important to consider the needs of all populations, particularly those who are traditionally underserved, in terms of the overall transportation system. The following groups should be considered: low income, low technical literacy, minorities, children, the elderly, people with disabilities, and those with limited English proficiency.	Sustainability is the ability to use resources without jeopardizing the ability of future generations to use the resources they need. The concept of sustainability is built on three pillars, sometimes referred to as a triple bottom line, i.e., profits, planet, people. In a transportation context, sustainability most commonly applies to de-carbonization of the transportation system, including production of materials for, and construction of, infrastructure projects and vehicles, energy consumption by, and emissions from, the vehicle fleet, including autos, transit, and trucks, and reducing vehicle miles traveled, particularly in single occupant vehicles. With transportation technology, there is an additional potential dimension of sustainability related to energy consumption in data centers.
Considerations for transition period	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 of 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?	As certain members of our communities have historically been underserved, their needs and preferences should better 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 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.	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 will be sought on how to best apply these Core Values, in the context of the TTSP, through the TransAction public outreach process.

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1.3 Vision and Goals

1.3.1 Vision

On December 17th, 2020[3], 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.

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

In 2020, NVTA began updating TransAction and that process was still ongoing at the time this plan was created. Part of that update will include adopting new goals. For these reasons, the strategies included in the TTSP have been mapped to both the goals set forth in TransAction 2040[4], and the candidate goals for the next edition of the long-range plan. (See Table 4 - Mapping TTSP Strategies to TransAction Goals.)

Current TransAction Goals	Strategy		Candidate TransAction Goals
	Number	Name	
Goal 1: Enhance quality of life and economic strength of Northern Virginia through transportation	1	Reduce congestion and increase throughput	Enhance quality of life by improving the mobility of Northern Virginians on the region's multimodal transportation system. [Mobility]
	2	Maximize access to jobs, employees and housing	
	3	Maximize cybersecurity and privacy for members of the public	
Goal 2: Enable optimal use of the transportation network and leverage the existing network	4	Minimize potential for Zero Occupancy passenger Vehicles	Strengthen the region's economy by increasing access to jobs, employees, markets, and destinations. [Accessibility]
	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	
Goal 3: Reduce negative impacts of transportation on communities and the environment	8	Advance decarbonization of the transportation system	Enhance operational performance of the multimodal transportation system under extreme or unusual travel conditions [Resiliency]

Table 4 - Mapping TTSP Strategies to TransAction Goals

[3] https://mailchi.mp/74a677f9f821/authority-meeting-highlights-december-2020?e=820d128a71

[4] https://thenovaauthority.org/planning/long-range-transportation/transaction-2040-update/

1.4 NVTA Roles

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. 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 Vehicle (ZOV) 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. In such a case, the Authority may incorporate these positions in legislative packages and/or otherwise 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 imitative(s.) Additionally, staff may support member jurisdictions in developing relevant initiatives/policies by serving on stakeholder committees or provision of technical assistance.
	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 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.
		Outreach/ Education	NVTA staff should stay abreast of developments in various transportation technologies and use the knowledge to inform the Executive Director, 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

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2.1 Related Initiatives

2.1.1 NVTA Funded Projects

Project Title	Project Sponsor	Program Year	Technology Focus	Other Mode(s)	Description	Total Project Cost	NVTA funded Portion
Glebe Road Corridor ITS Improvements	Arlington County	2015-16	Primary	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
Lee Highway Corridor ITS Enhancements	Arlington County	2017	Primary	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	2018-23	Primary	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	2015-16	Primary	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	2018-23	Primary	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	2018-23	Primary	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
Route 1 Widening - Mount Vernon Memorial Highway to	Fairfax County	2015-16/ 2018-23/ 2020-25	Secondary	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
Richmond Highway Bus Rapid Transit	Fairfax County	2018-23	Secondary	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
Shelters and RTI for DASH/WMATA	City of Alexandria	2014	Secondary	Bus	Construct bus shelters and provide associated amenities such as real time information at high ridership stops.	$ 2,649,478.00	$ 450,000.00
Alexandria Duke St Transitway	City of Alexandria	2018-23/ 2020-25	Secondary	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	2018-23		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

Table 6 - NVTA Funded Projects

2.1.2 Planning Initiatives

2.1.2.1 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 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, 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*

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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.pwcgov.org/government/dept/planning/Documents/MasterDocument_TechConn.pdf

2.1.2.2 - Larger DMV Initiatives

- 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 Northern Virginia Transportation Authority (NVTA), and the Department of Rail and Public Transportation (DRPT).
  - Learn more here: https://rm3pvirginia.org/
- I95 project (Stafford)
  - 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] priories, 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

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- 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 a 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 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/
- 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*

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continuing collaboration with partners interested in researching, testing, and implementing CAVs in Maryland."

- 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

2.1.2.3 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."
  - 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 scale[5] 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."*

[5] https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%9Clevels-of-driving-automation%E2%80%9D-standard-for-self-driving-vehicles

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  - 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=3FvjGRYdXSYnYFkJtcJwIDmXvQGGhUu9lIHYyKBYKhI%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."
  - *"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
  - Details to come.
- 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,*

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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

2.1.3 Federal Initiatives

- United States Department of Transportation (USDOT)' 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.*
    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/

2.1.4 Pilot Programs

2.1.4.1 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-

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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/VTTI (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 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
- 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, CARMA℠ 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.*
        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=3FvjGRYdXSYnYFkJtcJwIDmXvQGGhUu9lIHYyKBYKhI%3D

- Virginia Rural Microtransit Deployment (Bay Transit in Gloucester County and Town of Use and 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."*
  - 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/

2.1.4.2 Autonomous Shuttle Pilots

- Relay shuttle in Merrifield (Fairfax County, Virginia)
  - *"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 (VTTI), and George Mason University (GMU)."*

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  - The Relay shuttle operates Monday through Thursday, on a fixed route between the Dunn Loring Metrorail Station and the Mosaic District, in Merrifield, Virginia. A safety steward is always on-board to monitor operations of the shuttle, which travels at a maximum of 10mph. Passengers are required to wear safety belts and additional safety precautions are in place, due to the COVID-19 pandemic.
  - Learn more here: https://www.fairfaxcounty.gov/transportation/autonomous-shuttle-pilot
- Optimus Rise 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/
- 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 thru 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."*
  - 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, Virginia)
  - 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. The full pilot would happen in three phases and include a fleet of three vehicles, but a timeline has not yet been finalized.

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- Learn more here: https://www.baltimoresun.com/maryland/carroll/education/cc-autonomous-corridors-westminster-20201106-xwey7r3kkfhsdiatjsxloi5fxm-story.html

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2.2 Transportation Technology Trends

2.2.1 Overview

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 7- 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.

2.2.1.1 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. 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.

2.2.1.2 Sharing

There are many manifestations of the notion of sharing, which can pertain to both physical items and intangible assets. 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.[6] Further, this evolution has gone on to open doors for sharing other modes, like scooters, and there are no signs of this trend slowing.

2.2.1.3 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.[7] 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. [8]

[6] https://www.smartcitiesdive.com/ex/sustainablecitiescollective/amsterdam-beijing-global-evolution-bike-share/1100421/
[7] https://newsroom.aaa.com/2020/01/aaa-owning-an-electric-vehicle-is-the-cure-for-most-consumer-concerns/
[8] https://www.populus.ai/micro-mobility-2018-july

2.2.2 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 the Covid-19 pandemic. [9] 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, 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/Last Mile 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, 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. Similarly, AVs, regardless of ownership, may 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).[10]

[9] https://www.theguardian.com/technology/2020/aug/12/car-sales-covid-19-coronavirus-uber-zipcar
[10] https://journals.sagepub.com/doi/pdf/10.1177/0739456X18776062

2.2.3 Technologies

Strategies		Technologies										
Number	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
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	Minimize potential for Zero Occupancy passenger Vehicles	◑	◕	●	◑	◕	◑	◕	◕	●	●	◕
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	●	◑			◑						

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 Insuffecient Information Available
●	◕	◑	◔	○	

Table 7- Mapping Technologies to TTSP Strategies

2.2.3.1 Opportunities and Challenges

	Opportunities						Challenges					
	Reduced reliance on fallible humans	System optimization (reliability, compliance, management)	Reduced congestion	Reduced pollution	Facilitate emergency management	Resiliancy 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												

Key		
Potential Opportunity	Neutral	Potential Challenge

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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*.[11]. 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 2040[12]), means that significant increases in congestion may still occur, despite an expected decrease in VMT per capita[13]. Expanding infrastructure capacity, especially highway capacity, presents multiple challenges in mitigating this congestion (due to the phenomena of induced demand[14]) and achieving NVTA's goals of equity, sustainability and safety, although it will likely remain an important option.

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)[15] 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/Last Mile connections), or facilitate use of micro modes like walking, biking or scooting. Shared use of autonomous vehicles (AVs) would also contribute towards congestion reduction[16].

3.1.2 Relevant NVTA TransAction Goal

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[11] https://thenovaauthority.org/legislation/governing-legislation/house-bill-2313/
[12] https://nvtatransaction.org/wp-content/uploads/2018/11/TransAction_Technical-Report_Nov.-2018-FINAL-1.pdf
[13] https://www.mwcog.org/file.aspx?D=PXVsN0KkMkgXNwvPyDMX1kLIIQFFp2OJN0YoTa%2bUimA%3d&A=7xHcSpkGbtnCMhK%2fQTirVScizz%2flnwCEKIeZaqWs3K0%3d
[14] https://www.tysonspartnership.org/transportation/the-best-way-to-beat-traffic-avoid-it-completely-induced-demand-and-how-the-metro-disruption-could-be-a-blessing-in-disguise/
[15] https://www.roboticresearch.com/abrt-whitepaper/
[16] https://www.mdpi.com/2199-8531/5/2/24/htm

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/Last Mile 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. • Staff should advocate for 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.) • 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	• 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.) ○ Scenarios for planning exercises may include a variety in changes of personal convenience factors in use of several non-SOV modes. Specifically, increased (or decreased) supply of micro modes; impacts on mode shift resulting from system optimization and/or app usage or changes in the prevalence of teleworking or other distance working arrangements. • Staff should continue to consider[17] 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? [18] • Planning efforts should remain technology agnostic in long-range planning initiatives, to accommodate innovation and unknown developments.	Near Term
	Outreach/ Education	• Staff should stay abreast of developments in various technologies and use the knowledge to inform the Executive Director, 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 9 - Strategy #1, NVTA Roles

[17] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf
[18] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-D.pdf

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3.1.4 Application of Core Values

Safety	A recent study by the Victoria Transportation Policy Institute[19] 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.
Equity	Effectively managing congestion can improve travel time reliability[20]. 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 prohibitive[21]. These shared modes also have the potential to provide increased mobility to the people with disabilities[22].
Sustainability	The transportation sector is the largest producer of Greenhouse Gas Emission in the United States[23] and produces a series of other pollutants that reduce air quality[24]. These negative environmental impacts contribute significantly to climate change[25] and directly harm human health by exasperating chronic conditions like cardiovascular disease, asthma and increase risks for certain cancers etc.[26] 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 10 - 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

[19] https://www.vtpi.org/safetrav.pdf
[20] https://ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm
[21] https://www.nerdwallet.com/article/loans/auto-loans/total-cost-owning-car
[22] https://www.worldbank.org/en/news/feature/2015/12/03/for-persons-with-disabilities-accessible-transport-provides-pathways-to-opportunity
[23] https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation
[24] https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution
[25] https://www.epa.gov/transportation-air-pollution-and-climate-change/learn-about-air-pollution-transportation
[26] https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health

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 (MWCOG) projects that this region will have an additional million jobs by the year 2045.[27] 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 jobs[28]. 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.[29]" 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 MWCOG's Commuter Connections[30] and VDOT's Transform 66[31]) and have not been addressed elsewhere. MWCOG's 2019 State of the Commute report indicates that use of transit increases with proximity to stations[32] 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 and last mile services (integrated [Public Transport and Shared Autonomous Vehicle, or PT-SAV] system) can contribute to the sustainability of the transportation system."[33]) 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 garages[34].)

3.2.2 Relevant NVTA TransAction Goal

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[27] https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/
[28] https://www.mwcog.org/newsroom/2018/10/10/how-will-a-million-more-people-get-around-in-2045/
[29] https://www.greaterwashingtonpartnership.com/blueprint/solution-4.html
[30] https://www.mwcog.org/transportation/programs/commuter-connections/
[31] http://outside.transform66.org/commuter_options/default.asp
[32] https://www.mwcog.org/newsroom/2019/09/24/three-big-takeaways-from-the-2019-state-of-the-commute-survey/
[33] 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
[34] https://spectrum.ieee.org/cars-that-think/transportation/self-driving/autonomous-parking

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
Shared Roles	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.[35] • 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.[36]), to support use of shared and subscription-based rides, as well as new freight delivery options (drones, robo delivery bots[37] etc.) and micro modes. • Staff should advocate for other planning efforts in the region to address innovative methods to support accessibility to jobs, employees and housing.	Immediate
	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
Staff Roles	Planning	• 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.) ○ Scenarios for planning exercises may include full adoption of AVs; significant use of AVs in fleet and TNC contexts only; increased availability of transit or shared rides through demand-responsive routing and or access to subscription services; a variety in changes of personal convenience factors in use of several non-SOV modes (this would facilitate evaluation of increased supply of micro modes and facilitation of mode shift resulting from system optimization and/or app usage.) • 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.	Immediate
	Outreach/ Education	• Staff should stay abreast of developments in various technologies and use the knowledge to inform the Executive Director, 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 11 - Strategy #2, NVTA Roles

[35] https://journals.sagepub.com/doi/pdf/10.1177/0739456X18776062
[36] https://ddot.dc.gov/release/ddot-expand-pick-and-drop-zones-through-research-pilot
[37] https://www2.gmu.edu/news/574036

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3.2.4 Application of Core Values

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.
Equity	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. 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.
Sustainability	The transportation sector is the largest producer of Greenhouse Gas Emission in the United States[38] and produces a series of other pollutants that reduce air quality[39]. These negative environmental impacts contribute significantly to climate change[40] and directly harm human health by exasperating chronic conditions like cardiovascular disease, asthma and increase risks for certain cancers etc.[41] 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 12 - 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

[38] https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation
[39] https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution
[40] https://www.epa.gov/transportation-air-pollution-and-climate-change/learn-about-air-pollution-transportation
[41] https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health

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. Cybersecurity will be particularly important for AVs[42] and Smart City technologies like TSP and other Intelligent Transportation Systems (ITS[43].) 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 may be a barrier. Both the Federal Highway Administration Exploratory Advanced Research Program[44] and a private consortium of technology firms lead by IBM, called Mobility Open Blockchain Initiative (MOBI)[45], 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 provider[46] and insurance companies are able to monitor driver behaviors through telematics[47]. 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

Enhance Quality of Life and Economic Strength of Northern Virginia through Transportation

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[42] https://www.vtti.vt.edu/utc/safe-d/index.php/projects/automated-vehicle-behavior-monitoring-for-vulnerability-management/
[43] https://www.its.dot.gov/factsheets/cybersecurity.htm
[44] https://beta.sam.gov/opp/75f5fea0e3ec47d08bc2ffb9d7b34c33/view
[45] https://www.ibm.com/blogs/blockchain/2018/06/introducing-mobi-the-mobility-open-blockchain-initiative/
[46] https://sprite.utsa.edu/publications/papers/sureshkanthAutoSec20.pdf
[47] https://www.oecd.org/pensions/Technology-and-innovation-in-the-insurance-sector.pdf

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 RM3P[48] 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. • 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	Observer	• 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 Executive Director, the Authority and committees like the TTC and RJACC, may call upon staff to provide expertise resulting from these continued observations, when necessary. • Staff seek to understand any Federal action taken in regard to cybersecurity of emerging 5G technology[49], as this communications technology has many use cases in transportation, such as enabling AV communications.	Immediate

Table 13 - Strategy #3, NVTA Roles

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[48] https://rm3pvirginia.org/
[49] https://www.summitstrategies.us/wp-content/uploads/2019/11/5G-Policy-Primer-November-2019-1.pdf

3.3.4 Application of Core Values

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 inference (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 Personably 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. [50]
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.)
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 14 - Strategy #3, Application of Core Values

Potentially Applicable Technologies

- Automated/ Autonomous Vehicles
- SMDs
- Signal Technologies
- Apps
- System Optimization
- Surveillance/ Monitoring
- Data Generation/ Collection/ Sharing
- Smart Technologies/ Cities and IOT

[50] https://nacto.org/2019/05/30/managing-mobility-data/

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3.4 Strategy #4: Minimize Potential for Zero Occupancy passenger Vehicles

3.4.1 Description

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. 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 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 incentivised, and public transport fusion is recommended"*[51]

Even with all above nuances taken into consideration, there is still a possibility for Zero Occupancy Vehicles (ZOVs) 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, ZOVs will not only add VMT but also potentially increase congestion.

Strategy #4 will explore proactive policies, including pricing and incentive mechanisms, 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.)

3.4.2 Relevant NVTA TransAction Goal

Enable Optimal Use of the Transportation Network and Leverage the Existing Network

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[51] 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

NVTA Roles

Authority Roles	Policy	• The Authority may develop policies that discourage ZOV miles traveled. • The Authority may advocate for the Commonwealth to provide local jurisdictions the ability to levy fees on autonomous vehicles.	Near Term
	Advocate	• The Authority may advocate for legislation that limits ZOV 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.	Long Term
Shared Roles	Champion	• Staff should advocate for other planning efforts in the region to address the potential for ZOV Miles Traveled.	Long Term
	Facilitate	• Authority Members can facilitate minimization of ZOV Miles Traveled by publicly expressing support for the goal, through adoption of this plan. • The Authority can facilitate minimization of ZOV Miles Traveled by submitting letters of support for related projects (i.e., for funding applications to external entities.) • Staff can facilitate minimization of ZOV Miles Traveled by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Immediate
Staff Roles	Planning	• Staff should continue to consider minimization of ZOV Miles Traveled in long-range planning efforts (in terms of project eligibility criteria, the reevaluation of project scoring metrics and scenario planning.) ○ Scenarios for planning exercises may include full adoption of AVs; significant use of AVs in fleet and TNC contexts only; use of AVs in transit (micro, mass and rail) only; a variety in changes of personal convenience factors in use of several non-SOV modes (this would facilitate evaluation of increased supply of micro modes and facilitation of mode shift resulting from system optimization and/or app usage.)	Immediate
	Outreach/ Education	• Staff should stay abreast of developments in various technologies and use the knowledge to inform the Executive Director, 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. • It will be critical for staff to understand the safety impacts of various AV technologies (and the significance/validity of any certifications or standards they espouse[52], to ensure member jurisdictions can make informed decisions and provide accurate information to citizens.	Ongoing

Table 15 - Strategy #4, NVTA Roles

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[52] https://scipol.org/content/how-uber-might-self-certify-its-own-autonomous-vehicles-carry-public-nevada

3.4.4 Application of Core Values

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[53] and secondary crashes. AVs also have the potential to reduce aggressive and defensive driving and may provide automated vehicular inspection capabilities[54], to reduce incidents of component failure during operations.
Equity	Increasing the availability and viability of alternatives to personal vehicle ownership may reduce cost of living for members of our community. Reductions may be significant enough for additional people to afford to co-locate with their place of work, reducing their commute times and facilitating civic engagement. Practices and policies that contribute to the use of certain modes (particularly AVs[55]), which may be exclusionary, and/or exclusionary policies or land uses that may result from the use of new transportation technologies, should be avoided. Proactive steps should also be taken to ensure that new technologies which may contribute towards a desirable balance of VTM 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.
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.[56] 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 and dire.[57] Increasing the connectivity of multi-passenger, fleet vehicles can also maximize their use, through predictive maintenance[58], that allows fleet managers to more efficiently distribute use across the fleet, reducing need to replace the vehicles.

Table 16 - Strategy #4 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

[53] https://www.vtpi.org/safetrav.pdf
[54] https://patents.google.com/patent/US20190066398A1/en
[55] https://www.vtpi.org/avip.pdf
[56] https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation
[57] https://www.transportationandclimate.org/content/about-us
[58] https://ruor.uottawa.ca/handle/10393/40086

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 roads[59] and congestion pricing[60]) are already deployed in the region. Additionally, the Commonwealth is exploring the feasibility of fees based on Vehicle Miles Traveled[61].

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 (RM3P[62]). 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 Program[63] to the entire region. This sets a powerful precedence for future efforts to balance a multi-modal system and achieve optimal network functioning.

Strategy #5 will focus on pricing schemas that are directly related to emerging transportation technologies and are supported by the will of the Authority. (Local Express Lanes, like 459 NEXT[64], could potentially serve as preference.) 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 County[65]. Strategy #5 will also consider ways in which revenues from pricing initiatives could be used to enhance/encourage use of alternatives to ZOVs/ Single Occupancy Vehicles (SOVs), including transit (mass and micro) and micromobility.

3.5.2 Relevant NVTA TransAction Goal

Enable Optimal Use of the Transportation Network and Leverage the Existing Network

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[59] https://www.tollroadsinvirginia.com/
[60] http://66expresslanes.org/about_the_lanes/default.asp
[61] http://www.ctb.virginia.gov/resources/2019/mar/pres/8_legislative_update.pdf
[62] https://rm3pvirginia.org/
[63] https://www.fampo.gwregion.org/wp-content/uploads/2011/06/Intgrated-Corridor-Management.pdf
[64] https://www.495northernextension.org/
[65] https://www.arlnow.com/2020/12/08/arlington-county-to-launch-variable-parking-pricing-along-metro-corridors/

3.5.3 NVTA Roles

Authority Roles	Policy	• The Authority may consider pricing and incentive mechanisms to reduce congestions 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 polices 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 staff.	Immediate
Staff Roles	Planning	• 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.)	Immediate
	Outreach/ Education	• Staff should stay abreast of developments in various technologies and use the knowledge to inform the Executive Director, the Authority and committees like the TTC and RJACC. • Staff should work closely with the regional joint PIO group to develop consistent messaging and outreach around pricing mechanisms. • Staff may research pricing mechanisms in other localities, to identify best practices and lessons learned.	Near Term

Table 17 - Strategy #5, NVTA Roles

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3.5.4 Application of Core Values

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 crashes[66]. 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.
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.[67]
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."[68] 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 18 - 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

[66] https://www.vtpi.org/safetrav.pdf
[67] https://www.aarp.org/ppi/issues/livable-communities/transportation/
[68] https://www.virginiadot.org/info/resources/congestion_pricing/benefits_congestion_pricing.pdf

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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 supplement[69] 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 Roundtable[70], and in Uber's four Federal Infrastructure Principals[71] , 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 industry[72].) 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 transmitters[73], or creating a "digital twin"[74] 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 precedence[75]); 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.

[69] https://omniride.com/omniride/assets/File/PRTC-Recommendations-Summary.pdf
[70] https://mailchi.mp/1fd7506e46b2/driven-by-innovation-special-edition-transpo-roundtable-recap?e=224f69d532
[71] https://medium.com/uber-under-the-hood/ubers-federal-infrastructure-principles-9f214841ff3b
[72] https://vtnews.vt.edu/articles/2020/03/031720-vtti-usdottruckgrant.html
[73] https://www.summitstrategies.us/wp-content/uploads/2019/11/5G-Policy-Primer-November-2019-1.pdf
[74] https://www.ey.com/en_us/government-public-sector/four-ways-5g-connectivity-will-make-cities-smarter
[75] https://ddot.dc.gov/release/ddot-announces-next-innovation-curbside-management-program

3.6.2 Relevant NVTA TransAction Goal

Enable Optimal Use of the Transportation Network and Leverage the Existing Network

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 RM3P[76] 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 should advocate for 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.) • 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	• 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.) ○ Scenarios for planning exercises may include full adoption (and presence of supporting infrastructure) of 5G, increased prevalence of curbside management techniques in dense urban areas and a variety in changes of personal convenience factors regarding micro modes. • Staff should continue to consider[77] 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? [78]	Near Term
	Outreach/ Education	• 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 Executive Director, the Authority and committees like the TTC and RJACC. • Staff should continue to share information about forward-thinking infrastructure with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 19 - Strategy #6, NVTA Roles

[76] https://rm3pvirginia.org/
[77] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf
[78] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-D.pdf

3.6.4 Application of Core Values

Safety	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 vehicles[79]. 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.[80]
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.
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.

Table 20 - Strategy #6, Application of Core Values

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

[79] https://www.summitstrategies.us/wp-content/uploads/2019/11/5G-Policy-Primer-November-2019-1.pdf
[80] https://www.researchgate.net/publication/322851325_Active_Safety-Collision_Warning_Pilot_in_Washington_State

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 8[81]) 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.[82]) Interregional interoperability should also be considered, when possible and appropriate. 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., Dedicated Short Range Communications [DSRC] or Cellular Vehicle to Everything [CV2X] enabled devices for Autonomous Vehicles [AVs][83]), 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 talent[84]. (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.[85]) 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 Devices[86] 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 efforts[87]. This also reduces the need for potentially complex and costly data fusion, creates opportunities for comparisons and collaborations across the region and provides a

[81] https://www.dhcd.virginia.gov/pdcs
[82] https://www.greaterwashingtonpartnership.com/blueprint/solution-6.html
[83] https://www.auto-talks.com/technology/dsrc-vs-c-v2x-2/
[84] https://www.citylab.com/transportation/2017/09/amazons-hq2-hunt-is-a-transit-reckoning/541296/
[85] https://www.alexandriava.gov/news_display.aspx?id=106767
[86] https://lis.virginia.gov/cgi-bin/legp604.exe?201+sum+SB758&201+sum+SB758
[87] https://www.brookings.edu/research/modernizing-approach-to-data/

predictable and reliable business environment for Public Private Partnerships[88]. 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/prevailing data formats (like General Transit Feed Specification [GTFS][89], General Bikeshare Feed Specification [GBFS][90], Transactional Data Specifications [TDS][91], and Mobility Data Specification [MDS][92]) and establishing reasoning and objectives for data collection.

3.7.2 Relevant NVTA TransAction Goal

Enable Optimal Use of the Transportation Network and Leverage the Existing Network

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[88] https://omniride.com/omniride/assets/File/PRTC-Recommendations-Summary.pdf
[89] http://gtfs.org/
[90] https://github.com/NABSA/gbfs
[91] https://www.aarp.org/ppi/info-2020/modernizing-demand-responsive-transportation.html
[92] https://github.com/openmobilityfoundation/mobility-data-specification

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 should advocate for 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.) • 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	• 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.) ○ Scenarios for planning exercises may include full adoption of AVs; significant use of AVs in fleet and TNC contexts only; and a variety in changes of personal convenience factors in use of several non-SOV modes (this would facilitate evaluation facilitation of mode shift resulting from system optimization.) • 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.	Immediate
	Outreach/ Education	• 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 Executive Director, 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 21 - Strategy #7, NVTA Roles

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3.7.4 Application of Core Values

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.
Equity	A 2017 report from the Brookings Institution, on the topic of emerging transportation data, asserts that: *"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."* [93] 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.

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

[93] https://www.brookings.edu/research/modernizing-approach-to-data/

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.

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Table 22 - Strategy #7, Application of Core Values

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)[94], 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 fuel sources[95] that may be viable in the long run, but the most actionable at this time is electrification, which is gaining momentum in the Commonwealth[96].

Electric Vehicles (EV) typically cost less to power[97], and yield reduced emissions[98], when compared to Internal Combustion Engine (ICE) vehicles. Creation of an electric charging network could reduce 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 home[99], developing a network in such a manner that it could be used by individuals as well, could reduce "range anxiety", and allow for deepened market penetration. The reduction in greenhouse gas and other emissions resulting from expanded adoption would be beneficial to the environment.

Strategy #8 will explore continuing to fund purchase of electric 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[100]) going forward. In considering applications for this funding, special consideration could be given to electric (or other alternative fueled) microtransit, as this demand-responsive mode can create transit options in locations where none currently exist and/or to address First/Last Mile challenges. This may include autonomous EV transit vehicles, building on the precedence of the Autonomous Electric Shuttle Pilot Project in Fairfax County[101]. 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"[102] and to allow flexibility for this strategy to adapt to consider other alternative fuels if/when they become feasible for use in the region.

3.8.2 Relevant NVTA TransAction Goal

Reduce Negative Impacts of Transportation on Communities and the Environment

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[94] https://theicct.org/blog/staff/global-ice-phaseout-nov2020#:~:text=California%20is%20the%20latest%20jurisdiction,California%20must%20be%20zero%2Demission.
[95] https://afdc.energy.gov/fuels/
[96] http://www.ctb.virginia.gov/resources/2021/march/pres/ev_readiness_study_ctb_presentation_03-17-21_final.pdf
[97] https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs
[98] https://www.energy.gov/eere/electricvehicles/reducing-pollution-electric-vehicles
[99] https://www.energy.gov/eere/electricvehicles/charging-home
[100] https://thenovaauthority.org/funded-projects/
[101] https://www.fairfaxcounty.gov/transportation/autonomous-shuttle-pilot
[102] https://secureenergy.org/wp-content/uploads/2016/03/EC_Roadmap.pdf

3.8.4 NVTA Roles

Authority Roles	Funding	• Purchase of electric fleet vehicles, specifically those that facilitate First/Last Mile connections, should continue to be supported via TransAction. • Projects to create publicly available and/or fleet charging facilities should continue to be supported via TransAction. • 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 infrastructure.	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.[103]	Near Term
Shared Roles	Champion	• Authority Members can encourage their jurisdictions to seek out and apply for funding for EV related projects and/or to seek ways incorporate EV infrastructure into existing projects. • Staff should advocate for other planning efforts in the region to consider EV technologies.	Ongoing
	Facilitate	• Authority Members can facilitate the creation of an EV charging network by publicly expressing support for the goal, through adoption of this plan. • The Authority can facilitate the creation of an EV charging network by submitting letters of support for related projects (i.e., for funding applications to external entities.) • Staff can facilitate the creation of an EV charging network by assisting member jurisdictions in making the case for related projects and/or providing technical expertise.	Mid Term
Staff Roles	Planning	• Staff should consider EV technology in long-range planning efforts (in terms of project eligibility criteria, 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.	Immediate
	Outreach/ Education	• Staff should stay abreast of developments in EV technology and use the knowledge to inform the Executive Director, the Authority and committees like the TTC and RJACC. • Staff should continue to share information about EV technology with the public, via outreach mechanisms like Driven By Innovation.	Ongoing

Table 23 - Strategy #8, NVTA Roles

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

3.8.5 Application of Core Values

Safety	Creation of a robust electric vehicle-charging (or other ZEV 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.
Equity	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 ZEV buses also reduces health and environmental impacts on communities located closest to bus depots. Steps should be taken to ensure that stations in the charging (or 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/ZEV fueling infrastructure in disadvantaged communities, since the business case for private investment may not be as robust in these contexts.
Sustainability	Zero Emission Vehicles (ZEVs) generate no tail pipe emissions.[104] 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.[105] Additionally, EVs have the potential to get more efficient over time, as more efficient methods electricity generation are perfected and adopted. [106]

Table 24 - Strategy #8, Application of Core Values

Potentially Applicable Technologies

- Automated/ Autonomous vehicles
- SMDs
- System optimization

[104] https://ec.europa.eu/transport/themes/urban/vehicles/road/electric_en
[105] https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf
[106] https://blog.ucsusa.org/dave-reichmuth/new-data-show-electric-vehicles-continue-to-get-cleaner

Chapter 4

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4.2 Caveats and Assumptions *50*

4.2.1 Impacts of Covid-19 50

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 TransAction[107] and associated Six Year-Program updates.[108] A similar modeling approach was also taken in NVTA's initial analysis of the potential impacts of the Covid-19 pandemic.[109]

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 multi-modal 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 our Internal Combustion Engines (ICE), in pursuit of a more sustainable transportation sector.[110]
- 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.[111]
- Consensus will be achieved on communications format for AVs (DSRC and/or C-V2X) and that interoperability will be a key objective.[112]

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 make several suggestions for modifying/improving the approach of the upcoming TransAction[113] planning process.

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[107] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-E-1.pdf
[108] https://thenovaauthority.org/fy2024-2025-six-year-program-update/
[109] https://thenovaauthority.org/wp-content/uploads/2020/09/PPC-Meeting-Packet-9-29-2020-FINAL.pdf
[110] https://www.nature.com/articles/s41560-020-0644-3.epdf?sharing_token=cE6vaPzu-NDODFHLXk06PdRgN0jAjWel9jnR3ZoTv0PkV4h-0BfuDxTt20euiNiwgJB6g8CLgd2HJNRMDTCSC8_8JcBgF0-pv7-mboFgY-h88dzdoIggR95UkVmkCdlw2hfjGxCUzDwlWphvJ5ecSDurTdn-t4gEFdDq8Le_8BePUwATi1b2KiUt4axz5edIaKtcBQmW1y2ZxMBpK3nrgA%3D%3D&tracking_referrer=www.wired.com
[111] https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/
[112] https://www.consumerreports.org/car-safety/fcc-plan-could-stall-v2x-car-safety-revolution/
[113] https://nvtatransaction.org/

NVTA has later provided updates and contextualization[114] of these results by incorporating outcomes of other regional efforts, such as a 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. All of these reinforced the notion that telework is, and will continue to play, a significant role in the region, and the Commuter Connections survey revealed[115] that some of these changes might persist even beyond the end of the pandemic.

While this may contribute to reducing vehicular congestion, the associated reduction in transit ridership continues to create challenges for transit agencies. In fact, a Washington Metropolitan Area Transit Authority (WMATA) survey revealed[116] that 50 percent of pre-pandemic commuters would only ride again if there were an effective COVID-19 vaccine(s).

At the time of this publication, the COVID-19 pandemic is still ongoing, and thus, 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 contagion fears continue to suppress willingness to share rides or use mass/micro transit?
- Will transit and rail systems be able to effectively recover from financial hardships associated with the pandemic?
- Will employment/unemployment rates in the DMV stabilize to rates that were similar to the pre-pandemic situation?
    - Either way, will the number of jobs in the region remain similar and on a similar growth trajectory?
- Will there be changes to freight delivery capabilities/networks? Or impacts on the modal distribution of freight travel?
- Will there be changes in culture that alter peak (or spike) travel periods? (I.e., reductions in eating out or nightlife.)

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[114] https://thenovaauthority.org/wp-content/uploads/2020/09/PPC-Meeting-Packet-9-29-2020-FINAL.pdf
[115] https://www.wusa9.com/article/news/health/coronavirus/telework-here-to-stay-after-pandemic/65-a68032e2-4e77-436e-9e65-7c3fbcbec51f
[116] https://wjla.com/news/local/metro-riders-say-they-would-only-ride-trains-again-if-there-was-a-covid-vaccine

Chapter 5

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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 plan includes a list of Partners for each action, that 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 Plan aims to map the roles to direct actions, and details any assumptions that were made in doing so. A potential trigger point and metrics for measuring success of each action are also suggested.

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 Possible Outcomes

- Development of technology-related scenarios, for TransAction scenario (sensitivity) analysis, potentially on the following:
    - Incentives and pricing mechanisms to reduce car dependency
    - Climate change and resiliency of regional transportation system
    - Pandemic 'new normal' implications of increased work-from-home and e-commerce
- Technology-related outreach/education
    - Facts and Myths: Connected, Autonomous, Shared, and Electric (CASE) vehicles
- Identify potential additions/changes to NVTA's Legislative Program, these may include:
    - Support EV infrastructure
    - Support Zero Emission Vehicles
    - Concern regarding Zero Occupancy passenger Vehicles
- Identify potential refinements to future NVTA SYP project selection process, via the TransAction update process
    - 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

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** 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.*

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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 grow[117] through the year 2045, which may, despite an expected decrease in VMT per capita[118], 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 (MWCOG) 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.

5.2.2 Actions

No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
1A	Increase consideration of innovative technologies in TransAction	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[119], which prompted the Executive Director to establish the Transportation Technology Committee.	• Discuss transportation technology and innovation in TransAction kick off meeting. • Explore the possibility of incorporating considerations of technology and innovation	• NVTA Staff • TransAction Consultant • NVTA Committees • Authority Members	• Inclusion of technology or innovation focused project(s) in the top-down

[117] https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/
[118] https://www.mwcog.org/file.aspx?D=PXVsN0KkMkgXNwvPyDMX1kLIIQFFp2OJN0YoTa%2bUimA%3d&A=7xHcSpkGbtnCMhK%2fQTirVScizz%2flnwCEKIeZaqWs3K0%3d
[119] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
						in project eligibility and scoring. • Consider technology and innovation in developing top-down TransAction project list. • Evaluate the possibility of adding an additional project scoring metric that concerns itself with the goals of the TTSP. • Incorporate consideration of transportation technology and innovation in tasks 1.2, 1.3, 1.6, 1.7, 2.2, 2.5 and 3.2 of the TransAction planning process.[120] • Consider if terminology and project descriptions used in current planning efforts allow for the introduction of innovative solutions	• Member jurisdictions and agencies	TransAction project list. • Incorporation of eligibility or scoring criteria that consider the goals of the TTSP. • Initiation of a regional conversation about metrics for successful deployment of transportation technology.
1B	Consider transportation technology and innovation in NVTA procurements	NVTA Staff	Any time NVTA initiates a procurement process or seeks funding from an external source	Immediate		• 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	• NVTA Staff • Council of Councils • Authority Members • Member jurisdictions and agencies	• Inclusion of selection criteria that consider TTSP goals and objectives.

[120] https://thenovaauthority.org/wp-content/uploads/2020/11/TransAction-Update-RFP-Final-11.12.2020.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
						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.		
1C	Advocate for jurisdictional policies that leverage technology to reduce congestion and increase throughput	The Authority	Completion of task 1.8 of the TransAction update	Immediate	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/Last Mile 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.

Table 25 - Action Table, Strategy #1

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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 grow[121] through the year 2045, which may perpetuate congestion, despite an expected decrease in VMT per capita[122]. NVTA is committed to maximize 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	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
2A	Increase consideration of innovative technologies in TransAction	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[123], which prompted the Executive Director to establish the Transportation Technology Committee.	• Discuss transportation technology and innovation in 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	• 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. • Incorporation of eligibility or scoring criteria that consider the goals of the TTSP. • Initiation of a regional conversation about metrics for successful

[121] https://www.mwcog.org/documents/2018/10/17/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/
[122] https://www.mwcog.org/file.aspx?D=PXVsN0KkMkgXNwvPyDMX1kLIIQFFp2OJN0YoTa%2bUimA%3d&A=7xHcSpkGbtnCMhK%2fQTirVScizz%2flnwCEKIeZaqWs3K0%3d
[123] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
						top-down TransAction project list. • Evaluate the possibility of adding an additional project scoring metric that concerns itself with the goals of the TTSP. • Incorporate consideration of transportation technology and innovation in tasks 1.2, 1.3, 1.6, 1.7, 2.2, 2.5 and 3.2 of the TransAction planning process.[124] • Consider if terminology and project descriptions used in current planning efforts allow for the introduction of innovative solutions		deployment of transportation technology.

Table 26 - Action Table, Strategy #2

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[124] https://thenovaauthority.org/wp-content/uploads/2020/11/TransAction-Update-RFP-Final-11.12.2020.pdf

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 regards 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	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
3A	Increase consideration of cyber security and privacy in TransAction	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[125], which prompted the Executive Director to establish the Transportation Technology Committee.	• Consider adding scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.	• NVTA Staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Incorporation of eligibility or scoring criteria that consider the goals of the TTSP. • Initiation of a regional conversation about cyber security and protection of privacy.
3B	Increase consideration of cyber security and privacy in NVTA procurements	NVTA Staff	Any time NVTA initiates a procurement process or seeks funding	Immediate		• 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	• NVTA Staff • Council of Councils • Authority Members	• Inclusion of selection criteria that consider TTSP

[125] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
			from an external source			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.	• Member jurisdictions and agencies	cybersecurity and privacy.

Table 27 - Action Table, Strategy #3

5.5 Strategy #4: Minimize Potential for Zero Occupancy passenger Vehicles

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.[126] 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 Vehicles (ZOV.) These efforts can and should begin in 2021, with NVTA Staff exploring potential impacts of AVs and ZOVs 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.

5.5.1.1 Assumptions Made

- 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.

[126] 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.

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5.5.2 Actions

No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
4A	Consider minimization of ZOV Miles Traveled in long-range planning efforts.	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[127], which prompted the Executive Director to establish the Transportation Technology Committee.	• Discuss AVs and ZOV in TransAction kick off meeting. • Explore the possibility of addressing the potential for ZOVs in project eligibility and scoring. • Incorporate consideration of AVs and ZOVs in tasks 1.2, 1.3, 1.6, 1.7, 2.2, 2.5 and 3.2 of the TransAction planning process.[128]	• NVTA Staff • TransAction Consultant • NVTA Committees • Member jurisdictions and agencies	• Inclusion of emerging modes in modeling • One or more scenarios evaluated that consider AVs and potential for ZOVs.
4B	Develop Policies that discourage ZOV Miles Traveled.	Authority Members	Completion of Phase 1 of the TransAction update.	Near term	Objective 1.1 of the current iteration of TransAction is "Reduce congestion and crowding experienced by travelers in the region."[129] Additionally, it contains other objectives relating to improve operation of the regional system and reduce emissions, both of which would be detrimentally impacted by ZOVs.	• 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 Councils and Legislative Liaison. • Seek adoption by the Authority.	• NVTA Staff • NVTA Committees • Council of Councils • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	• Initiation of a region-wide conversation about discouraging ZOV miles traveled. • Adoption of a policy(s) that discourages ZOV Miles traveled.
4C	Advocate for the Commonwealth to	Authority Members	Initiation of development of	Near term	Objective 1.1 of the current iteration of TransAction is "Reduce congestion	• Seek input from member	• NVTA Staff	• Initiation of a region-wide, and

[127] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf
[128] https://thenovaauthority.org/wp-content/uploads/2020/11/TransAction-Update-RFP-Final-11.12.2020.pdf
[129] https://nvtatransaction.org/wp-content/uploads/2018/11/TransAction_Technical-Report_Nov.-2018-FINAL-1.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
	provide local jurisdictions the ability to levy fees on autonomous vehicles.		NVTA's 2022 legislative program.		and crowding experienced by travelers in the region."[130] Additionally, it contains other objectives relating to improve operation of the regional system and reduce emissions, both of which would be detrimentally impacted by ZOVs.	jurisdictions and partner agencies. • Consult with the Legislative Liaison and the Council of Councils. • Incorporate discussion of the ability of jurisdictions to levy fees on AVs in processes to draft and adopt a legislative program.	• NVTA Committees • Council of Councils • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	perhaps state-wide conversation about fees for AVs. • Inclusion of support for jurisdictions to gain the ability to levy fees on AVs.
4D	Advocate for legislation that limits ZOV miles traveled.	Authority Members	Significant deployments of AV Fleets in the region or sister regions.	Long term	Objective 1.1 of the current iteration of TransAction is "Reduce congestion and crowding experienced by travelers in the region."[131] Additionally, it contains other objectives relating to improve operation of the regional system and reduce emissions, both of which would be detrimentally impacted by ZOVs.	• Seek input from member jurisdictions and partner agencies. • Consult with the Legislative Liaison and the Council of Councils. • Incorporate discussion of ZOV miles traveled in development of both state and federal legislative programs.	• NVTA Staff • NVTA Committees • Council of Councils • 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.
4E	Advocate for state entities to continue to provide, and perhaps expand, funding for innovative pilot	Authority Members	National legislation and/or standards regarding AVs	Long term	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		• NVTA Executive Director • Member jurisdictions and agencies	•Initiation of a region-wide, and perhaps state-wide conversation about the value of AV pilot programs.

[130] https://nvtatransaction.org/wp-content/uploads/2018/11/TransAction_Technical-Report_Nov.-2018-FINAL-1.pdf
[131] https://nvtatransaction.org/wp-content/uploads/2018/11/TransAction_Technical-Report_Nov.-2018-FINAL-1.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
	projects and/or research efforts.		are passed/ enacted.		the National Highway and Transportation Safety Administration, and there have been several failed attempts to pass AV-related Acts through the US Congress.[132]			

Table 28 - Action Table, Strategy #4

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[132] https://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx

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 House Excessive Delay (PHED) per capita, of 26.7 hours[133]. 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 buy 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.

5.6.2 Actions

No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
5A	Develop and support policy(s) that support technology-based pricing mechanisms	The Authority	Completion of task 1.8 of the TransAction update	Immediate	There are several pricing schemas deployed in the region, such as the 495 NEXT initiative.[134] Additionally, NVTA is a co-sponsor of RM3P[135] which will apply ICM	• The Authority may consider pricing and incentive mechanisms to reduce congestions and encourage sustainable transportation options. • The authority may develop policies that suggest ratios, ranges or other types of	• NVTA Staff • Authority Members • NVTA Committees • Council of Councils	• Adoption of policy(s) to support pricing mechanisms • Reinvigoration of regional discussion on pricing mechanisms,

[133] http://www.virginiadot.org/about/resources/stip/Appendix_E_-PerformanceBasedPlanning-Performance_CMAQ-FINAL-4-30-19-Rev.pdf
[134] https://www.495northernextension.org/
[135] https://rm3pvirginia.org/

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
					concepts[136] at a regional level.	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. • Advocate that the Commonwealth coordinate with the region to develop pricing and incentive measures, to optimize the transportation network in a sustainable manner.	• Member jurisdictions and agencies	particularly in terms of technologies.
5B	Further integrate consideration of pricing mechanisms into planning efforts	NVTA Staff	TransAction update kickoff meeting.	Immediate	There are several pricing schemas deployed in the region, such as the 495 NEXT initiative.[137] Additionally, NVTA is a co-sponsor of RM3P[138] which will apply ICM concepts[139] 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 Councils • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	• Reinvigoration of regional discussion on pricing mechanisms, particularly in terms of technologies.

Table 29 - Action Table, Strategy #5

[136] https://www.fampo.gwregion.org/wp-content/uploads/2011/06/Intgrated-Corridor-Management.pdf
[137] https://www.495northernextension.org/
[138] https://rm3pvirginia.org/
[139] https://www.fampo.gwregion.org/wp-content/uploads/2011/06/Intgrated-Corridor-Management.pdf

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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 supplement[140] 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.[141]
- 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.

5.7.2 Actions

No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
6A	Consider preparations for emerging modes and innovations in TransAction	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[142], which	• 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	• NVTA Staff • TransAction Consultant • NVTA Committees	• Incorporation of eligibility or scoring criteria that consider the goals of the TTSP.

[140] https://omniride.com/omniride/assets/File/PRTC-Recommendations-Summary.pdf
[141] https://nacto.org/wp-content/uploads/2017/12/NACTO_Designing-for-All-Ages-Abilities.pdf
[142] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
					prompted the Executive Director to establish the Transportation Technology Committee.	technologies likely to be adopted in the region. • Consider adding scoring metric could be added to the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP. • 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.) • Staff should continue to consider[143] if terminology and project descriptions used in current planning efforts allow for preparation for innovative solutions.	• Authority Members • Member jurisdictions and agencies	• Initiation of a regional conversation about preparations for emerging modes and innovation in the region.
6B	Consider preparations for emerging modes and innovations in NVTA procurements	NVTA Staff	Any time NVTA initiates a procurement process or seeks funding from an external source	Immediate		• When the Authority seeks to apply for funding from an external source (as was the case with the RM3P[144] program), the application should be written in such a way as to encourage project components that minimize potential for obsolescence.	• NVTA Staff • Council of Councils • Authority Members • Member jurisdictions and agencies	• Inclusion of selection criteria that concerns itself with contribution towards the goals of the TTSP.

Table 30 - Action Table, Strategy #6

[143] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf
[144] https://rm3pvirginia.org/

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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.

5.8.2 Actions

No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
7A	Increase consideration of interoperability in TransAction	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[145], which prompted the Executive Director to establish the Transportation Technology Committee.	• 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.	• NVTA Staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Incorporation of eligibility or scoring criteria that consider the goals of the TTSP. • Initiation of a regional conversation about preparations for emerging modes and innovation in the region.

[145] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf

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No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
						• 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.) • Staff should consider if the metrics and reporting formats used in current planning efforts best support evaluation of interoperability moving forward.		
7B	Consider the creation of a committee or panel of experts to review procurement documents	NVTA Staff		Mid term		• 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 Councils • 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.

Table 31 - Action Table, Strategy #7

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5.9 Strategy #8: Advance decarbonization of the transportation system

5.9.1 Overview

While this plan should remain flexible enough to address many types of alternative fuels, such as hydrogen, and other Zero Emission Vehicle (ZEV) technologies, the actions below focus on Electric Vehicles (EV), as they are currently the most feasible option. 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 related to increasing prevalence of EV usage (including a promise to build 550,000 EV charging stations) that, if accomplished, would contribute to development of a national network to mitigate these concerns. Separately, the private entity, Electrify America, has selected the Washington D.C. metro area as a target area for investment in EV charging infrastructure in its Cycle 2 investment plan, due in part to its projects supply-demand gap and the Commonwealth has launched an "Electric School Bus Initiative". 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. Together these create an opportune environment for NVTA investment and policy development

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.

5.9.2 Actions

No.	Action	Responsible Party	Trigger Point	Time Frame	Current Status	Sub Actions	Partners	Metric(s) of Success
8A	Increase consideration of EV technology in TransAction	NVTA Staff	TransAction update kickoff meeting.	Immediate	The current iteration of TransAction included recommendations regarding technologies[146], which prompted the Executive Director to establish the Transportation Technology Committee. In the FY 2018-2023 program NVTA funded a project from the City of Alexandria which included the purchase of	• Purchase of electric fleet vehicles, specifically those that facilitate First/Last Mile connections, should continue to be supported via TransAction. • Projects to create publicly available and/or fleet charging facilities should continue to be supported via TransAction. • An additional scoring metric could be added to	• NVTA Staff • TransAction Consultant • NVTA Committees • Authority Members • Member jurisdictions and agencies	• Incorporation of eligibility or scoring criteria that consider the goals of the TTSP. • Reinvigoration of a regional conversation about EVs and associated charging infrastructure.

[146] https://nvtatransaction.org/wp-content/uploads/2018/11/Appendix-A.pdf

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					8 electric buses and supporting infrastructure.)[147]	the funding application evaluation process that concerns itself with contribution towards the goals of the TTSP.		
8B	Develop and adopt policies regarding EVs and charging infrastructure.	The Authority	Adoption of Federal policy and/or enactment of Federal programs	Near future	The General Assembly of the Commonwealth is exploring several initiatives regarding EVs (including HB 1850, HB 1979 and SB 1223) in their 2021 session.[148]	• 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 infrastructure.	• NVTA Staff • Council of Councils • 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.
8C	Advocate for Commonwealth policies that contribute to/support creation of a network of EV charging infrastructure	Authority Members	Initiation of development of NVTA's 2022 legislative program.	Near term	The General Assembly of the Commonwealth is exploring several initiatives regarding EVs (including HB 1850, HB 1979 and SB 1223) in their 2021 session.[149]	• 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	• NVTA Staff • NVTA Committees • Council of Councils • Authority Members • NVTA Legislative Liaison • Member jurisdictions and agencies	• Initiation of a region-wide, and perhaps state-wide conversation about EV charging infrastructure/ creation of a network. • Inclusion of support for jurisdictions to develop an EV charging network.

[147] https://thenovaauthority.org/funded-projects/
[148] https://thenovaauthority.org/wp-content/uploads/2021/01/Presentation-for-the-January-14-2021-Authority-Meeting-.pdf
[149] https://thenovaauthority.org/wp-content/uploads/2021/01/Presentation-for-the-January-14-2021-Authority-Meeting-.pdf

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						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.[150]		

Table 32 - Action Table, Strategy #8

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

5.10 Consolidated Actions Table

Roles									Immediate			Near Term				Mid Term	Long Term
									April - June, 2021	July - Sept, 2021	Oct - Dec, 2021	Jan - March, 2022	April - June, 2022	July - Sept, 2022	Oct - Dec, 2022	2023 - 2025	2026 - 2029	2030 and Beyond
Title	Applicable Strategies								TransAction kick-off		Completion of TransAction Phase 1		TransAction adoption		Development of legislative program			
	1	2	3	4	5	6	7	8			Development of legislative program	Six Year Program Update FY2022-2027						
Funding	1A, 1B	2A	3A, 3B			6A, 6B	7A	8A										
Policy				4B	5A			8B										
Advocate	1C			4C,4D, 4E	5A			8C										
Champion	✓	✓		✓		✓	✓	✓										
Facilitate	✓	✓		✓		✓	7B	✓										
Stakeholder			✓		✓													
Planning	1A	2A	3A	4A	5B	6A	7A	8A										
Outreach/ Education	✓	✓		✓	✓	✓	✓	✓										
Observer			✓															

Key				
Preparatory Action	Potential Direct Action	Direct Action	Follow Up Action	Continuous
Bold text indicates this Role is a focus of the Strategy-Specific mini-action				

Table 33 Consolidated Actions Table

5.11 Next Steps

The TTSP is currently progressing through the NVTA Committee review cycle, with the goal of achieving a recommendation for adoption by the Authority from each of the following Committees:

- Transportation Technology Committee[151], which is the champion of the TTSP;
- Technical Advisory Committee (TAC)[152];
- Planning Coordination Advisory Committee (PCAC)[153];
- Planning and Programming Committee (PPC)[154] and
- Additional feedback is also requested from the Regional Jurisdiction and Agency Coordination Committee (RJACC)

This TTSP review process has been developed to align and inform Northern Virginia's long-range transportation plan, TransAction.[155] To achieve this, the goal is to seek adoption of the TTSP by the Authority in spring of 2021.

5.12 Monitoring Progress and Updating the TTSP

As a living document, NVTA staff will revise the TTSP to reflect changing circumstances. The Executive Director'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 Executive Director, 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

After Authority adoption of TransAction, the TTSP will be regularly reviewed, and updated if necessary. As noted above, significant changes will require Authority approval.

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[151] https://thenovaauthority.org/about/committees/transportation-technology-committee-2/
[152] https://thenovaauthority.org/about/committees/tac/
[153] https://thenovaauthority.org/meetings-events/planning-coordination-and-advisory-committee/
[154] https://thenovaauthority.org/about/committees/planning-and-programming-committee/
[155] https://nvtatransaction.org/

5.12.1 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 process to update the document with any significant changes will necessitate committee reviews and Authority approval

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Glossary

Term	Acronym	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		A band of the radio spectrum. The 5.9 GHz portion of this band has historically been reserved for transportation safety and is referred to as the "safety band" by the US DOT. In 2019/2020, the Federal Communications Commission (FCC) proposed reallocation of a portion of this spectrum, to which the Department of Transportation objects.	https://www.transportation.gov/content/safety-band
Dedicated Short Range Communications	DSRC	DSRC is one of two technologies, which are not interoperable, currently being debated to provide 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/
Cellular Vehicle to Everything	C-V2X	C-V2X is one of two technologies, which are not interoperable, currently being debated to provide 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.	https://www.consumerreports.org/car-safety/fcc-plan-could-stall-v2x-car-safety-revolution/
Blockchain		"A digital database containing information (such as records of financial transactions) that can be simultaneously used and shared within a large decentralized, publicly accessible network"	https://www.merriam-webster.com/dictionary/blockchain
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
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	“AI refers to computer systems able to perform tasks that normally require human intelligence, such as image classification and speech recognition."	https://nvlpubs.nist.gov/nistpubs/ir/2019/NIST.IR.8269-draft.pdf

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Machine Learning	ML	"ML refers to the components of AI systems that learn from data to perform such tasks. The ML components of an AI system include the data, model, and processes for training, testing, and validation."	https://nvlpubs.nist.gov/nistpubs/ir/2019/NIST.IR.8269-draft.pdf
Autonomous Vehicles	AV	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
Automated Vehicles		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
Advanced Driver Assistance Systems	ADAS	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
Connected Vehicles		"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
Connected and Autonomous Vehicles	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
Vehicle to Vehicle	V2V	"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
Vehicle to Pedestrian	V2P	“Pedestrian detection systems can be implemented in vehicles, in the infrastructure, or with pedestrians themselves to provide warnings to drivers, pedestrians, or both. … Some	https://www.its.dot.gov/factsheets/pdf/CV_V2Pcomms.pdf

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		of the V2P applications in development include" mobile accessible pedestrian signal system; pedestrian in signalized crosswalk warning (transit) and automatic braking of personal vehicles.	
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
Vehicle to Infrastructure	V2I	"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 Everything	V2X	V2X is an umbrella term that typically encompasses V2V, V2I and V2P technologies.	https://www.transportation.gov/v2x
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
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/
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

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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/
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 / Last Mile	FLM	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
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
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/ghgemissions/overview-greenhouse-gases

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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/ghgemissions/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 analyzed to optimize products, services, and operations."	https://innovationatwork.ieee.org/internet-of-things/?utm_source=iaw&utm_medium=20190207_post&utm_campaign=iot_transportation&utm_content=text_link
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, scooter 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 provide 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

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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		Definition under development.	
Sandbox		"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 public right-of-way and are meant for short point-to-point trips."	https://nacto.org/wp-content/uploads/2019/09/NACTO_Shared_Micromobility_Guidelines_Web.pdf
"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 are 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

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Transit Signal Priority	TSP	"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/
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/
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/intro.asp

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