COMMONWEALTH OF VIRGINIA

VIRGINIA DEPARTMENT OF TRANSPORTATION (VDOT)

ADMINISTRATIVE SERVICES DIVISION

1201 E BROAD STREET

RICHMOND, VIRGINIA 23219

Note: To the extent allowed by law, this public body does not discriminate against faith-based organizations in accordance with the Code of Virginia, § 2.2-4343.1 or against a bidder or offeror because of race, religion, color, sex, national origin, age, disability, sexual orientation, gender identity, political affiliation, or status as a service disabled veteran or any other basis prohibited by state law relating to discrimination in employment. VDOT is committed to increasing procurement opportunities for small and micro businesses, including small or micro businesses that are owned by minorities, women, or disabled veterans, and strengthening the Commonwealth's overall economic growth through the development of its IT Offerors.

REQUEST FOR QUALIFICATIONS (RFQ) 156859 for

Project Name: ***Artificial Intelligence-Based Decision Support System (AI-DSS) for Enhancing Transportation Incident Management***

Issue Date:	August 31, 2021
Due Date/Time:	October 6, 2021, 4:00 PM Eastern
Single Point-of-Contact (SPOC):	Tiffany Winfrey
Ph. No:	804-692-0455
E-mail Address:	tiffany.winfrey@vdot.virginia.gov

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1. INTRODUCTION

A. Objective of the Request for Qualifications

This Request for Qualifications ("**RFQ**"), issued by the Virginia Department of Transportation ("**VDOT**"), is to solicit an Expression of Interest (EOI) from qualified Offerors interested in contracting to implement, deploy, and operate an ***Artificial Intelligence-Based Decision Support System ("AI-DSS") for Enhancing Transportation Incident Management*** **in Northern Virginia ("NoVA") and Metropolitan Fredericksburg**. The purpose of this RFQ is to solicit information that will enable VDOT to determine which Offerors are best qualified to successfully execute and operate the AI-DSS project. Those Offerors determined to be best qualified will be invited to submit proposals in response to VDOT's AI-DSS Request for Proposal (RFP).

Any Offeror capable of meeting the "**Must-Have Factors**" of the solicitation (see Section 3, Subsection B) may respond to this RFQ. VDOT Evaluation Team will review and score all EOI responses in accordance with the evaluation criteria established in this RFQ. VDOT shall advise in writing each Offeror who submitted an EOI whether that Offeror has been prequalified. In the event that an Offeror is denied prequalification, the written notification to the Offeror shall state the reasons for the denial of prequalification. Only those Offerors pre-qualified by VDOT may then respond to the subsequent RFP, which will be issued shortly after the letters are disseminated. The evaluation of the EOI will not factor into the evaluation of the AI-DSS RFP.

In this document, "Offeror" means any entity that submits an EOI response to this RFQ. Offeror, Contractor, and Vendor are used interchangeably in this RFQ document.

The pre-qualification letter will pertain only to the composition of the Offeror team described in the EOI submission. "Offeror team composition" refers to the proposed organizational structure of the Offeror team that will perform the work (prime/subcontractor, joint venture, other alliances, etc.) and identification of the partner members (firms, universities, and other organizations) who will participate on the Offeror team. Changes in team composition between the EOI submission and subsequent RFP response that alter the qualifications and experience of the team may impact evaluation.

TO BE ELIGIBLE TO RESPOND TO THE RFP ON AI-DSS, AN OFFEROR MUST BE THE RECIPIENT OF A SIGNED LETTER FROM VDOT STATING THE OFFEROR IS PRE-QUALIFIED (PER THE OFFEROR'S EOI SUBMISSION). A COPY OF THAT LETTER MUST BE INCLUDED IN THE PROPOSAL RESPONSE TO THE RFP.

B. Project Term and Options

- The contract awarded from the subsequent RFP is estimated to include an *initial term* of *36 months* as listed below: 24 months for development and deployment of the AI-DSS, and
- 12 months for operational support of the AI-DSS initiative.

Optional renewal periods extending the AI-DSS operational support will be included beyond the initial contract term.

NO CONTRACT WILL BE AWARDED FROM THIS RFQ. THE CONTRACT AWARD WILL BE DETERMINED BASED ON THE SUBSEQUENT RFP.

C. Project Overview

The purpose of the request of qualifications (RFQ) is to establish a list of offerors qualified to submit sealed proposals through the competitive negotiations to provide a Software-as-a-Service ("SaaS") system to review and evaluate the current transportation conditions, predict future conditions, and help agency operators make informed decisions when cooperatively managing recurring and non-recurring circumstances that impact their transportation networks (transit, arterial, freeway, and parking) in NoVA and Metropolitan Fredericksburg (Stafford County, Spotsylvania County, and the

City of Fredericksburg). AI-DSS is a multi-agency collaborative tool using real-time and historical data to improve safety, reliability, and mobility for travelers. Under the AI-DSS initiative, public and private-sector transportation safety and service providers across NoVA and Metropolitan Fredericksburg will adopt technologies to improve multi-modal travel conditions and make available to operating agencies the tools to collaborate and coordinate in responding to transportation events. It is anticipated that stakeholders engaged in transportation-related activities across the region will participate in AI-DSS.

A companion project to the AI-DSS is called the *Commuter Parking Information System* (CPIS). CPIS is planned as a real-time, app-based parking availability system that will provide reliable information on parking space availability at lots serving bus, vanpool, and carpool commuters. The system will monitor parking conditions at the individual commuter lots, reporting out static and real-time occupancy information. Another component of the parking initiative will be to *predict parking space availability* – i.e., to advise commuters on the prognosis for finding available parking at specified lots 15, 30, and 60 minutes into the future. Predicting parking availability will be a function of the AI-DSS.

VDOT is seeking an innovative system of AI-DSS solutions that (1) predict incidents, congestion, and parking availability; (2) select appropriate pre-agreed response plans to respond to actual and predicted events; and (3) furnish associated services to support these systems, including response plan development, response plan evaluation, alerts for agency actions, and an interface for agencies to integrate the system with their management systems.

D. Innovation to Government

The Commonwealth encourages all Offerors to bring innovative ideas and/or solutions to government—ideas that result in cost and operational efficiencies or improvements, while simultaneously enhancing the services that government provide its citizens.

E. DBE and SWaM Participation in Project

It is the policy of the Commonwealth to contribute to the establishment, preservation, and strengthening of small businesses and micro businesses, including those small or micro businesses owned by women, minorities, or service-disabled veterans; and to encourage their participation in Commonwealth procurement activities. The Commonwealth encourages all Suppliers to provide for the participation of these small businesses through partnerships, joint ventures, subcontracts, and other contractual opportunities.

Offerors qualified to submit sealed proposals through competitive negotiations will be subject to a Small Business Subcontracting Plan and DBE participation. Certification applications are available through DSBSD online at www.sbsd.virginia.gov.

The DBE goal for this procurement is 12%.

In responding to this RFQ, Offerors shall identify their DBE and SWaM team members, the roles these members will perform on the project, and the estimated percent of total work each firm shall perform as part of their team composition. Offerors are not required to submit a Supplier Procurement and Subcontracting Plan as part of the EOI response.

F. VDOT Overview

VDOT serves the citizens of the Commonwealth and traveling public daily through its mission to plan, deliver, operate, and maintain a transportation system that is safe, moves people and goods, enhances the economy, and improves quality of life. The Commonwealth Transportation Board guides the Department's work much like a board of directors and provides funding for roadways, airports, seaports, and rail and public transportation. The Virginia Secretary of Transportation functions as the Chair.

Virginia has the third largest state-maintained highway system in the country. VDOT maintains over 58,000 miles of roads, bridges, and tunnels, and employs over 7,700 people through a diverse workforce. VDOT has nine highway districts, divided into thirty-one residencies; the residencies are responsible for one to four counties each. VDOT also has five Transportation Operations Centers (TOCs) across the Commonwealth. These centers monitor traffic and travel conditions, dispatch personnel to respond to incidents and events, coordinate traffic signals, manage the collection and usage of traffic data, and provide information to travelers to make informed choices about when and how they travel.

G. Overview of RM3P

The *Regional Multi-Modal Mobility Program* (RM3P) – a partnership between the Office of the Secretary of Transportation, the Virginia Department of Transportation (VDOT), the Northern Virginia Transportation Authority (NVTA), and the Virginia Department of Rail and Public Transportation (DRPT) – is an innovative technology initiative funded under the Commonwealth of Virginia's Innovative Technology and Transportation Fund (ITTF). This initiative aims to improve safety, reliability, and mobility for travelers in Northern Virginia and Metropolitan Fredericksburg. The intent of this technology initiative is to leverage the collaborative use of real-time data by Virginia's public and private sectors to optimize the functioning of the transportation network, as well as to provide to customers the tools to make more informed travel choices. Stakeholders across the region are expected to participate in this important advancement, known to many as the *RM3P Initiative*.

To achieve the goals of improving travel safety, reliability, and mobility, five sets of technological projects – referred to as program elements – are being implemented under the RM3P Initiative. These include the:

- Data-Exchange Platform (DEP),
- Artificial Intelligence-Based Decision Support System for Enhancing Transportation Incident Management (AI-DSS),
- Commuter Parking Information System (CPIS),
- Multi-Modal Analytical Planner (MMAP), and
- Regional Multi-Modal Mobility Enhancement via Dynamic Incentivization (DI).

As shown in Figure 1, the RM3P Region is comprised of two tiers: a *Northern Tier*, that encompasses Northern Virginia, and a *Southern Tier*, that includes Metropolitan Fredericksburg (i.e., Stafford County, Spotsylvania County, and the City of Fredericksburg). The Northern Tier is the "core area" of RM3P, where all five RM3P program elements will be implemented. Expansion to the Southern Tier was made possible by award of a federal Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant to VDOT. Specifically, the ATCMTD grant will enable the AI-DSS and CPIS components to be deployed in the Southern Tier of the region. Additionally, limited DEP capabilities necessary to support the AI-DSS and CPIS extensions will apply to the Southern Tier.

This RFQ pertains to deployment of the AI-DSS. The AI-DSS will facilitate multi-agency and multi-modal strategies to mitigate the adverse impact of various events in the region, such as roadway crashes, transit delays, bad weather, congestion, transit crowding, and other occurrences that negatively impact the regional transportation network.

H. Responding to this RFQ

Interested Offerors must demonstrate they have the necessary qualifications, prior relevant experience, and capabilities to meet VDOT's requirements to implement and deploy the AI-DSS, as specified in Section 4, Scope of Project.

Offerors responding to this RFQ must certify they meet all of the *Must-Have Factors* of the DI initiative (see Section 3, Subsection B). Only those submissions that meet 100-percent of the Must-Have Factors will be further evaluated.

Responses to the core elements of the RFQ are limited to twenty (20) pages (additional pages are allotted for supplemental information, such as resumes). Detailed instructions on the required content of the EOI response, including the associated evaluation factors, may be found in Section 3.

VDOT retains the option of inviting prequalified Offerors to demonstrate their products in the RFP evaluation process.

Alliances among Offerors are acceptable to meet the requirements of this procurement. However, VDOT requires a single point-of-contact for interfacing with the Offeror team.

VDOT reserves the right to adjust the requirements or scope of this solicitation. In the event that any modifications become necessary, amendments to this solicitation will be posted on the Commonwealth's procurement portal, eVA, at: http://www.eva.virginia.gov.

I. Protest

The Offeror may elect to appeal the VDOT's prequalification decision as provided in §2.2-4357 and §2.2-4364 of the Code of Virginia.

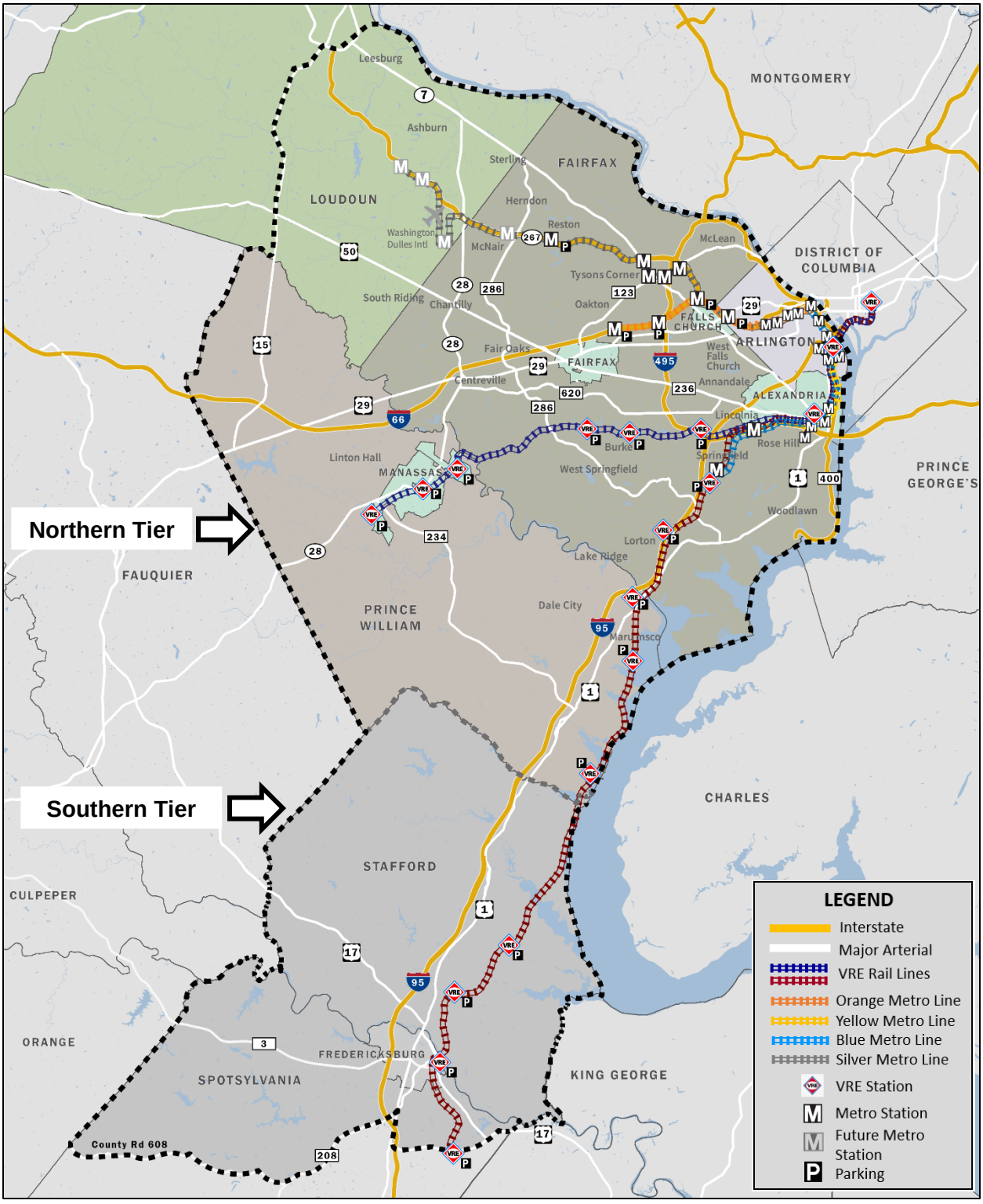

Figure 1: The RM3P Region

2. PROPOSAL ADMINISTRATION

A. Overview

This RFQ was developed to provide potential Offerors with the information necessary to prepare and submit an Expression of Interest (EOI). This section, together with the information in Section 3, "RFQ Response Instructions," outlines the administrative procedures and guidelines you must use and comply with when preparing a submission. Nothing in this RFQ constitutes an offer or an intention to contract.

This RFQ consists of the following:

- The current document entitled, *Artificial Intelligence-Based Decision Support System (AI-DSS) for Enhancing Transportation Incident Management.* This document includes:
  - Section 1, Introduction
  - Section 2, Proposal Administration
  - Section 3, RFQ Response Instructions
  - Section 4, Scope of Project
- Appendix A – AI-DSS System Needs and Requirements
- Appendix B – RM3P/ATCMTD Concept of Operations – Draft
- Appendix C – RM3P/ATCMTD Evaluation Plan – Draft
- Appendix D – State Corporation Commission (SCC) Form
- Appendix E – DBE/SWaM Business Subcontracting Plan **(for informational purposes only)**
- Appendix F– Enterprise Cloud Oversight Service (ECOS) and Assessment Questionnaire **(for informational purposes only)**
- Appendix G – Proprietary/Confidential Information Summary Form

Of the Appendix documents, only the *SCC Form* (Appendix D) and *Proprietary/Confidential Information Summary Form* (Appendix G) are required to be completed and submitted as part of the EOI response to the RFQ. Note that the *Proprietary/Confidential Information Summary Form* must be submitted only if there is proprietary information the Offeror proposes to delete from any public disclosure of the EOI. For additional information on the specific materials that must be submitted as part of the EOI, please see Section 3, Table 3.

B. Virginia Public Procurement Act (VPPA)

This RFQ is governed by the Virginia Public Procurement Act ("**VPPA**"), Code § 2.2-4300 *et seq.*, and other applicable laws.

C. Anti-Discrimination- § 2.2-4310 and § 2.2-4311, and § 2.2-4343.1(E)

By submitting its EOI, an Offeror certifies to the Commonwealth that it will conform to the provisions of the Federal Civil Rights Act of 1964, as amended as well as the Virginia Fair Employment Contracting Act of 1975, as amended; and, where applicable, the Virginians With Disabilities Act, the Americans With Disabilities Act and § 2.2-4311 of the VPPA.

D. Ethics in Public Contracting - § 2.2-4367 *et seq.*

By submitting its EOI, an Offeror certifies that its submission is made without collusion or fraud; that the Offeror has not offered or received any kickbacks or inducements from any other bidder, Offeror, manufacturer, or subcontractor in connection with its submission; and that the Offeror has not conferred on any public employee having official responsibility for this procurement transaction any payment, loan, subscription, advance, deposit of money, services, or anything of more than nominal value, present or promised, unless consideration of substantially equal or greater value was exchanged. In addition, an Offeror will disclose any actual or perceived conflicts of interest in its submission and will notify VDOT if it becomes aware of a potential conflict of interest in the future.

E. Authorized to Transact Business in the Commonwealth - § 2.2-4311.2

The Offeror must submit the completed State Corporation Commission (SCC) Form as part of its RFQ response. All Offerors organized as a stock or nonstock corporation, limited liability company, business trust, or limited partnership, or registered as a registered limited liability partnership must be authorized to transact business as a domestic or foreign business entity if so required by Title 13.1 or Title 50 of the Code, or as otherwise required by law. In its RFQ response, Offeror must include either (i) Offeror's identification number issued to it by the State Corporation Commission; or (ii) a statement explaining why Offeror is not required to be registered. The Appendix D form includes a space for Offeror to provide the information required in (i) or (ii) of this subsection. If an Offeror anticipates the use of additional resources through a partnership or subcontracting relationship with other entities, the requirements of this Section 2.F will also apply to any entities that are engaged as partners or subcontractors of Offeror providing services directly to the Commonwealth upon award of a contract.

F. Prohibited Products and Services - § 2.2-5514

No Offeror may include as part of its EOI submission (or a future proposal), whether directly or indirectly through subcontractors, any hardware, software, or services that have been prohibited for use on federal systems by the U.S. Department of Homeland Security.

G. Prohibited Contributions and Gifts - § 2.2-4376.1

No Offeror that submits an EOI in response to this solicitation, and no individual who is an officer or director of the Offeror shall knowingly provide a contribution, gift, or other item with a value greater than $50 or make an express or implied promise to make such a contribution or gift to the Governor, his political action committee, or the Secretary of Administration during the period between the submission of the EOI and the award of any resulting contract award with an expected value of $5 million or more dollars.

H. Liability

The issuance of this RFQ and the receipt of information in response to this RFQ will not cause VDOT to incur any liability or obligation, financial or otherwise, to any Offeror. VDOT assumes no obligation to reimburse or in any way compensate an Offeror for expenses incurred in connection with its submission.

I. Nondisclosure

All information submitted by an Offeror will be treated as confidential and will not be disclosed except as required by law or by court order.

J. Proprietary Information

VDOT reserves the right to use information submitted in response to this document in any manner it may deem appropriate in evaluating the fitness of the solution(s) proposed. Ownership of all data, materials, and documentation originated and prepared for VDOT pursuant to the RFQ shall rest exclusively with VDOT and shall be subject to public inspection in accordance with the § 2.2-4342 of the VPPA and the Virginia Freedom of Information Act.

Trade secrets or proprietary information submitted by an Offeror in connection with a procurement transaction or prequalification application submitted pursuant to subsection B of § 2.2-4317 of the Code shall not be subject to the Virginia Freedom of Information Act (Code § 2.2- 3700 *et seq.*) if an Offeror:

i). invokes the protections of this section in writing prior to or upon submission of the data or other materials,
ii). identifies specifically the data or other materials to be protected, and
iii). states the reasons why protection is necessary.

Please note that you may not designate as trade secrets or proprietary information (a) an entire bid, proposal, or prequalification application; (b) any portion of a bid, proposal, or prequalification application that does not contain trade secrets or proprietary information; or (c) line item prices or total bid, proposal, or prequalification application prices.

FAILURE TO COMPLY WILL RESULT IN THE DATA OR OTHER MATERIALS BEING RELEASED TO OFFERORS OR THE PUBLIC AS PROVIDED FOR IN THE VIRGINIA FREEDOM OF INFORMATION ACT.

You should provide in your submission (per Appendix G) a list of all pages in the EOI that contain proprietary information and the reason you deem the information proprietary. The classification of the entire submission as proprietary or trade secret is not acceptable and will not be honored by VDOT or the Commonwealth. (See Section 3, Subsection E for additional instructions.)

K. Expression of Interest Protocol

In order to be considered for down-selection, you must submit a complete response to this RFQ no later than **4:00 PM local time on October 6, 2021.**

VDOT requires that all Offerors submit their Expressions of Interest (EOI) in eVA as detailed below. The size limit per file is 60MB; there is no limit, however, on the number of files that can be uploaded. All files need to be titled as specified in Section 3, Subsection A.

1. Submit one (1) complete original containing all information specified in this RFQ.
2. Submit one (1) complete original, with redactions, if necessary, consistent with the requirements of RFQ, Section 2, Subsection K and Section 3, Subsection E. (If redactions to the EOI are not being made, submission of this second file is unnecessary.)

The EOI must be signed by an authorized representative of the Offeror.

The EOI must be prepared and organized as indicated in Section 3, "RFQ Response Instructions." Emphasis should be placed on completeness and clarity of content. Responses must adhere to the specified page limits.

L. Single Point-of-Contact

It is the responsibility of the Offeror to inquire about and request clarification of any requirement in this RFQ that is not understood. No verbal inquiries will be accepted. Submit all inquiries concerning this RFQ in writing by email, subject: "Questions on RFQ # 156859" to:

SPOC: Tiffany Winfrey
Email: tiffany.winfrey@vdot.virginia.gov

The deadline for submission of questions is **4:00 PM local time on September 9, 2021.** No questions will be answered after that date. **Offerors are to limit all contact**, whether verbal or written, pertaining to this RFQ to the designated SPOC for the duration of this RFQ/RFP process. It is not permissible for any Offeror, or any entity working on behalf of an Offeror, to solicit information from any individual or government source other than from the official SPOC listed above. Any unauthorized solicitations for information from anyone other than the SPOC may be grounds for disqualification of Offeror's EOI.

M. Procurement Website

The Commonwealth's procurement portal, http://www.eva.virginia.gov, provides information about Commonwealth solicitations and awards. Offerors are encouraged to check this site on a regular basis and, in particular, prior to submission of their EOI responses to identify any amendments to the RFQ that may have been issued.

N. Timetables

The table, below, summarizes key milestone dates associated with submitting an EOI in response to this RFQ.

Table 1: Milestone Dates for RFQ #156859

Milestone	Date
RFQ posted to eVA	August 31, 2021
Deadline for submitting written questions	September 9, 2021, 4:00 PM
Deadline for submitting electronic Expressions of Interest in response to this RFQ	October 6, 2021, 4:00 PM
Issuance of Pre-Qualification Determination Letters to Offerors	November 8, 2021 (Targeted Date)

O. eVA Registration Required

By the date of award, the selected Offeror(s) must be registered and able to accept orders through eVA. To register with eVA, select the "Vendor" tab at the eVA website, http://www.eva.virginia.gov, for registration instructions and assistance.

P. Excluded Parties List

An Offeror will not be awarded a contract if it, or any of its affiliates or subcontractors, is an excluded entity on the federal government's System for Award Management ("SAM") at https://www.vita.virginia.gov/supply-chain/scm-policies-forms/#sam, or the Commonwealth's Debarment List as provided by Code § 2.2-4321 at the time of award.

3. RFQ RESPONSE INSTRUCTIONS

Interested Offerors must demonstrate that they have the necessary qualifications, prior relevant experience, and capabilities to meet VDOT's requirements to implement and deploy the AI-Based Decision Support System (AI-DSS), as specified in Section 4, Scope of Project.

Offerors submitting Expressions of Interest (EOI) in response to this RFQ must adhere to the specific format set forth in Table 3 below. VDOT will reject any EOI submission not in the specified format, or that does not address all the requirements of this RFQ.

It is essential that the EOI submission be thorough and concise. Avoid broad, unenforceable, or unmeasurable responses. Include all requested information in each section as indicated below. EOI responses should be written specifically to answer this RFQ.

A. File Naming and Document Limits

In order to facilitate VDOT's review of the EOI, you must label the files using the following naming convention: [RFQ#].[Submission Date in format YYYYMMDD].[Name of Lead Offeror].Tab[#].

Each tab should be saved as a separate computer file and contain the information specified for that tab in Table 3. If you are not redacting any parts of your submission, you do not need to submit Tab 5.

In the event that the size of any single file size exceeds 60MB, an additional file should be created so that all files are within the size limits. If, for example, the "Response Content" (Tab 3) of your submission is greater than 60MB, break the content into two files, labeling them Tab3A and Tab3B, respectively.

Submit the EOI response as an MS Word document. Font size must be 11-pt. or larger; top, bottom, and side margins must be one-inch or larger. The page limits, noted in Subsection E, must be strictly adhered to.

The optional EOI Redaction File (identifying proprietary information), if submitted, should be in portable document format (PDF).

The EOI response must be submitted electronically through the procurement portal. Go to www.eva.virginia.gov. Navigate to this RFQ opportunity. Then select "Respond Online."

B. Must-Have Factors

Offerors responding to this RFQ must certify they meet all of the Must-Have Factors listed in Table 2:

Table 2: Must-Have Factors

No.	***Must-Have (M) Factors***
1.	(M) The Expression of Interest must be received by the due date and time. Late submissions will not be reviewed.
2.	(M) The Lead Offeror or its team members have experience successfully implementing at least one transportation-focused DSS project.
3.	(M) The team members have experience successfully implementing at least one transportation-related prediction project in real-time.

VDOT will review each proposal to confirm that these Must-Have Factors are met. All Must-Have Factors will be evaluated on a met-or-not-met basis. Any EOI response that does not meet all of the Must-Have Factors will be set aside and receive no further consideration.

Only those submissions that meet 100 percent of the Must-Have Factors will be further evaluated.

C. RFQ Solutions and Experience Summary

In the EOI, interested Offerors will prepare and submit the requested information describing their approach, capabilities, and qualifications to address the requirements of the DSS initiative as specified in Appendix A.

Those responses meeting all Must-Have Factors will be reviewed and scored using the maximum point values associated with each content item below. Offerors' aggregate scores will then be rank ordered, and those Offerors with the highest rankings will be invited to prepare technical and cost proposals in response to the RFP.

EOI Responses to this RFQ are **limited to twenty (20) pages** in length. This limit is exclusive of cover letter, "Must Haves" sheet, and resumes. Resumes should be presented in Tab 4—a maximum of four (4) resumes may be included, with individual resumes each limited to two (2) pages or less.

D. Response Content and Point Values

The following content items must be included in the EOI response. The maximum number of evaluation points associated with each item are shown in parentheses:

1. **Project Approach (25 points):** Provide a high-level description of your planned approach, methodology, and phasing to develop/deploy the AI-DSS. Identify pertinent Offeror products you will utilize and discuss your plans for implementing a Software-as-a-Service (SaaS) solution. The goal of this content item is to evaluate the Offeror's capabilities to develop and execute a project approach for sophisticated, multi-faceted IT deployments.
2. **Team Composition (10 points):** Identify the organizations comprising the Offeror team, highlighting roles and qualifications for each. Identify the planned organizational structure (prime/subcontractors, joint venture, etc.). Identify team members certified as Small, Women-Owned, and Minority-Owned (SWAM) businesses and Disadvantaged Business Enterprises (DBEs); specify the estimated percent of total work to be performed by these firms.
3. **Pertinent Experience (20 points):** Describe your team's experience performing comparable projects. To the extent applicable, please be precise about experience in the following areas: (a) designing and implementing decision support systems, including DSSs supporting transportation operations; (b) preparing multi-modal response plans; (c) developing and implementing rules engines, modeling engines, and prediction engines; (d) administering large-scale DSSs; and (e) developing and implementing prediction projects. When citing "example" projects that the Offeror team has performed, identify specific outcomes and current project status.
4. **Staffing (10 points):** Furnish resumes for a maximum of four (4) key personnel to be assigned to the project. For each staff, identify at a minimum: (a) name, (b) firm, (c) position within firm, (d) proposed role on project, (d) relevant project experience, and (e) percent time that the staff will be available to work on this project beginning in the first quarter of 2022. Resumes are limited to a maximum of two (2) pages each.
5. **Agile Project Management (10 points):** Summarize your methodology, process, qualifications, and experience managing systems and software development projects using an Agile-based process. Identify your approach to using Agile in a Software-as-a-Service (SaaS) project. What is your expectation regarding VDOT's involvement and partnership in the Agile process?
6. **Quality Assurance (10 points):** Describe your methodology and practices for verification and validation testing. Identify the phases of testing you propose to perform in this project and how you will build QA/QC into the Agile process.
7. **Innovation (15 points):** Identify and describe specialized innovations that the team will bring to the project. These may include technological innovations, access to particular datasets that may not otherwise be available to VDOT, etc. Explain how these innovations will contribute to the success and sustainability of the project. The goal of this content item is to evaluate the Offeror's skills related to innovation planning.

E. Offeror's EOI Submission Format

Responses should include all elements and information identified above and be organized as specified below.

The EOI submission should be organized by "Tab" number in a single electronic file, as indicated in Table 3.

Table 3: EOI File Organization and Content

Tab No.	Section Title	Content Summary
Tab 1	**Transmittal (Max. 1 page)**	• A signed letter, including identification of the name, title, affiliation, phone, and email of the Offeror's point-of-contact for this effort. • Acknowledge any Addendums to the RFQ. • Include a copy of the completed eVA registration confirmation.
Tab 2	**Forms and Documents (Max. 2 pages)**	• Respond to the "Must-Have Factors" in Subsection B. List all factors, certifying for each whether the Offeror Team satisfies the factor. • Include SCC Form (Appendix D).
Tab 3	**Response Content (Max. 20 pages)**	• Project approach. • Team composition and commitment to DBE goal. • Pertinent experience. • Agile project management. • Quality assurance. • Innovation.
Tab 4	**Resumes (Max. 8 pages)**	• Include a maximum of 4 resumes. • Individual resumes may not exceed 2 pages each.
Tab 5	**EOI Redaction File (Optional)**	• Include this file only if there is proprietary information you propose to delete from any public disclosures of your EOI. The file should be in PDF format. • Mark those sections deemed "proprietary." • Complete the Appendix G form.

If any material in your EOI is proprietary, you should include Tab 5 in your EOI. Please review the guidance in Section 2, Subsection K on proprietary information. Create a new file, duplicating the entire content of the EOI (Tabs 1-4) and follow the instructions for Tab 5 in Table 3.

By responding to this RFQ, the Offeror certifies that all information provided in the submission is true and accurate.

4. SCOPE OF PROJECT

This scope of work is a general guide and is not intended to be a complete list of all the work necessary to complete the project. This scope is provided for informational purposes only, to assist Offeror's in developing their EOI submissions. Therefore, no specific responseis required for this section, beyond the content called for in Section 3, above.

The AI-DSS is to be furnished as Software-as-a-Service (SaaS), providing the functionality to review and evaluate the current conditions, as well as to predict conditions of the Northern and Southern Tier transportation network; to help agency operators make informed decisions in managing both recurring and non-recurring congestion conditions that affect their transportation networks (transit, arterial, and freeway conditions, and parking availability); and to make recommendations on the actions to be taken to optimally respond to transportation events in the region. It is assumed that the AI-DSS will be a multi-phased functional deployment with additional functionality deployed during each phase until the full SaaS technologies proposed by the Offeror are completed.

VDOT is requesting that the Offeror propose an innovative solution that meets the following high-level needs and functions for the AI-DSS:

- Predict/project transportation events (location, expected duration, severity) that will occur in a customer-configurable future period, such as between 15 minutes and an hour into the future;
- Predict/project traffic congestion (location, expected duration, intensity) that will occur between 15 minutes and an hour in the future;
- Predict/project transit crowding that will occur between 15 minutes and an hour in the future;
- Predict/project the availability of parking spaces at selected individual regional parking facilities between 15 minutes and an hour in the future during AM Peak;
- Develop multi-modal, multi-agency response plan elements through coordination and agreement with regional operating agencies;
- Develop business rules and operating procedures for responding to incidents and congestion through coordination and agreement with regional operating agencies;
- Recommend response plan elements for actual and predicted transportation incidents and the expected impact of the response plan;
- Recommend response plan elements for actual and predicted traffic congestion;
- Recommend response plan elements for actual and predicted transit crowding conditions;
- Provide a data interface for parking availability predictions to send data and prediction information to the RM3P Data-Exchange Platform (DEP);
- Provide a web-based graphical user interface that authorized transportation operators can view modify, and coordinate recommended response plans;
- Provide response plan recommendations to regional stakeholders in various formats including but not limited to an API for agency operating systems to integrate the DSS data, a web-based GUI, and alerts in text and email format;
- As a separate option to the AI-DSS project, the Vendor for the Data Incentivization (DI) project may need to generate triggers within the DSS to implement various DI strategies. The AI-DSS vendor may be asked to develop an interface for the DI vendor to connect to the AI-DSS system and provide documentation for the DI triggers in the response plans. This work is an optional task, and will require separate pricing during the technical proposal pricing phase; and
- Provide a data interface to the RM3P Data-Exchange Platform (DEP) to send prediction information, response plan recommendations, and the executed response plan elements.
- Develop a data interface to the DEP to obtain current traffic, transit, and parking information.

The Offeror will propose its SaaS approach based on its expertise and proposed technologies; teaming arrangements are encouraged. VDOT is open to innovative solutions and the Offeror shall detail how its solution meets the needs and functions listed above.

Below is a list of probable elements in an AI-DSS solution. VDOT anticipates that these components or capabilities are likely to be reflected in Offerors' responses. Where specific elements are not needed, Offerors should explain the work-around.:

Rules Engine
The Rules Engine contains the logic to make determinations based on pre-defined rules. This includes monitoring current conditions to determine when a response plan needs to be created, updated, or deactivated; and developing response plans from a set of rules applied to current conditions.

In order to assist regional operators, a Rules Engine may be needed and shall be developed by the selected DSS Offeror. For transit, freeway, or arterial related events, the Rules Engine could evaluate the location, time-of-day, severity of an event, and other variables. It should use rules to determine the need for a response plan and, if needed, select the most appropriate or applicable response plan elements. The Rules Engine should re-evaluate the event throughout the life of the event and potentially recommend different response plans and actions. This process should be performed until the event has cleared. The Rules Engine may use logic and business processes that can be expanded to any mode and event type that might occur in the region (e.g., Mobility Service Providers, Parking, Transit).

Modeling Engine
An AI-DSS Modeling Engine may be used for evaluation and development of various response plans and events within the corridors and hot spots listed in the Predictive Engines section. Using the existing regional planning models as a baseline, it would be expected that a macroscopic/mesoscopic model may be developed to include the additional modal alternatives, including the expansion, calibration, and use of the model for the multi-modal analysis. The results of the analysis, modeling, and simulation (AMS) task may be used along with other relevant field, and stakeholder input to develop a set of pre-defined response plans or elements for use by the Rules Engine. All proposed modeling software needs to be approved by VDOT prior to use.

The Model may be used by the selected Offeror to assist in the training of its predictive service.

Response Plans
Several agencies within the region have existing response plans and standard operating procedures (SOP) for events within their areas of responsibility. The selected Offeror/Vendor may use the existing response plans and SOPs. It shall develop a new set of coordinated response plan elements for general and/or specific events identified by VDOT and its partners. These response plan elements can be specific actions for types of events, or full pre-agreed response plans for specific locations of events. The Vendor may use various technologies to develop a recommended response plan for agencies to implement. It is expected that the Vendor will coordinate the development of response plans through a series of workshops and table top exercises with regional stakeholders. It is expected that response plan elements may be recommended based on actual events and predictive events that meet a minimum confidence value. The Vendor should clearly inform agencies if their existing response plans and SOPs are in need of modification. Response plans may have various associated needs such as reducing demand, providing incentives to drivers, increasing transit capacity, providing triggers to external systems, recommending traveler information, modifying existing traffic control devices, and detouring traffic to approved detour routes.

Predictive Engines
The selected DSS Vendor will provide incident prediction based on current conditions; roadway congestion and transit crowding prediction; and parking availability prediction using their proposed technology. The Vendor shall develop and present methods for ensuring practical, time-efficient, and ethical decision-making when training the Predictive Engine and the resulting predictions.

a. During the RFP, Offerors will be provided access to current historical data within the DEP to evaluate and recommend sub-regions within NoVA and Metropolitan Fredericksburg. Other publicly available data, such as origin-destination data, regional planning model networks, transit GTFS data, and historical crash data, can be used for this evaluation. Offeror may make

recommendations to VDOT on the schedule needed for planned data sources being integrated into the DEP.

b. Offeror shall identify any additional 3rd-party data services or publicly available data that it needs to calibrate its service offering, and additional data collection it will perform.
c. The Offeror shall plan to develop a base service for a minimum of a single sub-area of the NoVA region to pilot their service from the list below and expanded over time to include the other listed sub-regions for their full-service offering where data is sufficient based on the Vendor's review. Additionally, the final service offering shall be expandable to include the Southern Tier. As an example, sub-regions could be developed for this program which include corridors and hot spots in both NoVA and Metropolitan Fredericksburg, such as the following high priority corridors:

    1. I-95 corridor
    2. I-66 corridor
    3. I-495 corridor
    4. SR-267 corridor (Dulles Toll Road)
    5. Route 28
    6. Fairfax County Parkway
    7. Tyson's Corner
    8. Route 7
    9. Routes 29 and 50 in NoVA
    10. Route 1 in NoVA and Metropolitan Fredericksburg
    11. Routes 3 and 17 in Metropolitan Fredericksburg

    However**, Offeror shall provide its recommended sub-regions and phasing as part of its technical proposal.** Offeror shall present its recommendations and sequential rational to VDOT for approval.

Incident Prediction
A predictive service will be provided to calculate the risk of an incident occurring in the next 15 to 60 minutes (location, expected duration, severity) with a confidence interval per prediction (i.e., crash at location X in 30 minutes, 60% confidence). A minimum confidence interval will be configurable, and initially will be agreed to by the selected Offeror and VDOT for notification. Response plan rules may take the confidence interval into consideration when recommending whether a response plan is needed.

Congestion Prediction
A predictive service will be provided to calculate the risk of non-recurring roadway congestion and transit crowding occurring in the next 15 to 60 minutes (location and length of queue, expected duration) with a confidence interval per prediction. A minimum confidence interval will be configurable, and initially will be agreed to by the selected Offeror and VDOT for notification. Response plan rules may take the confidence interval into consideration when recommending whether a response plan is needed.

Parking Prediction
A predictive service will be provided to calculate the expected availability at individual commuter parking facilities within the region over the next 15 to 60 minutes. Predictions are to be generated **during the weekday AM rush hour and during special events identified by VDOT;** prediction is not required for other time periods. A minimum confidence interval will be agreed to by the Vendor and VDOT for notification.

Response Prediction
A predictive service will be provided to calculate the response plan elements and their expected impact/benefit for various events.

AI-DSS Interfaces
The AI-DSS software will use several types of data, both static and dynamic, provided by the DEP. The static data includes data which will not change very often, if at all, during the development and deployment of this project and its on-going operation. While a data set could be limited from the Data-Exchange Platform

(DEP), the Offeror is encouraged to identify supplemental necessary data (e.g., telematics, transit real-time crowding) as part of this proposal or recommend new data sources and priority of planned data sources into the DEP. **Proprietary data used by the selected Offeror for training and operation of its service will not be required to be shared with VDOT. However, it is requested that the metadata of the proprietary data be shared. Additional data sources from local agency systems will be added in the future.** It is expected that VDOT will provide historical data for AI-DSS calibration and training from the DEP to include data from the following sources:

Table 4: Data-Exchange Platform - Data Feeds Existing and Planned

DEP Data Feeds	Notes	Historical Data	Availability Schedule
Alexandria DASH Static GTFS (static GTFS data incl. Bus Lines, Routes, Stops, and Schedule)	**Bus**		
Arlington ART GTFS-RT (dynamic GTFS da**ta**)	**Bus**		
Arlington ART Static GTFS	**Bus**		
Arlington Co. - Traffic Signal System Active Timing	**Signal**		
Arlington Co. - Traffic Signal System Detector Data (ped)	**Signal**		
Arlington Co. - Traffic Signal System Detector Data (volume)	**Signal**		
Arlington Co. - Traffic Signal Location and Status Data	**Signal**		
Arlington Co. - Traffic Signal System Timing Plan Config	**Signal**		
Capital Bikeshare	**Bike**		
Fairfax Connector Static GTFS	**Bus**		
INRIX Traffic Data (speed and travel time)	**Roadways**	2018-07 to Present	Existing
Parking Lot Inventory	**Parking**		Sep. 2021
Parking Occupancy Data	**Parking**	2016, 2018, and limited 2019 & 2020	Sep. 2021
PRTC GTFS-RT	**Bus**		Mar. 2022
PRTC Static GTFS Data	**Bus**		Mar. 2022
Transurban Device Status	**Express Lanes**		Mar. 2022
Transurban Incident and Congestion Data	**Express Lanes**		Mar. 2022
Transurban Work Zone	**Express Lanes**		Mar. 2022
VDOT Signals - KITS	**Signal**		Mar. 2022
VDOT ATMS Device Status Data (DMS, CCTV, etc.)	**Interstate**	2015 – Present	Existing
VDOT ATMS Incident Data	**Interstate**	2013-03 – Present	Existing
VDOT ATMS Weather Events Data	**Interstate**	2013-03 – Present	Existing
VDOT ATMS Work Zone and Planned Events Data	**Interstate**	2013-03 – Present	Existing

DEP Data Feeds	Notes	Historical Data	Availability Schedule
VDOT Parking (Haymarket)	**Parking**		Dec. 2021
VDOT RWIS	**Weather**	5+ years data available outside DEP	Sep. 2021
VRE GTFS	**Train**		Sep. 2021
VRE GTFS-RT	**Train**		Sep. 2021
VRE Incident and Alerts	**Train**		
VRE Parking Data	**Parking**		Sep. 2021
Waze Incidents	**Roadways**	2016-12 to Present	Sep. 2021
Waze Work Zones	**Roadways**		Sep. 2021
WMATA Bus non-GTFS Incident	**Bus**		Dec. 2021
WMATA Bus Static Data	**Bus**		Dec. 2021
WMATA Bus GTFS-RT Data	**Bus**		Dec. 2021
WMATA Parking	**Parking**		Dec. 2021
WMATA Rail Non-GTFS Incident	**Metro Rail**		Dec. 2021
WMATA Rail Static Data	**Metro Rail**		Dec. 2021
WMATA Rail Station Arrival Data	**Metro Rail**		Dec. 2021

Offeror shall identify any gaps in data types needed for their service offerings, as part of its proposal, and identify any data sources the Offeror can provide to fill some of those gaps. Data currently available from the DEP for evaluation during the proposal phase is shown in Table 4. Offeror may recommend and use other data sources that it has access to for evaluation and service offering calibration.

Dynamic data includes data that have an impact on current operations, such as real-time traffic conditions, current location of bus and train vehicles, and items which change rapidly and will assist the operators of the network in making decisions.

Both static and dynamic data types will be important to operational activities in the region and will drive the response selection of the AI-DSS.

As discussed previously, the AI-DSS will utilize the existing static data, events, and performance data in determining response plan recommendations for the operational agencies. Once a response plan is recommended, the AI-DSS will provide a feedback loop to the affected stakeholders through the Agency Interface (see below). The impacted stakeholders, including the DI vendor, will provide a response (agree, modify, or disagree) for the request and provide this response back to the AI-DSS.

Agency Interface

The purpose of the Agency Interface is to provide the Application Programming Interface (API) for integrating with the Agency's transportation operational systems and the RM3P Data Exchange Platform (DEP), and the Graphical User Interfaces (GUI) needed for the **coordination of responses** to incidents, construction, and special events. The Agency Interface is the presentation layer for the AI-DSS in simplest terms, along with the interfaces and APIs for stakeholder agency systems. Stakeholder agencies will have the option to interface the AI-DSS with their operational systems outside the scope of this project. Additionally, a notification system to include e-mails and text messages shall be provided to allow notifications to stakeholders for various alarms, actions, and requests from the AI-DSS.

A. Technical Requirements

The technical requirements for the potential AI-Based DSS components are identified in *Appendix A.* The requirements are a composite of requirements based on the needs identified by stakeholders, and potential technologies that could be used by the selected Offeror.

B. VDOT Responsibilities

VDOT will be responsible to:

- Designate a project manager.
- Form a project oversight committee to guide and advise the project.
- Facilitate partnering with operation and incident responders and other relevant agencies.
- Provide existing documentation in VDOT's possession on the equipment and systems required to interface with the AI-DSS.
- Approve Offeror's access to the DEP. Coordinate the documentation for an interface with other projects. Acquire an Interface Control Document from other projects such as the DEP, DI, and CPIS project, if required.
- Provide priority input and participate in solution elaboration, Agile sprint planning, sprint demonstrations, integration, acceptance testing and implementation, training, and technical standups.
- Review, comment, and approve the documentation and other deliverables.
- Monitor the project's implementation progress and schedule.
- Establish performance metrics to be monitored by the AI-DSS system.
- Provide facility access and staff support.
- Participate in requirements reviews, integration testing, acceptance testing, implementation, training, and status meetings.
- Coordinate between Vendors of the other RM3P Program Element systems, particularly the DEP, DI, and CPIS systems.

C. General Obligations of the Selected Prequalified OFFEROR:

The selected Offeror awarded a contract as a result of the RFP and its subcontractors will be responsible to:

- Designate a project manager and key project team members.
- Provide a resource-loaded Microsoft Project Schedule.
- Utilize an Agile System Development Methodology approved by VDOT.
- Provide detailed system design and integration with complete system design documentation.
- Use a cloud-hosting provider approved by VITA or use the VITA ECOS approval process, prior to contract notice to proceed.
- The proposed approach shall comply with the Commonwealth Enterprise Architecture (EA) policies (EA 200) and standards (EA 225) as published by VITA at https://www.vita.virginia.gov/policy--governance/itrm-policies-standards/.
- The Offeror shall review and comply with all relevant Commonwealth Adopted Data Standards. A complete list of all adopted data standards is published at: https://www.vita.virginia.gov/media/vitavirginiagov/it-governance/psgs/pdf/COV_Adopted_Standards.xlsx.
- Test all functional capabilities of the service.
- Provide network and workstation security for service.
- Provide all training/maintenance materials, submittals, and documentation to VDOT.
- Implement a rigorous, structured integration methodology.
- Implement a rigorous configuration and change management system.
- Train VDOT-designated personnel.
- Project management and control, including leading periodic progress meetings with (and reporting to) VDOT.

- Maintenance and support of their DSS service for the duration of the contract.
- Provide warranty services for the duration of the contract.
- Create and maintain a project file-sharing site during the contract period to:
  - Update project progress,
  - Post documentation, and
  - Post meeting agendas, minutes, and action items.
- Provide all necessary data to VDOT's independent evaluator.

D. Overview of the Project Approach

Methodology

Innovation is one of the primary principles of the AI-DSS solution, and VDOT will provide an environment where vendors have the flexibility to pursue innovative approaches to problems. However, VDOT is committed to deliver certain functionality on a fixed budget within an established timeframe. To meet both of these objectives, VDOT's expected approach is an Agile/Waterfall Hybrid methodology. The approach is intended to establish fixed boundaries within which the project will operate, but allow maximum flexibility within those boundaries. Figure 2 shows the overall process.

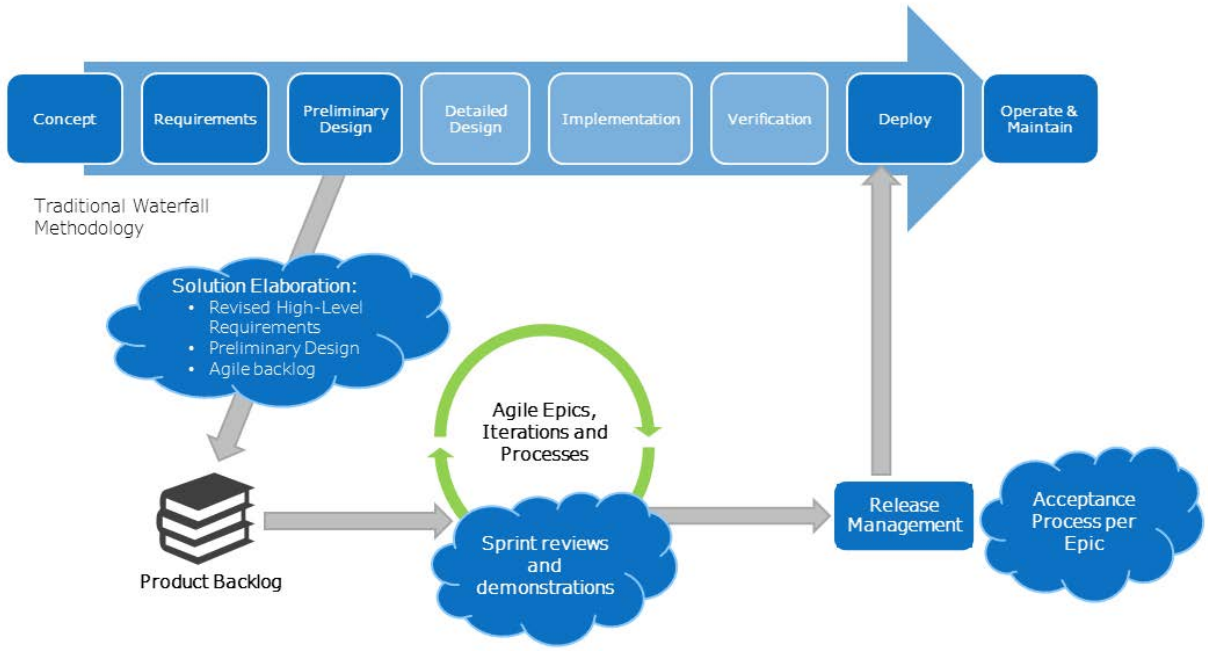

Figure 2: Agile/Waterfall Hybrid Process

Steps already completed by VDOT and other stakeholders

The concept has already been developed and is described within Appendix A to this document. Similarly, the high-level requirements have been prepared and are attached in Appendix A. However, the requirements are not as detailed as those necessary for a Traditional Waterfall approach since there is no expectation for a full Waterfall systems engineering approach.

The goal of these requirements is to give vendors a clear understanding of the minimal functionality for the system so they can consider resources and capabilities necessary to deliver within budget and schedule constraints.

Solution Elaboration

One of the first phases of the project will be solution elaboration. This phase will be carried out jointly by the vendor and VDOT and will serve as the transition from the Waterfall method to the Agile method. There are key deliverables within this phase:

- Revised high-level requirements: The requirements will be updated to provide additional detail and to take advantage of features available from vendor COTS products or special capabilities. The goal of this document is to provide mutual assurance to both VDOT and the vendor that the solution can be delivered on time and within budget. Detailed requirements will be amended to the requirement document throughout the Sprint development process. It will also serve as the foundation of the Requirements Traceability Matrix which will be used to verify deliverables.
- Conceptual design: This document will describe the following aspects of the system:
    - High-level logical architectures –Identify the major components of the system and how they interact (including components in other RM3P program elements.)
    - Data flows for major use cases – Identify what types of data flow to which components through the workings of the system. This will not include detailed data formats, but should identify the nature of all data exchanges.
    - Plans or mockups of user experience for major workflows. This will give VDOT a clear picture of the user experience.
- Initial Product Backlog: This document will describe the software that will need to be developed over the duration of the project, including additional functionality, data interfaces, and services being provided. The goal of this document is to mitigate risks which might endanger delivery:
    - The schedule does not have enough time to cope with re-architecting or major re-factoring. Architectural issues must be thoroughly examined and resolved early.
    - Changes to data flows or locations of data residence (particularly regarding personally identifiable data) may force a revaluation of the project data management processes per VDOT policy.
    - Having a clear picture of the user experience will establish boundaries for all stakeholders and reduce scope creep.

The selected Offeror/Vendor will be responsible for these deliverables, but VDOT will work closely with the Vendor and stakeholders to provide inputs, reviews, and approvals. A critical goal of the solution elaboration phase will be to clearly communicate and document which requirements and features must be delivered within the given schedule and budget. Additional requirements and features may be described as well, but both the revised requirements and the preliminary design document should clearly distinguish between the ”must haves” and the recommended.

Development

The Vendor will use the deliverables from the solution elaboration phase to develop the agreed to system. VDOT expects that the Offeror will use industry best practices for Agile development and the preferred framework is Scrum. VDOT expects that the Vendor will provide the following:

- Visibility into the product backlog and its current state.
- Access to the current sprint schedule, including epics and (if determined) user stories for each sprint.
- Regular VDOT participation in sprint reviews.
- Any modifications to the requirements arising from the Agile process must be documented through a process agreed to by VDOT and the Offeror.

Agile Principles

VDOT fully embraces the principles motivating the Agile approach and places particular priority on the following:

- Flexibility to Change: Innovation cannot be perfectly planned in advance. The AI-DSS solution will break new ground, and VDOT and the Offeror need to be prepared to learn and adapt along the way.
- Communication: Candid and effective communication between the Offeror and all stakeholders is a foundational element for a successful project.

- Performing Software: While the AI-DSS solution will be innovative, it is not a research project or a pilot. It is critical that the software is reliable and performant.
- Being Lean: VDOT will work with the Offeror to identify which requirements and features are absolutely essential and ensure that the solution fulfills them.
- Continuous Improvement: The consumer environment and expectations are constantly evolving. To remain relevant and effective, the solution must also be able to continuously evolve and improve.

Release Management

VDOT expects that, per the Agile methodology, there will be multiple releases of the system as new functionality is added. However, major releases will be tied to payment milestones and will require a formal acceptance and release management process. For those milestones VDOT expects the vendor to provide the following:

- Acceptance test plan.
- Acceptance test scripts.
- Requirements Traceability Matrix.
- Perform tests under VDOT observation.

For non-milestone releases, VDOT will work with the vendor to determine the best and most efficient process for verification and regression testing.

E. Project Tasks

The expected tasks for the AI-DSS include:

- Task 1: Project Management
- Task 2: Solution Elaboration
- Task 3: System Build and Integration
- Task 4: Service Enablement
- Task 5: System Training
- Task 6: Warranty Support and Operations
- Task 7: ATCMTD Documentation and Administrative Support

Task 1 – Project Management (Offeror)

At a minimum, the selected Offeror's/Vendor's project manager will be responsible for:

- Organizing a project team and managing the team members.
- Providing periodic updates, every 3 months at a minimum, to the work plan and schedules. Changes to the work plan and schedules that exceed 10 percent of the baseline require approval by VDOT through a change management process.
- Submitting monthly project status reports detailing the following:
    - A brief overall project status in 3-5 sentences.
    - Action item updates from the previous meetings.
    - Technical activities and accomplishments during the preceding month.
    - Accomplishment vs. schedule.
    - Technical problems or other issues.
    - Schedule status.
    - Critical path issues.
    - Spending to date, spending vs. percent complete.
    - Plans for the upcoming month.
    - Offeror performance assessment and supporting details.
    - Risk management status.

Management Reports
VDOT requires the deliverables indicated below from the Vendor, in order to monitor progress and ensure compliance:

- Project Management Plan
- Service Development Plan
- Change Management Plan
- Data Management Plan

Project Management Plan
The selected Offeror/Vendor shall develop a Project Management Plan (PMP) which, at a minimum, includes the following sections:

a) *Scope* – The Vendor will provide an overview of the scope of the service offering, including descriptions of all deliverables.

b) *Staffing Plan* – The Offeror will identify the key individuals to be involved in the project during negotiations and indicate in the staffing plan the number of personnel assigned to each element of the Tasks. A key individual is defined as a person who is a task leader or individual contributor with specialized knowledge applicable to the project. Any changes to key personnel on the project will require notification and approval by VDOT. Offeror shall maintain a personnel transition plan for key roles and staff with plans for replacement of personnel over the life of the project. Offeror shall ensure staff availability to meet the scope, schedule, and budget of its proposed solution.

c) *Detailed Schedule* – The Vendor shall develop a baseline schedule in Microsoft Project based on the WBS and the initial 3-month work plan. This will be described in and referenced by the Detailed Schedule Section. The Project Schedule will be delivered as a separate deliverable.

d) *Risk Management Plan* – The Vendor shall develop a risk management plan that identifies initial project risks and possible ways to mitigate those risks. The Vendor shall report on the status of each identified risk in the monthly progress report until that risk is fully mitigated. Risks shall be classified as: 1) cost, 2) schedule, and/or 3) scope. Even though the contract is limited to a maximum budget; task budget, scope, and schedule may be adjusted through an amendment process. It is critical that the Vendor keep VDOT informed of any potential impacts to cost allocations and what steps the Vendor is taking to mitigate the cost impact. It is in VDOT's best interest for the Vendor to meet its cost and schedule commitments, and VDOT will actively support the Vendor in achieving those commitments. When new risks are identified, revision to the pertinent section in the Risk Management Plan shall be issued.
    - The Vendor shall, at a minimum, address the following potential risk areas:
        - Development of new software modules
        - User adoption
        - Platforms for integration and testing
        - Stability of cloud hosting alternatives
        - System security

e) *Requirements Traceability Verification* Matrix – The Vendor shall develop a Requirements Traceability Verification Matrix to map the functional requirements to their service offering.

f) *Document Management Plan* – The Vendor shall provide a plan to manage the creation, versioning, and publishing of documents to include the identification of documents that will be iteratively developed during the project's Agile Development process.

Project Risk Register
The Risk Management Plan section in the Project Management Plan shall describe how risks are managed; the Project Risk Register will identify risks and be updated throughout the project. The Project Risk Register will be maintained online with a tool, such as a SharePoint, so the project team and the management team can work with this register collaboratively.

Project Schedule
The Vendor shall develop and maintain a detailed schedule in Microsoft Project based on the WBS and each 3-month work plan that, at a minimum, identifies:

1. Milestones – including those tied to payments
2. Earliest start dates for tasks
3. Latest start dates for tasks
4. Earliest finish dates for task
5. Latest finish dates for tasks
6. Schedule float time in days
7. Duration of tasks in days, where the minimum increment is one day
8. Task names and task numbers
9. Resource loading
10. Critical path information

VDOT anticipates there will be changes to the schedule as the project progresses. The initial schedule should cover the first six months of the project in detail, and the remainder of the project in broader strokes. The Project Schedule shall be updated by the Offeror as needed, but no less frequently than once every 3 months. Updated schedules shall be submitted to VDOT for review.

Change Management Plan
The Vendor shall prepare and deliver a *Change Management Plan (CMP)* that defines what and how changes will be triggered, requested, reviewed, approved, and scheduled that impact the scope, schedule and budget of their service and may require a contract modification. Any change request proposing a contract modification will require the VDOT Contract Officer's approval. The draft CMP shall be submitted to VDOT within 30 calendar days of NTP. The final CMP will be due within 10 calendar days of receipt of VDOT's comments on the draft document.

Data Management Plan
The Offeror shall prepare and deliver a Data Management Plan (DMP) which describes the solution approach to data storage, governance, and retention outside the DEP. It will describe any security measures and user protections for Personally Identifiable Information (PII) that is part of the system and will adhere to relevant Commonwealth laws and policies. The draft DMP shall be submitted to VDOT within 30 calendar days of NTP. The final DMP will be due within 10 calendar days of receipt of VDOT's comments on the draft document.

Project Management Meetings
The Vendor shall organize and host the following administrative meetings. In-person or virtual meetings will be held, as follows:

- Kickoff Meeting
  - The kickoff meeting shall occur within 30 days of Notice-to-Proceed for the project.
- Monthly Status Meetings
  - The Vendor shall provide monthly status to VDOT via virtual or in-person meeting/teleconference.
- Weekly Standup Meetings
  - To address technical matters as input to the Scrum Masters and Product Owners. (During the week that the Monthly Status Meeting is scheduled, the two meetings can be combined.)
- Project Closeout and Post-Mortem Meeting
  - Near the end of the project, the Vendor shall provide a project closeout and post-mortem meeting to provide lessons learned from each phase of the project.
- Meeting agenda shall be provided 3 business days prior to all meetings.

- Meeting supporting materials (i.e., Presentation slides) shall be provided at least 1 business day prior to all meetings.
- Meeting minutes with action items shall be provided within 3 business days after all meetings.

Transmittal of Deliverables

Developed Document Deliverables
Document deliverables are an important tool to contain work plans, products, and important decisions made between VDOT and the Vendor and shall conform to the following process for consistent, timely development.

Document Deliverable Process

1. The Vendor and VDOT agree on deadlines for the document deliverable submittal activities (described below) that fit within and are to be integrated into the project schedule.
2. The Vendor will submit the completed document according to the submittal procedure below.
3. The Vendor shall provide a finalized document after all comments have been completed by the deliverable final due date. A final document shall have the DRAFT watermark removed and the version number of the document incremented to the next whole number.
4. VDOT shall mark the document as final in the document library and email the Vendor that the final document has been accepted.

Document Deliverable Submittal and Review Procedure:

1. The Vendor shall deliver each draft deliverable in an editable format, such as Microsoft Word, to VDOT by the draft deliverable due date.
2. VDOT will review the deliverable and provide comments to the Vendor by the deliverable review due date. Comments will be provided as comment balloons and tracked changes if using Microsoft Word; else, a comments table will be developed by the Vendor which will track each comment's text, reference location within the deliverable, and a place for the Vendor's response, and a status of the comment.
3. The Vendor will address comments by modifying the submittal and answering questions by the revision due date. Changes to the deliverable shall be tracked using the tracked changes feature of Microsoft Word if the deliverable is in that format; otherwise, a list of changes made to the deliverable shall be provided with the comments' responses.
4. VDOT shall review the Vendor's responses and deliverable changes by the revision review due date. All comments shall be marked as completed using the "Mark as Completed" function of the comment balloon if using Microsoft Word; otherwise, satisfactory completions shall be acknowledged in the comments table.
5. Steps 3 and 4 will repeat until VDOT marks all comments as completed.

Task 2 – System Development Planning
The Offeror shall provide its proposed AI-DSS service using an Agile System Development Process. Project files shall be set up and overall coordination of staff and all agencies involved will be maintained. The goal of this task is to complete everything needed to put system developers in a position to work efficiently to build the system.

The selected Offeror/Vendor will work with VDOT to enhance the system requirements, adding detail and revisions to take advantage of Vendor capabilities. This will be a dialogue between VDOT and the Vendor that will culminate in an updated system requirements document. The Offeror will conduct a requirements walkthrough with VDOT and its representatives to ensure that both have a common understanding of what will be built and what capabilities the system will include. VDOT has sole discretion of the acceptance of any changes to the requirements.

The Vendor will create the initial iteration of the System Design Document (SDD). The goal is that throughout the project the Vendor will add detail to the SDD so that when the project is complete there is a full and coherent description of the system. The intent is NOT to develop a detailed design prior to development; the SDD will ultimately serve as an as-built document. However, VDOT does want the Vendor

to write and update the document during the project, rather than after the work is complete. Throughout the life of the project, the SDD will serve as a record of what has been established and achieved to date by VDOT and the Vendor. At this stage, the SDD will describe the:

- Logical architecture of the system as a whole.
- General purpose of each component.
- Implementation technology.
- Deployment environment.
- Connectivity to other components.
- Major data flows and use cases utilizing the component.

The Vendor will use the requirements, solution architecture, and high-level design document to develop the initial product backlog. An additional asset available during this process are the use cases already developed by VDOT and other stakeholders. Many of these can lead directly to the development of user stories.

The system elaboration tasks include:

System Requirements Specification
The Vendor shall conduct a requirements walkthrough with VDOT and its representatives to ensure that both have a common understanding of what will be built and what capabilities the system will include. VDOT has sole discretion on the acceptance of any changes to the requirements.

- After this walkthrough is completed, the Vendor shall update the System Requirements Specification with agreed changes and clarifications made during the requirements walkthrough.

AI-DSS Software as a Service Development Plan
Vendor shall develop a detailed AI-DSS Software as a Service Development Plan (SDP) for review and approval by VDOT for their base, expanded, and final services. The elements of the plan will include:

- Network Development – The SDP will define how the Vendor plans to use the available data to build the network geometry within the selected area for their prediction and evaluation services. In order to allow the prediction service to line up with the largest amount of systems it is anticipated that any existing transportation network models may be leveraged. All imports, and the processes used will need to be listed, and clearly defined. Any piece of the network that could not be created from available models must be clearly identified in the Gap Analysis along with the associated data needs.
- Network Calibration Criteria – The SDP will provide the details to how the network shall be calibrated to correctly represent the real-world operations and capacities. This will include types of data to be used for calibration, and techniques for data adjustment and calibration prior to real-time operation. This is to ensure that a sufficient level of calibration is being planned and that it meets with the accepted practices, at a minimum following the calibration standards and techniques in VDOT's latest Traffic Operations and Safety Analysis Manual (TOSAM), any deviations to TOSAM must be identified during the planning phase. The calibration plan must be approved by VDOT prior to implementation.
- AI-DSS Validation Criteria – As a key part to any AI-DSS creation, it is important to document and agree on the MOEs and their targets that will show that the AI-DSS is valid. These values typically reference the quality of the AI-DSS to represent the roadway flows, travel times and overall queue, and are done both statistically and visually. MOE targets will be proposed by the OFFEROR for review and approval by VDOT.
- Gap Analysis – Vendor will identify any gaps in the existing historical data provided by the DEP and work to address the severity of the gap, the impact of the gap and any potential solutions. It is likely that pieces of network may not be available in the existing transportation network models, and should be identified as part of the gap analysis.
- Service Scope Planning – Vendor will identify their phased service offering for their Base, Expanded, and Final service offerings which may include the following:

a. Base Service – Vendor shall deploy a base service for prediction of incidents, congestion and parking availability for a minimum of one sub-region of the Northern Tier. This service will also include response plan elements for this sub-region, and a dissemination process to notify stakeholders when response plans should be enacted. This base service is expected to be operational no later than 12 months after NTP.

b. Expanded NoVA Service – Vendor shall expand its service for the additional Northern Tier sub-regions identified in its proposal. It is expected this can be partially completed 18 months after NTP and all sub-regions 24 months after NTP.

c. Metropolitan Fredericksburg Service – Vendor shall expand its service to the Southern Tier. This service is expected to be operational no later than 24 months after NTP.

- Epics Development Plan – Vendor shall identify the functionality and sprints required for the development of each level of their service identified in the Service Scope Planning. At the conclusion of each sprint and Epic, the Vendor shall provide test results to VDOT on whether the sprints were successful and indicate any risks to the schedule developed.

Task 3 – System Build and Integration
The AI-DSS should be built and integrated using an Agile Design and Development process for software development tasks. The selected Offeror/Vendor will identify the process for each component of its proposed solution. Once all system components and services have been developed or deployed, the full AI-DSS system integration will be performed to ensure all components and services work together.

VDOT anticipates that the Vendor will use an Agile development process and supports this approach, provided the Offeror understands that the final delivery dates for this project are firm. VDOT expects to be informed of the epic/sprint schedules and to participate in sprint review meetings periodically. VDOT further expects the Vendor to organize weekly standups with VDOT's selected personnel to provide input to epic/sprint activities. This schedule shall be reported in the form of an Agile Epic/Sprint Development Plan and will be updated as appropriate. Alternatively, the Vendor may provide VDOT visibility into the sprint management dashboard.

The Vendor will be responsible for demonstrating to VDOT that development is progressing according to the schedule. VDOT and/or designated representatives from the oversight committee expect to take part in epic/sprint reviews regularly.

The Vendor shall propose an EPIC schedule at the outset of development. Since the proposed solution could include several potential technologies, the EPICs schedule will be a mixture of traditional engineering tasks (response plan workshops and creation), configuration of services, and Agile-based development.

The following are the expected subtasks VDOT has identified for developing the AI-DSS. However, depending on the technological approach the Offeror proposes, these tasks may be updated as part of its approach to doing this work.

Task 3A – Develop Response Plans
This subtask consists of using existing agency response plans, SOPs, and stakeholder workshops to develop response plan elements and rules for responding to various actual and predicted events within the RM3P region. These response plans should be developed in support of the corridors and hot spots proposed by the Offeror for its SaaS. VDOT expects that response plans will be developed for times of day (AM Peak, PM Peak, off-peak, and special events) and for various congestion levels. Since this task does not include development of a software or system, Vendor will not be required to use an Agile approach.

Response plan elements are to be evaluated by the Vendor using either an offline model, or its prediction engine technology to develop expected benefits for each response plan element for a typical scenario associated with the response plan (ex. Crash on EB I-495 south of US50 during the AM Peak with 2 miles of congested queue.) The evaluation tool shall be provided to VDOT as part of its service offering. This service can be an offline model or as part of its SaaS. The software packages for the offline models shall be identified as part of the AI-DSS SDP and approved by VDOT.

Based on the workshops and the response plans developed, the Vendor shall develop criteria for selection which can be used as part of the logic for the Response Engine development in Task 3B.

Once the Vendor has prepared the response plan elements, criteria for selection, and typical benefits, a workshop with VDOT and stakeholder operations will be performed to present the response plans and elicit feedback. Vendor will use the feedback to update and establish a baseline set of response plan elements, and criteria to be used in the development of Task 3B. This workshop may be repeated by the Vendor for each corridor/hot spot proposed as part of its service offering. At a minimum, it is expected that a workshop for the Northern Tier and one for the Southern Tier will be provided.

Task 3B – Implement Response Engine
This task will develop and implement a response engine through a minimum of three iterations of its service (base RM3P, expanded RM3P, Metropolitan Fredericksburg expansion). Vendor shall use the response plan elements and criteria developed in Task 3A as the basis for the logic and response of its Response Engine service.

Solution Elaboration
VDOT must have a clear picture of the user experience early in the process. The Vendor will prepare information on all of the following items which were not already described during Task 3:

- User interface screens for solution management functions (wireframes or other graphics.)
- Workflows, use cases, and/or user stories for major system tasks.
- Descriptions or examples of system reports.
- Additional detail for shared services Interface Control Document (ICD), e.g., identify individual data elements for those functional data exchanges identified in Task 3.

The Vendor will create and update a System Design Document (SDD) during development with all new information. VDOT and the Vendor will review the SDD updates together and confirm that the user experience is on the right track. It is understood that there may be modifications to the design throughout the Agile development process. This review serves as a checkpoint about the user experience.

Agile Development
VDOT anticipates that the Vendor will use an Agile development process and supports this approach, provided the Vendor understands that the final delivery dates for this project are firm. VDOT expects to be informed of the epic/sprint schedules and to participate in sprint review and sprint planning meetings periodically. If VDOT is not satisfied with the sprint review/planning process, then VDOT will request, and the Vendor will organize brief weekly meetings with VDOT's selected personnel to cover epic/sprint activities. This schedule shall be reported in the form of an Agile Epic/Sprint Development Plan and will be updated as appropriate. Alternatively, the Vendor may provide VDOT visibility into the sprint management dashboard.

The Vendor will be responsible for demonstrating to VDOT that development is progressing according to the schedule. VDOT and/or designated representatives from the oversight committee expect to take part in epic/sprint reviews regularly.

The Vendor should propose an epic schedule at the outset of development. VDOT's notional schedule for this task includes:

- Epic 1: Data integration, workflow, and logic for selection of a response plan
- Epic 2: User interface and application programming interfaces
- Epic 3: AI-DSS base service
- Epic 4: Expanded AI-DSS service
- Epic 5: Metropolitan Fredericksburg expansion service

Deployment and Acceptance
The Vendor will provide at least two system environments (production and pre-production). The pre-production environment will be identical to the production environment and will be used for testing and training.

The Vendor will deploy the working solution to the pre-production environment and complete testing and acceptance. Once this is complete and accepted, the Vendor will migrate the solution to the production environment and validate its operation.

The solution will be used by the agency operators, so it is critical that the solution is available and functioning correctly. Once the solution is launched, the Vendor will be responsible for ensuring that the solution is functionally operational 99.9% of the time. Planned outages will not count towards total downtime.

VDOT expects that working software will be deployed to the production environment at the conclusion of each epic per the release management processes.

When new functionality is deployed to the production environment, the Vendor will prepare an Acceptance Test Plan for approval by VDOT. The acceptance testing will cover:

- Functional conformance with all requirements
- User experience
- Stress testing

The test plan will describe the schedule, environment, staff, and dependencies for the testing effort. Stress testing can make use of automated test systems.

The Vendor will prepare Acceptance Test Scripts. The scripts will have detailed instructions for running all tests. The Vendor will prepare a Requirements Traceability Matrix, associating requirements (using revised requirements from Task 3) with test scripts.

VDOT and the Vendor will conduct the tests together in the pre-production environment. Any failures or issues identified during testing will be logged and corrected by the Vendor. VDOT will work with the Vendor to verify corrections for issues identified during testing.

The Vendor will work with VDOT to determine the most thorough and efficient way to verify that the release does not introduce any regressions.

Deliverables

1. Solution Elaboration
    a. User interface wireframes or graphics
    b. Workflows and user stories
    c. Updates to SDD and user experience checkpoint
    d. Updated ICD
2. Agile Development
    a. Agile Epic/Sprint Development Plan
    b. Epic/Sprint Review and Planning Meetings
    c. Weekly Epic/Sprint activity meetings if requested
3. Acceptance
    a. Working solution for pre-production environment
    b. Verified solution in production environment
    c. Acceptance Test Plan
    d. Acceptance Test Scripts
    e. Requirements Traceability Matrix
    f. Acceptance Testing
        i. User Experience Testing
        ii. Stress Testing
        iii. Requirements Conformance
4. Task Closeout
    a. Training Materials

Task 3C - Implement Prediction Engine

This task will develop and implement a Prediction Engine for predicting incidents, congestion, and parking availability. As previously stated, Vendor shall develop a base service for a minimum of a single sub-area of the NoVA region to pilot their incident and congestion prediction service and expand their service offering over time to include the other sub-regions for their full-service offering where data is sufficient based on the Vendor's review. For parking prediction, Vendor shall propose grouping NoVA parking lots into "base" and

"expanded" services, with Metropolitan Fredericksburg area lots as the lowest priority in the expanded services category. These groupings can be based on available real-time and/or historical parking data. The vendor will identify corridors and hot spots with insufficient data and identify additional data that it needs or can obtain to improve the accuracy of its prediction service. Vendor shall present the selection and sequential rational to VDOT for approval.

Solution Elaboration
VDOT must have a clear picture of the user experience early in the process. The selected Vendor will prepare information for the following items for the prediction service:

- User interface screens for solution management functions (wireframes or other graphics).
- Workflows, use cases, and/or user stories for major system tasks.
- Descriptions or examples of system reports.
- Additional detail for shared services Interface Control Documents (ICD) (e.g., identify individual data elements for those functional data exchanges identified in Task 3).

The Vendor will create and update a System Design Document (SDD) during development with all new information. VDOT and the Vendor will review the SDD updates together and confirm that the user experience is on the right track. It is understood that there may be modifications to the design throughout the agile development process. This review serves as a checkpoint about the user experience.

Agile Development
VDOT anticipates that the Vendor will use an Agile development process and supports this approach, provided the Vendor understands that the final delivery dates for this project are firm. VDOT expects to be informed of the epic/sprint schedules and to participate in sprint review and sprint planning meetings periodically. If VDOT is not satisfied with the sprint review/planning process, then VDOT will request, and the Vendor will organize brief weekly meetings with VDOT's selected personnel to cover epic/sprint activities. This schedule shall be reported in the form of an Agile Epic/Sprint Development Plan and will be updated as appropriate. Alternatively, the Vendor may provide VDOT visibility into the sprint management dashboard.

The Vendor will be responsible for demonstrating to VDOT that development is progressing according to the schedule. VDOT and/or designated representatives from the oversight committee expect to take part in epic/sprint reviews regularly.

The Vendor should propose an epic schedule at the outset of development. VDOT's notional schedule for this task includes:

- Epic 1: Data integration and interfaces, training of the prediction engine for base corridor
- Epic 2: Application Programming Interface and integration into Operations GUI
- Epic 3: Base AI-DSS prediction service
- Epic 4: Expanded AI-DSS service
- Epic 5: Metropolitan Fredericksburg expansion service

Deployment and Acceptance
The Vendor will provide at least two system environments (production and pre-production). The pre-production environment will be identical to the production environment and will be used for testing and training.

The Vendor will deploy the working solution to the pre-production environment and complete testing and acceptance. Once this is complete and accepted, the Vendor will migrate the solution to the production environment and verify it there.

The solution will be used by the agency operators, so it is critical that the solution is available and functioning correctly. Once the solution is launched, the Vendor is responsible for ensuring that the solution is functionally operational 99.9% of the time. Planned outages will not count towards total downtime.

VDOT expects that working software will be deployed to the production environment at the conclusion of each epic per release management processes.

When new functionality is deployed to the production environment, the Vendor will prepare an Acceptance Test Plan for approval by VDOT. The acceptance testing will cover:

- Functional conformance with all requirements
- User experience
- Stress testing

The test plan will describe the schedule, environment, staff, and dependencies for the testing effort. Stress testing can make use of automated test systems.

The Vendor will prepare Acceptance Test Scripts. The scripts will have detailed instructions for running all tests. The Vendor will prepare a Requirements Traceability Matrix, associating requirements (using revised requirements from Task 3) with test scripts.

VDOT and the Vendor will conduct the tests together in the pre-production environment. Any failures or issues identified during testing will be logged and corrected by the Vendor. VDOT will work with the Vendor to verify corrections for issues identified during testing.

The Vendor will work with VDOT to determine the most thorough and efficient way to verify that the release does not introduce any regressions.

Deliverables

1. Solution Elaboration
    a. User interface wireframes or graphics
        i. Workflows and user stories
    b. Updates to SDD and user experience checkpoint
    c. Updated ICD
2. Agile Development
    a. Agile Epic/Sprint Development Plan
    b. Epic/Sprint Review and Planning Meetings
    c. Weekly Epic/Sprint activity meetings, if requested
3. Acceptance
    a. Working solution for pre-production environment
    b. Verified solution in production environment
    c. Acceptance Test Plan
    d. Acceptance Test Scripts
    e. Requirements Traceability Matrix
    f. Acceptance Testing
        i. User Experience Testing
        ii. Stress Testing
        iii. Requirements Conformance

Task 4 – Service Enablement

The selected Offeror/Vendor shall deploy the AI-DSS into its VITA-approved production cloud environment, based on the Release Management Plan. This plan shall, at a minimum include:

- Deployment Diagram – Provide and describe a figure that depicts where all system products will reside within the operational site(s), and how they can be accessed by VDOT and their partners.
- Verification of Installation – Complete unit testing showing installation and service start-up was successful.

The Vendor shall conduct a service readiness meeting with VDOT prior to enablement of the SaaS solution, for verification and validation of the service.

Task 5 – System Training

The selected Offeror/Vendor shall develop training plans, perform training, and provide training materials for operations and maintenance of the AI-DSS. The Vendor shall provide training as early as it can be

scheduled after each service implementation milestone is reached. Training materials will be provided to trainees to include an updated description of system functions, application procedures, and error troubleshooting guides including contingencies and/or alternative modes of operations (backup plan). This will include providing Updated End-User Training Materials, and Updated Technical User Manuals. Training will be provided using scenario-based training for operators of the AI-DSS service. In-person training is preferred and will be recorded and available online for viewing at a later time. The training tasks include:

Training Plan
Vendor shall develop a Draft Training Plan, which will describe how the system operators and users will be trained prior to operation of the system and on-going training for routine scenario-based training. The draft plan will be provided to VDOT for review and comment. Once comments are addressed, a Final Training Plan will be developed.

Training Schedule
As part of the project schedule, a high-level training schedule shall be included.

Training Manuals
Vendor shall develop and provide the Training Plan, Training Schedule, and Training Manuals corresponding to the subsystems being built, prior to System Testing and Acceptance.

Training Workshop
The Vendor shall provide a training workshop (in-person and virtual formats) for each subsystem being provided as part of the AI-DSS. Scenario-based training will be used to train operators on the AI-DSS.

Task 6 – Warranty Support and Operations
The selected Offeror/Vendor shall provide operational support of its service during the warranty period and any subsequent operations and maintenance periods. The services provided during this period shall include:

- Improvements to the accuracy of the prediction service (i.e., training with new data sources)
- Updates and creation of response plans and associated criteria
- Monthly Reports via online dashboard to include:
    - Prediction accuracy for each type of service (incidents, congestion, parking)
    - Response plans implemented and results (expected versus actual)
    - Issues with service and resolution
    - Risks to the service accuracy (e.g., Pandemic, major construction projects, etc.)

Additionally, technical support shall be provided via phone and/or email during the warranty and operational period. The Vendor shall provide the appropriate staff to respond and support the AI-DSS with the following support in accordance with agreed to Service Level Agreements:

- An on-call support phone number shall be made available to VDOT for all support calls. Support staff will be available, as needed, 24-hours per day, seven-days per week, year-round. Support calls will have a 30-minute response time. Calls made to the support number shall be routed to the appropriate staff as described below.
- Issues reported to the on-call support phone number will be entered as new issues into the offeror-provided issues tracking system by the Vendor's support staff. The support staff will provide the caller with insight as to how long it will take to resolve the issue. The Vendor will estimate the time required to address the issue in its response.

The following tiered support staff shall be available and respond to issues:

As part of standard operations and maintenance support, the Vendor will have support staff on call to address system issues and usage questions encountered by users. Users can initiate a support ticket with support staff available 24/7, and triage support request to Tier 1 and Tier 2 support teams on the following schedule (all times Eastern):

Daytime peak-period support, Monday-Friday, 5:00AM-9:00AM ET and 3:00PM-7:00PM ET

- Emails received during peak-period support hours will be acknowledged and responded to within thirty (30) minutes. Support requests that will be worked on immediately during this time include basic questions about AI-DSS usage, bug reports or issues with AI-DSS usability. If a bug report

or usability issue comes in during this time, support staff will work to diagnose the issue and resolve it during peak hours; if the issue requires longer-term development, the support team will strive to provide a workaround for the user so operations can continue.

- In the event of tool downtime or other events during which the AI-DSS is unexpectedly unavailable, support shall resolve this within sixty (60) minutes or less.
- Support will respond to questions about user accounts or assist a user with creating a new account within thirty (30) minutes.
- For user questions about underlying data in the provided tools, calculations used, etc., support shall provide a detailed, thorough explanation to the user within three (3) hours.
- If an issue affects tool usability and requires a change to the code base, support strives to have a fix written, quality checked and deployed within forty-eight (48) hours.

Weekday off-peak support, Monday-Friday, 9:00AM-3:00PM ET and 7:00PM-5:00AM ET

- Emails received during peak-period support hours will be acknowledged and responded to within thirty (30) minutes. During daytime off-peak support hours, support staff will also process AI-DSS account creation, questions about accounts and access and data use agreement processing. This support period will also address more detailed user questions such as requests for deeper analyses of underlying data or calculations. Support shall inform the Offeror's training staff about specific issues that need to be demonstrated via in-depth tool demonstrations during the scheduled training sessions for AI-DSS users.
- In the event of tool downtime or other event during which AI-DSS is unexpectedly unavailable, support shall resolve this within sixty (60) minutes or less.
- Issues that are managed during weekday off-peak support hours, such as requests for accounts or scheduling of training, will be held until normal business hours.

Extended support on Saturday, Sunday, and Federal holidays.

- During extended support hours on Saturday, Sunday, and Federal holidays, the Vendor will continue to actively monitor RM3P AI-DSS system health. If a user receives a report of a significant issue affecting its ability to access or use the AI-DSS, support will respond within thirty (30) minutes. Other support requests received, such as questions about tool usage or data, will be responded to within two (2) hours of receipt.
- In the event of tool downtime or other event during which a tool is unexpectedly unavailable, support shall resolve this within sixty (60) minutes or less.

Additionally, the Vendor shall:

- Conduct necessary system maintenance and upgrades on a scheduled basis, with a minimum of five (5) business days advance notice to VDOT, to ensure the AI-DSS performs as designed. These activities include database management, operating system patches, and upgrades to servers, and applying updated security patches.
- Provide a web-based issue tracking tool for users to collaborate with support staff with the following functions and constraints:
    - Users will be able to report defects, issues, and enhancement requests.
    - This system shall be available 24-hours a day/7-days a week.
    - Administrators and support staff will be able to respond to users, update issues with additional information, and log maintenance activities in accordance with the support hours.
    - An tracking tool shall be used to track issue status, the staff that worked/is working on the issue, any comments recorded by the support staff, how the issue was resolved, and other issue information agreed upon between VDOT and the Vendor.
    - Information collected by the issue tracking tool shall be the property of VDOT.
- Attend weekly operational review meetings with VDOT for the first two months after deployment, followed by monthly operational review meetings for the remainder of the CONTRACT.

- Bring current all manually updated data sets within one week of when new data becomes available, per their data management plan.
- Provide warranty of its SaaS for the duration of the contract term.

Task 7 – ATCMTD Documentation and Administrative Support
The selected Offeror/Vendor shall support VDOT by providing input and deliverables that are required as part of the federal ATCMTD grant for the Metropolitan Fredericksburg expansion of the AI-DSS and parking availability prediction. The Vendor shall provide necessary documentation supporting the ATCMTD grant for the Expansion to Southern Tier of the service. Deliverables shall be 508-compliant in accordance with the following standard regarding IT Accessibility and 508 Compliance:

https://www.VDOT.virginia.gov/media/VDOTvirginiagov/it-governance/pdf/ETAITAccessibilityTopicReportGOV103.pdf

ATCMTD deliverables shall include the following:

- Project Management Plan
- Data Management Plan
- Final Systems Requirements Document
- Final Systems Design Document
- Report Summarizing the Project and Outcomes

APPENDICES

Appendix A – AI-DSS System Needs and Requirements

NOTE: ***This section is provided for informational purposes only to assist Offeror's in developing their EOI submissions. Therefore, no response is required for this section.***

The concept for the AI-DSS is a system of systems that receives data from the Data-Exchange Platform and utilizes this information in the AI-DSS. Figure 1 shows the AI-DSS architecture as several engines and response plans – the Supplier will use some or all of these engines and data for their service.

The DSS receives real-time data and analyzes conditions to predict when incidents and congestion are likely to occur, and when an event requires a coordinated, multi-agency response. The data includes freeway, arterial, transit, weather, parking and other available regional data, which could have an impact on the region.

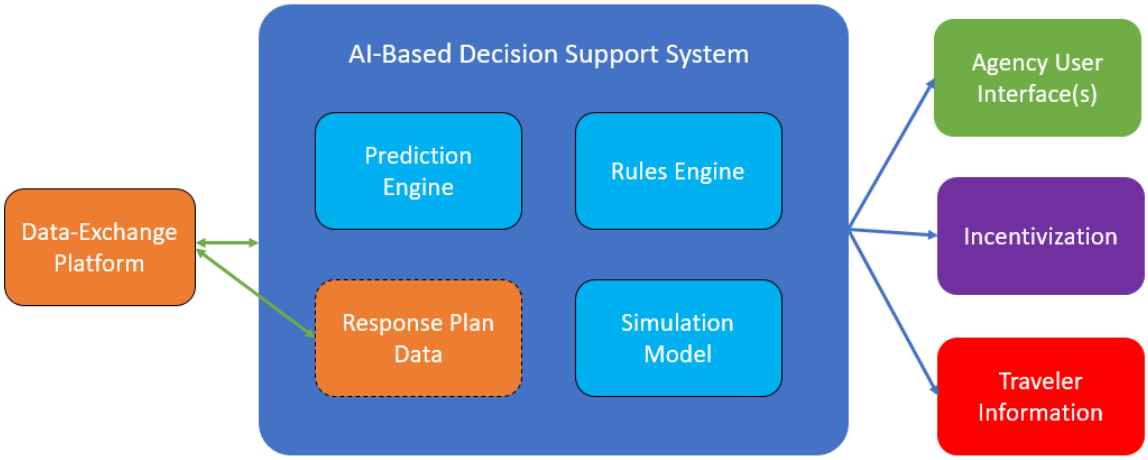

Figure 1: AI-Based DSS Logical Architecture

Needs and Prioritization

The core needs of the AI-DSS are shown in Table 1, below.

The AI-DSS needs are rank-ordered using the following prioritization criteria:

High = Need/feature must be addressed by the system.

Medium = Desirable that the need/feature be addressed, but not a necessity.

Low = Addressing the need/feature is optional.

The "priority" rankings are reported in the table, below.

Table 1: Needs

Need ID	Need Statement	Priority (H, M, L)	Description
DS-N1	Need to predict incidents within the region	H	In order to be more proactive with incident management, predictions of when incidents are likely to occur need to be provided to regional agencies for various incident types.
DS-N2	Need to predict recurring congestion within the region	H	In order to be more proactive with incident management, predictions of when congestion is likely to occur need to be provided to regional agencies.
DS-N3	Need to predict non-recurring congestion within the region	H	In order to be more proactive with incident management, predictions of when congestion is likely to occur need to be provided to regional agencies.
DS-N4	Need to predict durations for incidents detected within the region	H	In order to be more proactive with incident management, predictions of when and how long an incident is likely to take and its impact on the network need to be provided to regional agencies.
DS-N5	Need to predict impacts of incidents	H	In order to be more proactive with incident management, predictions of how long an incident is likely to take and its impact on the network need to be provided to regional agencies.
DS-N6	Need to evaluate and respond to recurring congestion within the region	H	In order to more effectively respond to congestion, regional agencies need to understand the likely impact and the best way to respond based on regional operating procedures.
DS-N7	Need to evaluate and respond to non-recurring congestion within the region	H	In order to more effectively respond to congestion, regional agencies need to understand the likely impact and the best way to respond based on regional operating procedures.
DS-N8	Need to evaluate and respond to events within the transit network within the overall network	M	In order to more effectively respond to events, regional agencies need to understand the likely impact and the best way to respond to transit events based on agency operating procedures (current procedures may need updating based on regional goals).
DS-N9	Need to evaluate and respond to events within the freeway network within the overall network	H	In order to more effectively respond to events, regional agencies need to understand the likely impact and the best way to respond to freeway events based on regional operating procedures.

Need ID	Need Statement	Priority (H, M, L)	Description
DS-N10	Need to evaluate and respond to events within the arterial network within the overall network	M	In order to more effectively respond to events, regional agencies need to understand the likely impact and the best way to respond to arterial events based on regional operating procedures.
DS-N11	Need to store pre-agreed incident response plans	M	Regional agencies need a means to collect and store pre-agreed response plans in order to allow corridor agencies to understand collective roles and responsibilities communicate effectively and improve response times in reacting to events within the corridor.
DS-N12	Need to coordinate incident responses among agencies to ensure that conflicting responses are not enacted	H	Regional agencies need to coordinate responses and understand roles and responsibilities as well as jurisdictional boundaries, such that conflicting responses are not enacted and the correct information is provided to the public.
DS-N13	Need to coordinate incident responses among agencies to ensure prompt response to events	H	Regional agencies need to coordinate responses such that agencies understand roles and responsibilities and jurisdictional boundaries in order to ensure prompt response to events and accurate information is provided to the public.
DS-N14	Need to provide alternate route options to travelers	M	In order to reduce congestion and improve efficiency of the entire corridor, alternate route options need to be provided to the traveling public to allow them to make informed decisions about their trips. This information could be provided pre-trip or upstream of events.
DS-N15	Need to provide detour route options to travelers	H	In order to reduce congestion and improve efficiency of the entire corridor, detour routes need to be provided to the public to allow them to make informed decisions about their trips due to the roadway closures. This information would be provided near events (within queue or approaching a queue).
DS-N16	Need to provide information on alternate modes of transportation to travelers	M	In order to reduce congestion and improve efficiency of the entire corridor, alternate modes of travel options need to be provided to the public to allow them to make informed decisions when planning trips or en-route.
DS-N17	Need to track and store history of enacted response plans	H	Regional agencies need to be able to track and store history of actions associated with pre-approved response plans after they have been enacted, in order to determine, if any changes are required to improve the response plans.

Need ID	Need Statement	Priority (H, M, L)	Description
DS-N18	Need to assess the impact of an enacted response plan on the transportation network	H	During the response to an event in the corridor, the corridor agencies need to be able to determine whether the pre-planned response is effective and if the response is having the intended effect. This includes verifying what conditions exist after implementation of the response. If the operators of the systems determine that their response is not effective, they should be able to change components of their response plans or implement a new response plan.
DS-N19	Need to maintain and modify enacted response plans	H	As an event progresses and conditions change, agency operators should be able to modify the current response and communicate changes to other agencies within the corridor in order to effectively adjust to changing conditions and improve conditions in the corridor.
DS-N20	Need to maintain and modify stored pre-approved response plans	H	Regional agencies need to be able to make recommendations and modify pre-approved response plans, and communicate ideas with other agencies within the corridor, in order to improve response to conditions that will impact the corridor.

Requirements

Components to the AI-Based DSS are expected to include (1) a Response Plan database of all existing regional response plans, (2) a set of Business Rules and a Rules Engine to select the most appropriate sets of response plans, (3) a Predictive subsystem used to predict incident location, incident duration and congestion duration (or queue), and (4) an off-line model that will be to used evaluate the effectiveness of implemented response plans. Additionally, the system will coordinate with operators and local agency users, and manage the invocation of the approved response plan actions. Once the system has deployed a response plan, the DSS will continue to monitor the status of the transportation network for changes and will be able to implement revised response plans, if needed, until the congestion and/or incident has been alleviated and the response plans can be modified or deactivated. The core needs of the DSS were provided in the Features and Needs document, and are referenced in the Requirements List below.

Requirements List

This section covers the functional, performance, interface, data, and hardware requirements. It also covers non-functional and enabling requirements and constraints. For the requirements provided below, the requirement ID provides the level of requirement:

Level 1 – System level requirements for the DSS.

Level 2 – Subsystem level requirements as children of Level 1 requirements.

Level 3 – Component level requirements as children of Level 2 requirements.

Requirement Types

Within the requirements list, the requirement type is abbreviated as follows:

- F = Functional
- I = Interface (interface between DSS and external systems)
- D = Data (internal storage, send and receive data within the DSS)
- C = Constraint

- P = Performance
- H = Hardware

Verification Method
Within the requirements list, the verification methods indicated are as follows:

- **Analysis** = Analysis (*Analysis is the use of established technical or mathematical models or simulations, algorithms, or other scientific principles and procedures to provide evidence that the item meets its stated requirements.)*
- **Inspect** = Inspection (*Inspection is observation using one or more of the five senses, simple physical manipulation, and mechanical and electrical gauging and measurement to verify that the item conforms to its specified requirements.)*
- **Demo** = Demonstrate (*Demonstration is the actual operation of an item to provide evidence that it accomplishes the required functions under specific scenarios.)*
- **Test** = Test (*Test is the application of scientific principles and procedures to determine the properties or functional capabilities of items.)*

Requirement Priority for Desirable Items

- H = High
- M = Medium
- L = Low

Assumptions and Dependencies

- Existing operational systems will be used for command-and-control of field infrastructure.
- A User Interface is required for viewing the data and response plan requests.

Table 2: AI-DSS Functional Requirements

Functional Area	Requirement Number	Requirement
AI-DSS	DS-R1	The AI-DSS shall predict incidents within the region
AI-DSS	DS-R2	The AI-DSS shall predict congestion within the RM3P defined region
AI-DSS	DS-R3	The AI-DSS shall predict the impact of an incident
AI-DSS	DS-R4	The AI-DSS shall evaluate congestion within the region
AI-DSS	DS-R5	The AI-DSS shall evaluate and respond to events within the transit network
AI-DSS	DS-R6	The AI-DSS shall evaluate and respond to events within the freeway network
AI-DSS	DS-R7	The AI-DSS shall evaluate and respond to events within the arterial network within the overall network
AI-DSS	DS-R8	The AI-DSS shall store pre-agreed incident response plans
AI-DSS	DS-R9	The AI-DSS shall coordinate incident responses among agencies to ensure that conflicting responses are not enacted
AI-DSS	DS-R10	The AI-DSS shall coordinate incident responses among agencies to ensure prompt response to events
AI-DSS	DS-R11	The AI-DSS shall store the history of enacted response plans
AI-DSS	DS-R12	The AI-DSS shall predict the impact of an enacted response plan on the transportation network
AI-DSS	DS-R13	The AI-DSS shall predict the availability of parking spaces within the region
AI-DSS	DS-R14	The AI-DSS shall send the Data Incentivization system a notification of incentive

Table 3: Predict Functional Requirements

Functional Area	Requirement Number	Requirement
Prediction Engine	DS-R1.1	The AI-DSS Prediction Engine shall compute the location of an incident
Prediction Engine	DS-R1.2	The AI-DSS Prediction Engine shall compute the time an incident is likely to occur within 15 minutes into the future
Prediction Engine	DS-R1.3	The AI-DSS Prediction Engine shall correctly predict events 95% of the times it provides a prediction
Prediction Engine	DS-R1.4	The AI-DSS Prediction Engine shall receive current transportation data from the DEP
Prediction Engine	DS-R1.5	The AI-DSS Prediction Engine should use an algorithm to predict the location of an incident
Prediction Engine	DS-R1.5.1	The AI-DSS Prediction Algorithm shall recalibrate within a user defined time range
Prediction Engine	DS-R1.6	The AI-DSS Prediction Engine should use an algorithm to predict the time-of-day of an incident
Prediction Engine	DS-R1.6.1	The AI-DSS Prediction Engine should predict time-of-day within 30 minutes
Prediction Engine	DS-R1.7	The AI-DSS Prediction Engine shall send appropriate agency users an alert when an incident is likely to occur via the DEP

Functional Area	Requirement Number	Requirement
Prediction Engine	DS-R1.8	The AI-DSS Prediction Engine shall send predicted incidents to the DEP
Prediction Engine	DS-R1.9	The AI-DSS Prediction Engine shall send predicted incident durations to the DEP
Prediction Engine	DS-R1.10	The AI-DSS Prediction Engine shall provide the capability for an administrative user to update the prediction algorithm for incident prediction
Prediction Engine	DS-R1.11	The AI-DSS Prediction engine shall provide the capability for an administrative user to update the prediction algorithm for incident duration prediction
Prediction Engine	DS-R1.12	The AI-DSS Prediction engine shall provide 99% availability
Prediction Engine	DS-R2.1	The AI-DSS Prediction Engine shall predict the location of congestion within a half mile of beginning of queue
Prediction Engine	DS-R2.2	The AI-DSS Prediction Engine shall predict the time congestion is likely to occur within 15 minutes
Prediction Engine	DS-R2.3	The AI-DSS Prediction Engine shall correctly predict congestion location 95% of the times it provides a prediction
Prediction Engine	DS-R2.4	The AI-DSS Prediction engine shall receive current transportation data from the DEP
Prediction Engine	DS-R2.5	The AI-DSS Prediction Engine shall include an algorithm to predict the location of an incident
Prediction Engine	DS-R2.5.1	The AI-DSS Prediction Algorithm should automatically update as more historical data is provided
Prediction Engine	DS-R2.6	The AI-DSS Prediction Engine shall include an algorithm to predict the time-of-day of an incident
Prediction Engine	DS-R2.7	The AI-DSS Prediction Engine shall notify an agency user when an incident is likely to occur
Prediction Engine	DS-R2.8	The AI-DSS Prediction Engine shall send predicted congestion to the DEP
Prediction Engine	DS-R2.9	The AI-DSS Prediction Engine shall send predicted congestion durations to the DEP
Prediction Engine	DS-R2.10	The AI-DSS Prediction Engine shall provide the capability for an administrative user to update the prediction algorithm for congestion prediction
Prediction Engine	DS-R2.11	The AI-DSS Prediction Engine shall provide the capability for an administrative user to update the prediction algorithm for congestion duration prediction
Prediction Engine	DS-R3.1	The AI-DSS Prediction Engine shall predict the impact of an incident
Prediction Engine	DS-R14.1	The AI-DSS Prediction Engine shall predict the availability of parking in commuter lots during weekday AM peak hours
Prediction Engine	DS-R14.2	The AI-DSS Prediction Engine shall compute the availability of parking within 15 minutes into the future
Prediction Engine	DS-R14.3	The AI-DSS Prediction Engine shall correctly predict parking availability 95% of the times it provides a prediction
Prediction Engine	DS-R14.4	The AI-DSS Prediction Engine shall receive current parking data from the DEP

Table 4: Rules Engine Functional Requirements

Functional Area	Requirement Number	Requirement
Rules Engine	DS-R4.1	The Rules Engine shall evaluate rules to determine if a response plan is needed for identified congestion
Rules Engine	DS-R4.1.1	The Rules Engine shall send a recommended response plan to agency users for congestion
Rules Engine	DS-R4.1.2	The Rules Engine shall send an updated response plan to agency users once different rules have been met
Rules Engine	DS-R4.1.3	The Rules Engine shall send a response plan termination notice to agency users once congestion has dissipated
Rules Engine	DS-R4.2	The Rules Engine shall provide 99% availability
Rules Engine	DS-R5.1	The Rules Engine shall evaluate rules to determine if a response plan is needed for a transit event
Rules Engine	DS-R5.1.1	The Rules Engine shall send a recommended response plan to agency users
Rules Engine	DS-R5.1.2	The Rules Engine shall send an updated response plan to agency users once different rules have been met
Rules Engine	DS-R5.1.3	The Rules Engine shall send a response plan termination notice to agency users once a transit event is complete
Rules Engine	DS-R5.1.4	The Rules Engine shall send a termination notification to agency users once the event has been closed
Rules Engine	DS-R6.1	The Rules Engine shall evaluate rules to determine if a response plan is needed for a transit event
Rules Engine	DS-R6.1.1	The Rules Engine shall send a recommended response plan to agency users
Rules Engine	DS-R6.1.2	The Rules Engine shall send an updated response plan to agency users once different rules have been met
Rules Engine	DS-R6.1.3	The Rules Engine shall send a termination notification to agency users once the event has been closed
Rules Engine	DS-R7.1	The Rules Engine shall evaluate rules to determine if a response plan is needed for an arterial event
Rules Engine	DS-R7.1.1	The Rules Engine shall send a recommended response plan to agency users
Rules Engine	DS-R7.1.2	The Rules Engine shall send an updated response plan to agency users once different rules have been met
Rules Engine	DS-R7.1.3	The Rules Engine shall send a termination notification to agency users once the event has been closed

Table 5: Model Engine Functional Requirements

Functional Area	Requirement Number	Requirement
Model Engine	DS-R13.1	The Model Engine shall simulate an event and the impacts of an associated response plan for the calibrated region
Model Engine	DS-R13.1.1	The Model Engine shall simulate the defined transportation network for the geographic area of the RM3P program

Functional Area	Requirement Number	Requirement
Model Engine	DS-R13.1.2	The Model Engine shall simulate the travel demand for the geographic area of the RM3P program
Model Engine	DS-R13.1.3	The Model Engine shall use the origin/destination data for the geographic area of the RM3P program
Model Engine	DS-R13.1.4	The Model Engine shall simulate the transit demand within the geographic area of the RM3P program
Model Engine	DS-R13.1.5	The Model Engine shall simulate complete trips within the geographic area of the RM3P program
Model Engine	DS-R13.1.6	The Model Engine shall simulate the traffic control devices within the geographic area of the RM3P program
Model Engine	DS-R13.1.7	The Model Engine shall provide the capability for an authorized user to administer the engine
Model Engine	DS-R13.1.8	The Model Engine shall receive transportation data from the DEP
Model Engine	DS-R13.1.9	The Model Engine shall send simulated transportation data to the DEP
Model Engine	DS-R13.1.8	The Model Engine shall receive parking data from the DEP
Model Engine	DS-R13.1.9	The Model Engine shall receive incentivization data from the DEP
Model Engine	DS-R13.2	The Model Engine shall provide predicted measures-of- effectiveness to the DSS based on the simulated response plan
Model Engine	DS-R13.3	The Model Engine shall provide predicted measures-of-effectiveness to the DSS based on a "do-nothing" response
Model Engine	DS-R13.4	The Model Engine shall provide a confidence interval for all simulations

Table 6: Data/User Interface Functional Requirements

Functional Area	Requirement Number	Requirement
Data/ GUI	DS-R8.1	The Response Plan data store shall store all pre-agreed response plans
Data/ GUI	DS-R8.1.1	The Response Plan data store shall store freeway event response plans
Data/ GUI	DS-R8.1.2	The Response Plan data store shall store transit event response plans
Data/ GUI	DS-R8.1.3	The Response Plan data store shall store arterial event response plans
Data/ GUI	DS-R8.2	The Response Plan data store shall provide the capability for an authorized user to modify existing response plans
Data/ GUI	DS-R8.3	The Response Plan data store shall provide the capability for an authorized user to delete existing response plans
Data/ GUI	DS-R8.4	The Response Plan data store shall provide the capability for an authorized user to add additional response plans
Data/ GUI	DS-R9.1	The DSS shall provide agency users the capability to view current status of the transportation network
Data/ GUI	DS-R9.2	The DSS shall receive current status of the transportation network from the DEP
Data/ GUI	DS-R9.2.1	The DSS shall receive traffic signal status data from the DEP
Data/ GUI	DS-R9.2.2	The DSS shall receive weather data from the DEP
Data/ GUI	DS-R9.2.3	The DSS shall receive incident data from the DEP
Data/ GUI	DS-R9.2.4	The DSS shall receive construction data from the DEP

Functional Area	Requirement Number	Requirement
Data/ GUI	DS-R9.2.5	The DSS shall receive parking data from the DEP
Data/ GUI	DS-R9.2.6	The DSS shall receive transit data from the DEP
Data/ GUI	DS-R9.2.7	The DSS shall receive link data from the DEP
Data/ GUI	DS-R9.2.8	The DSS shall receive transit data from the DEP
Data/ GUI	DS-R9.3	The DSS shall provide an agency user the capability to receive a response plan implementation request
Data/ GUI	DS-R9.3.1	The DSS shall provide an agency user the capability to approve a response plan implementation request
Data/ GUI	DS-R9.3.2	The DSS shall provide an agency user the capability to reject a response plan implementation request
Data/ GUI	DS-R9.3.3	The DSS shall provide an agency user the capability to modify a response plan implementation request
Data/ GUI	DS-R9.4	The DSS shall provide an agency user the capability to manage events
Data/ GUI	DS-R10.1	The DSS shall provide an agency user the capability to set an approval profile
Data/ GUI	DS-R10.1.1	The DSS shall provide an agency user the capability to automatically approve a response plan implementation request after a defined value of time

Appendix B – RM3P/ATCMTD Concept of Operations – Draft

1 Executive Summary

1.1 Introduction

RM3P builds on previous VDOT-led Integrated Corridor Management (ICM) planning studies that examined the North-South corridor (with I-95 and I-395 as the anchors) and the East-West corridor (with I-66 as the anchor.) Both studies emphasized strategies for improving regional multi-modal mobility. With participation and support of the regional stakeholders, the East-West effort identified three goals that formed the basis of RM3P: (i) *Optimization*, optimize performance of the transportation infrastructure; (ii) *Reliability*, enhance travel time reliability across the region and corridors; and (iii) *Choice*, support on-demand multi-modal choices for travelers.

This document briefly summarizes the operational concept for the RM3P effort but specifically focuses on those activities funded under the ATCMTD grant. The document identifies specific project stakeholders, goals, objectives, and user stories that will be leveraged to develop and validate the final system's design and deployment.

1.2 Regional Multi-Modal Mobility Concept

The *Regional Multi-Modal Mobility Program* (RM3P) is a partnership between the Office of the Secretary of Transportation, the Virginia Department of Transportation (VDOT), the Virginia Department of Rail and Public Transportation (DRPT), the Northern Virginia Transportation Authority (NVTA), and the Fredericksburg Area Metropolitan Planning Organization (FAMPO). RM3P is an innovative technology initiative that is funded under the Commonwealth of Virginia's Innovative Technology and Transportation Fund (ITTF). It aims to improve safety, reliability, and mobility for travelers in Northern Virginia. The intent of this technology initiative is to leverage the collaborative use of real-time data by Virginia's public and private sectors, as well as to give public the tools to make more informed travel choices. Stakeholders across the region are expected to participate in this important advancement, known to many as the *RM3P Initiative*.

To achieve the goals of improving travel safety, reliability, and mobility, five sets of interdependent and synergistic technology projects – referred to as program elements – are being implemented under RM3P. These are the:

Data-Exchange Platform (DEP) – The DEP will be a reliable, continuously updated, cloud-based data storage and exchange system. It will be used by regional partners and third-party providers to capture, process, and exchange information on real-time and historic multi-modal travel conditions. DEP's initial focus will be on providing data that supports the other RM3P activities. The multi-modal mobility cloud-based data-exchange platform is envisioned as a host of internal and external sources with dynamic and static data access that will interface with local, regional, and statewide systems. It will enable partners to exchange data, in a secured environment, on travel conditions across modes, jurisdictions, and networks.

AI-Based Decision Support System (AI-DSS) – The AI-DSS will help predict the impact of disruptions to the transportation network and provide coordinated response options to agencies. This automated tool for operators will use travel data to monitor emerging conditions and recommend plans for coordinated, multi-agency responses to congestion, incidents, and events. The AI-DSS will generate response plans for VDOT and its partner agencies, the implementation of which will result in collective agency actions, thereby contributing to a cohesive and optimal regional response. Additionally, this project will implement a system built on the DEP that will include real-time conditions and historic data, to help predict congestion/incidents and their associated impacts. The ATCMTD grant supports expansion of the AI-DSS southward to Metropolitan Fredericksburg (including Stafford County, Spotsylvania County, and the City of Fredericksburg) along the I-95 corridor.

Commuter Parking Information System (CPIS) – The CPIS will entail a real-time system that provides reliable information about parking space availability at lots serving bus, vanpool, and carpool commuters, through third-party apps. The system will communicate parking availability data to operators and commuters to facilitate carpooling, transit access, increases in per-vehicle occupancy, etc. The availability of both typical parking usage and real-time parking availability information can influence commuter mode choice and congestion. The RM3P objective is to deploy minimum field infrastructure for gathering the parking usage information and seek partnerships with third-party providers for disseminating the information. Additionally, the ATCMTD grant enables the development of predictive parking information using an AI-based approach for both Northern Virginia (the Northern Tier) and Metropolitan Fredericksburg (the Southern Tier) of the RM3P operational region.

Multi-Modal Analytical Planner (MMAP) – The MMAP will be a tool for transportation service providers to help identify unmet needs in the transportation network. It will enable mobility providers to better meet travel demand by identifying underserved areas, especially during disruptive events. This project will gather traditional and non-traditional sources of data to gain greater insights about customers' travel behavior and movement and identify service gaps.

Dynamic Incentivization (DI) – DI will be a data-driven system offering the public incentives to modify their travel choices and behaviors in response to real-time travel conditions. The incentives will be offered through one or more custom apps and will also be made available to existing transportation apps via a robust back-end solution. Regional agencies and third-party providers may provide incentives to influence commuters' transportation choices to avoid areas of severe congestion, incidents, and planned work zones and events.

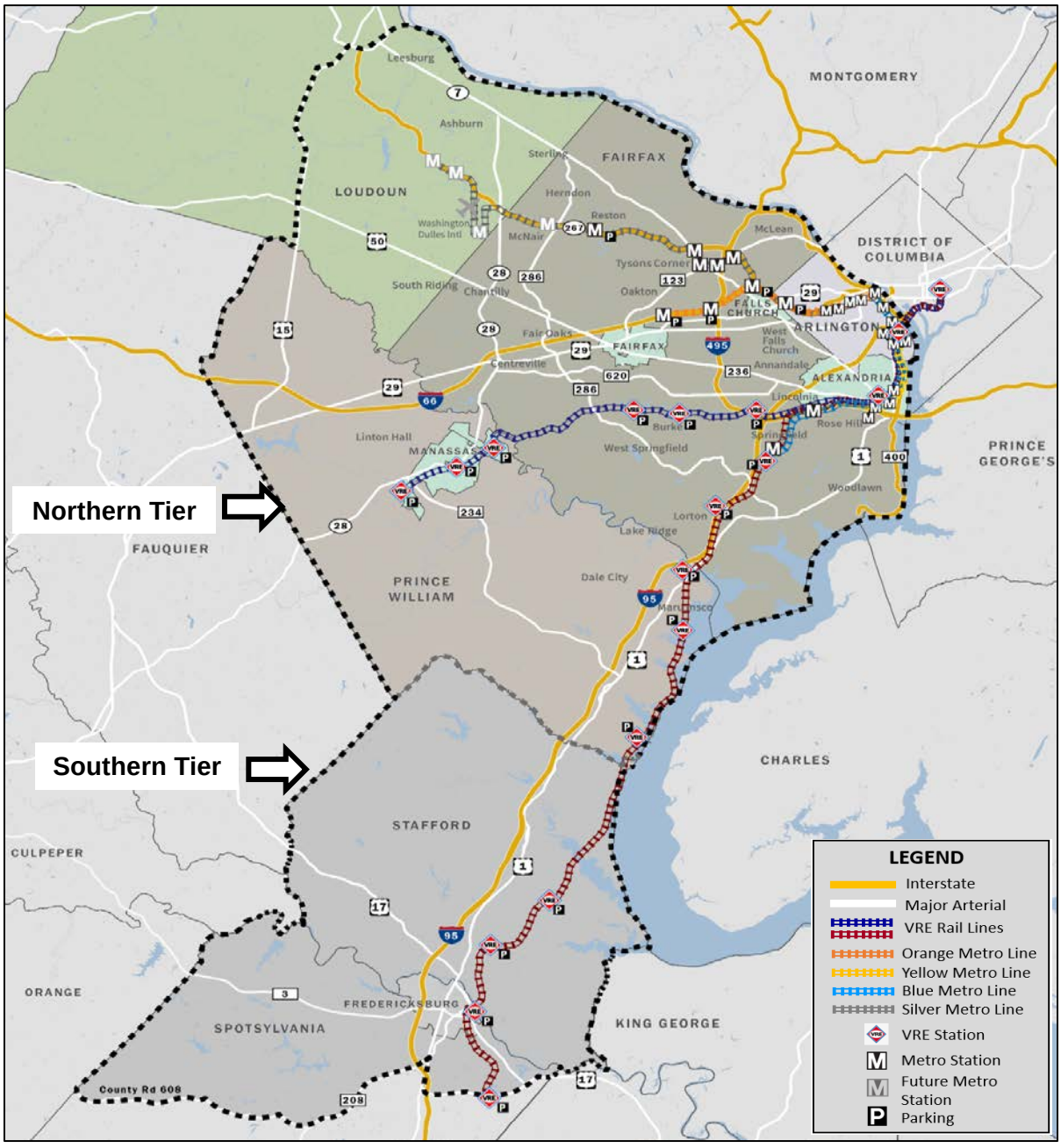

Figure 1: RM3P Boundaries

As noted above, the award to VDOT of an *Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)* grant by the Federal Highway Administration (FHWA), extends the functionality of the RM3P initiative. The grant funds (1) expansion of the AI-DSS capabilities to metropolitan Fredericksburg, and (2) development of a predictive parking capability for deployment across the entire region.

Figure 1 delineates the boundaries of the core influence area, centered around Northern Virginia (Northern Tier), where all five program elements will be deployed. It also depicts the expansion to Fredericksburg (Southern Tier), where AI-DSS and elements of CPIS will be implemented as part of this grant.

2 Scope and Summary

This section describes the scope of the ATCMTD-funded initiative, briefly describes the region, and identifies key concepts. Stakeholders and their responsibilities are identified in Section 3.

IMPORTANT NOTE: This document does not present a concept of operations for the entire RM3P initiative. Rather, it focuses predominantly on those RM3P elements funded under the ATCMTD grant. The broader information about RM3P is presented for contextual purposes only.

2.1 Project Scope

Under the ATCMTD funding, the *Artificial Intelligence-Based Decision Support System (AI-DSS)* will be implemented in the Southern Tier of the region. The original VDOT-furnished funding for this program element covers DSS activity only for the Northern Tier. The ATCMTD grant funding allows VDOT to extend the DSS coverage to the Southern Tier. The planned AI-DSS will employ advanced machine-learning techniques and artificial intelligence to generate incident and congestion management responses based on real-time conditions.

The second ATCMTD-sponsored project will *deploy Predictive Parking Availability Information Using Artificial Intelligence (AI)*. It will implement AI-based technologies to use a combination of historical data, samples of real-time parking data, and crowd-sourcing information to predict parking availability status more effectively in commuter lots. Commuters, planning their trips and traveling enroute, will be better able to gauge where to find available parking.

2.2 Regional Demographics

Northern Virginia, or NoVA, refers to the area located at the north-east corner of the Commonwealth of Virginia, lying across the Potomac River from the Nation's Capital, Washington D.C. and is part of the Washington Metropolitan Statistical Area (MSA).

Northern Virginia's proximity to the nation's capital has, in part, fueled its population growth for over three decades. As of 2018, NoVA had a population of approximately 3.1 million residents, or 37 percent of Virginia's total population, making it the most populous region in both Virginia and the Washington MSA. The region has seen a sustained population growth of more than 12 percent since 2010. Based on current

estimates, NoVA's population is projected to increase by about 19 percent, to more than 3.7 million residents, by 2040.

Northern Virginia is home to numerous U.S. government facilities, including the Pentagon, Central Intelligence Agency (CIA), and United States Geological Survey (USGS). It is often characterized as the "economic engine" for the Commonwealth of Virginia, accounting for a significantly larger job base than either Washington, D.C., or the Maryland suburbs. As the economy has evolved from one primarily based on the Federal government, to one that is more driven by private-sector expansion, NoVA has attracted workers commuting from D.C., suburban Maryland, and points outside the Washington MSA, including many commuters from the Fredericksburg area. As of 2018, per the U.S. Bureau of Labor Statistics, approximately 1.6 million people were employed in NoVA.[1] The Commonwealth was recently named by CNBC as the "Top State for Business."[2]

Metropolitan Fredericksburg, including Stafford County, Spotsylvania County, and the City of Fredericksburg, lies halfway between Washington, D.C. and Richmond. The area has a combined population of more than 300,000 and is home to a workforce of 180,000. Significantly, approximately 1 million workers live within a 40-mile radius of Greater Fredericksburg. More than 120,000 vehicles travel daily from or through Fredericksburg on Interstate 95. Additionally, the Virginia Railway Express (VRE) connects Fredericksburg to Metropolitan Washington; there are 3 VRE stops in Fredericksburg.

2.3 Key Concepts

VDOT and its partners – DRPT, NVTA, and FAMPO – defined a comprehensive strategy, in the form of the RM3P initiative, to implement a regional ICM paradigm. The strategy is intended to address the transportation vision for NoVA, as adopted by NVTA in its Authority Meeting (December 2020, p. 5):[3]

> *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.*

Towards this end, the aim of the RM3P initiative is to bring structure, stability, and balance to multi-modal transportation across the RM3P region. The vision is one of continuous situational awareness on conditions in the corridors, so that operations

[1] https://www.bls.gov/regions/mid-atlantic/data/xg-tables/ro3fx9538.htm

[2] https://www.cnbc.com/2019/07/09/virginia-is-americas-top-state-for-business-in-2019.html

[3] https://thenovaauthority.org/wp-content/uploads/2021/02/5.-Authority-Meeting-Draft-Minutes-Dec-17-2020_ML_MB.pdf

teams can respond quickly and appropriately to changing circumstances. The aim is an integrated transportation network in which travelers have steady, easy access to a suite of real-time transportation options, enabling them to arrive at informed traveler choices. Travel-time reliability will be significantly improved, so that the time needed to complete individual trips can be more effectively judged. Travelers will be exposed to incentives and strategies to curb peak-period transportation demand.

Goals. The overall RM3P goals are to:
Optimize transportation system performance by improving the efficiency of agency responses to travel disruptions. Advanced prediction capabilities will forecast travel conditions some minutes into the future. Travel time estimates will be based on current and projected travel conditions, helping to improve the reliability of the information.

Enhance travel time reliability. Current travel information using advanced prediction capabilities will give people a better understanding of how long a trip is likely to take, so they can plan when and where to travel accordingly. It will also result in more reliable travel times.

Support on-demand, multi-modal trip choices for travelers. The availability of real-time data and partnerships with the public and private sectors will provide travelers with informed choices across multiple modes and routes.

Program Elements. RM3P encompasses these five technological program elements:

- *Data-Exchange Platform (DEP),*
- *Artificial Intelligence-Based Decision Support System (AI-DSS),*
- *Commuter Parking Information System (CPIS),*
- *Multi-Modal Analytical Planner (MMAP), and*
- *Dynamic Incentivization (DI).*

Activities funded under the ATCMTD grant will directly impact the AI-DSS and CPIS program elements. Data to support these activities will also need to be captured and processed in the DEP.

3 Stakeholders and Responsibilities

This section describes the major stakeholders involved in the RM3P initiative, the transportation infrastructure they manage, and key responsibilities. The RM3P program is a complex system of jurisdictions and transportation providers in both Northern Virginia (Northern Tier) and Fredericksburg (Southern Tier). This makes the program area somewhat unique in comparison to the suburbs of other major metropolitan areas. For example, VDOT owns and maintains most roadways and signals in the RM3P region, except for those in Arlington County and the independent cities and towns in the region (Fairfax, Falls Church, Manassas, Alexandria, Fredericksburg, etc.). Various jurisdictions run their own transit services as supplements to service provided by WMATA, which is funded through a compact from agencies in Northern Virginia, Washington, and Maryland.

Table 1 provides a high-level overview of the ownership, operations, and maintenance obligations of the jurisdictions and agencies in the expanded RM3P region.

Table 1: Ownership, Operations, and Maintenance of RM3P Transportation Assets

Jurisdiction/ Agency	Roadways and Trails	Signals	Transit
VDOT	Owns and maintains interstate highways in the project limits and primary/secondary roadways in Fairfax, Prince William, and Loudoun Counties.	Owns and maintains most signals outside of Arlington County and those in independent cities and towns.	-
Arlington County	Maintains primary roadways in County (VDOT owns). Owns and maintains secondary		Arlington County
Fairfax County	Owned and maintained by VDOT.	Owned and maintained by VDOT.	Fairfax Connector
Loudon County	Owned and maintained by VDOT.	Owned and maintained by VDOT.	Loudoun County Transit
Prince William County	Owned and maintained by VDOT.	Owned and maintained by VDOT.	PRTC

Jurisdiction/ Agency	Roadways and Trails	Signals	Transit
Spotsylvania County	Owns and maintains secondary roadways in County.		
Stafford County	Owns and maintains secondary roadways in County.		
Independent Cities –Fairfax, Falls Church, Fredericksburg, Manassas, Manassas Park, Alexandria	Owned and maintained byindividual cities.	Owned and maintained by individual cities.	CUE (City of Fairfax) FRED (City of Fredericksburg) DASH (City of Alexandria)
Independent Towns –Dumfries, Herndon, Vienna, Leesburg, Haymarket	Owned and maintained byindividual towns.	Owned and maintained by VDOT.	-
MWAA	Dulles Toll Road and DullesAirport Access Road.	-	-
Private Companies	Dulles Greenway, I-495/395/95 Express Lanes, Future I-66 Express Lanes Outside theBeltway.	-	-
WMATA	-	-	Metrobus and Metrorail
Northern Virginia Transportation Commission	-	-	VRE Commuter Rail (Operated by PRTC and NVTC)
Northern Virginia Regional Parks Authority	Own and maintain W&OD, Custis, and Four Mile Run Trails.	-	-
US National Park Service	Own and maintain GeorgeWashington Parkway and Mount Vernon Trail.	-	-
Emergency Services (police) – Virginia State Police, US Park Police, Arlington County Police, City of Alexandria Police, City of Fairfax Police, Fairfax County Police, Fredericksburg Police, Loudoun County Police, Prince William County Police, Spotsylvania County Sheriff, Stafford County Sherriff	Provide enforcement and incident response.		
Incident Response (VDOT) – Regional Incident Management Coordinator (IMC), Safety Service Patrol (SSP)	Provides incident response services and incident coordination		

Jurisdiction/ Agency	Roadways and Trails	Signals	Transit
Emergency Services (Fire) – Arlington County Fire, City of Alexandria Fire, City of Fairfax Fire, Fairfax County, Fredericksburg Fire, Loudoun County Fire, Prince William County, Spotsylvania County, Stafford County	Provide first responder and incident response services.		

3.1 Existing System Integration Efforts

The following initiatives represent major ongoing efforts in the region to share information between agencies and coordinate responses to incidents and emergencies.

3.1.1 MPSTOC

The *McConnell Public Safety and Transportation Operations Center (MPSTOC)* is a partnership between Fairfax County and the Commonwealth of Virginia that brings multiple agencies and functions together, under one roof, to enhance the effectiveness of public safety response, improve traffic congestion management, and better manage the response to, and recovery from, major emergencies. The MPSTOC is located just south of I-66 in Fairfax County, adjacent to VDOT's Northern Virginia District Office. Within the MPSTOC, the following agencies are housed:

- VDOT's Northern Region Transportation Operations Center (TOC) and Signal Operation Center (SOC). The TOC monitors traffic and incidents (focused on interstates) by using cameras and other information-gathering mechanisms to better manage day-to-day traffic flow and large incidents. This includes dispatching Safety Service Patrols (SSP) and responding to incidents, as well as sharing information via DMS, 511, and social media. The SOC monitors secondary roadways and traffic signals in Fairfax, Prince William, and Loudoun counties, adjusting signal timings where needed.
- The Virginia Department of State Police (VSP) Division 7 Communications Center, which receives and dispatches all interstate-related calls for Northern Virginia.
- Fairfax County Department of Public Safety Communications, which receives and dispatches all 9-1-1 emergency and non-emergency police, fire, and rescue calls in the county.
- Fairfax County Office of Emergency Management (OEM), which oversees and activates the county's Emergency Operations Center (EOC) during emergency incidents. OEM is equipped to receive and transmit Homeland Security and emergency information to state, regional, and federal partners.
- Fairfax County Fire and Rescue Department staff for assisting with specific dispatching.

- Fairfax County Police Department Forensics.

3.1.2 MATOC

The *Metropolitan Area Transportation Operations Coordination (MATOC)* program is a cooperative partnership between transportation agencies in D.C., Maryland, and Virginia that aims to improve safety and mobility in the region through information-sharing, planning, and coordination. It is financially supported by MDOT, DDOT, and VDOT. WMATA is not a funding partner but serves on the Steering Committee. The Metropolitan Washington Council of Governments (MWCOG) also provides staff to support the Steering Committee. MATOC gathers information using the *Regional Integrated Transportation Information System (RITIS)*. RITIS aggregates data from regional agencies and provides a visual aid for viewing and analyzing traffic conditions across the metropolitan area. The MATOC team uses this information to facilitate and manually coordinate the exchange of transportation system information among the inter-jurisdictional operating agencies.

4 Existing Assets

This section provides an overview of the existing assets and infrastructure for the various modes of travel operating in the RM3P region. The infrastructure includes devices deployed in the field along freeways and arterials, technology deployed on transit vehicles, and other alternate modes of travel.

4.1 Data Assets

Real-time data is the development of data management strategies and practices to capitalize upon timely information to make informed decisions. With the rise of new technologies, such as Connected Vehicles (CVs), transportation and other public agencies expect to collect a significant and exponentially growing volumes of data. There is, however, a gap in the expertise required to collect, analyze, manage, and integrate multiple data sources from both the public and private sectors to inform the public and improve transportation operations. The various data sources provide information on different intervals, at different times, and use different network segmentation. Data must be analyzed, normalized, and fused to become a data set that most accurately depicts current conditions on the network. For the RM3P program, several existing data sources and initiatives will be leveraged.

4.1.1 RITIS

The *Regional Integrated Transportation Information System (RITIS)*, identified above, is a situational awareness, data archiving, and analytics platform that provides an enhanced macro-level view of the transportation network. RITIS is used by transportation officials, first responders, planners, researchers, and others to view transportation and related emergency management information through innovative visualizations and use it to improve their operations and emergency preparedness. RITIS also uses regional standardized data to provide information to third parties, the media, and other traveler information resources including, web sites, paging systems, and 511. There are three principalcomponents to RITIS:

- Real-time data feeds, which provide direct access to real-time incident, event, detector, probe, weather, transit, and other data sources including ITS device status. The RITIS platform allows each agency to determine which data elements it wishes to provide in the data feed, and which elements it wishes to seclude from other agencies or the public.
- Real-time situational awareness tools (e.g., those tools used by MATOC facilitators), which allow users with appropriate credentials to view real-time RITIS

data in a browser. These tools enable users to interact with the various real-time data feeds in maps, lists, and other graphics.

- Archived data analysis tools, which allow users to query, analyze, and derive performance measures. Users can use these tools for identifying incident hot spots, analyzing queue length and bottlenecks, and evaluating the effectiveness of transportation operations strategies.

With almost 8,000 users nationwide and over 1,000 users in Virginia, RITIS continues to be an asset for transportation center operators, decision-makers, researchers, planners, operations specialists, the military, and homeland security officials. RITIS is hosted at the University of Maryland's CATT Lab in College Park, MD, just northeast of Washington, D.C., on behalf of the region's major supporters, including VDOT, MDOT, DDOT, and WMATA.

RITIS has been selected as the foundational platform for the RM3P DEP. RITIS' functionality is well-known to many regional users, it already contains some data and supports many functions required by RM3P, and it encompasses a robust infrastructure capable of expansion to address the full functional requirements of the RM3P DEP.

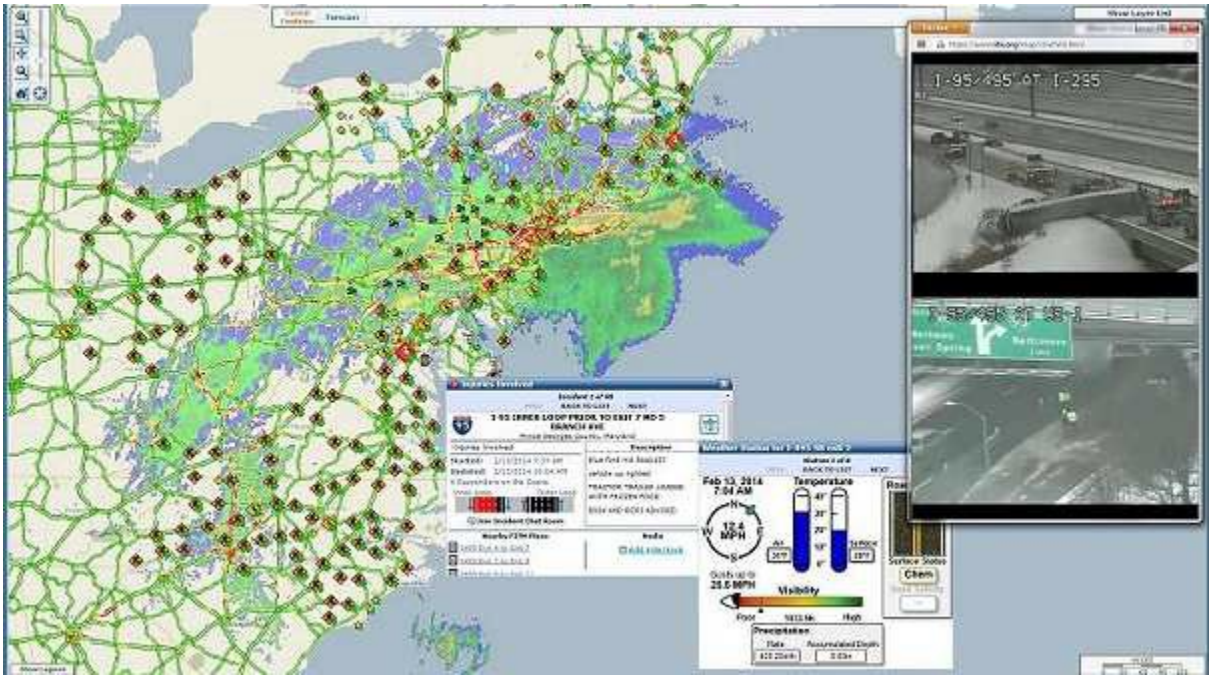

Figure 2: RITIS Real-Time Situational Awareness Tools

4.1.2 Open-Data Portal

The Virginia Open-Data Portal serves to extend access to Commonwealth data, empowering constituents to interpret, analyze, and transform data into actionable intelligence. Secure and appropriate data-sharing is fundamental to the success of our society because information supports engagement. Commonwealth data is a strategic

asset that, when leveraged, can drive innovation, increase quality of life, and promote economic growth.

The Virginia Open-Data Portal provides access to dashboards and allows users to create visualizations, filter data, and access the data via APIs (application programming interfaces) to build solutions in web and mobile applications. The Commonwealth of Virginia is committed to continue growing the number of open datasets available through the portal, facilitating public participation and engagement.

4.1.3 SmarterRoads

SmarterRoads is VDOT's open-data portal that makes raw and processed transportation data available to approved users and participating third parties. A variety of data is available through this portal, including information on road conditions, incidents, work zones, and multi-modal transportation and asset information like road signs. Signal data is also accessible to support the connected and automated vehicle industry, third-party enterprises, and the public. Datasets range from real-time and near real-time sensor streams, to annual data files available in varied formats.

4.1.4 Virginia Roads

Virginia Roads is VDOT's open-data portal, that was developed as part of an effort to provide user-friendly access for exploring and downloading open data. This portal provides the traveling public, lawmakers, and partners with easy-to-understand information that demonstrates how VDOT manages the state's transportation infrastructure. It offers access to VDOT open data, stories related to VDOT initiatives, as well as web maps and apps.

4.1.5 VDOT ATMS/Open TMS

The VDOT ATMS is a computerized transportation communications system that employs communication technology to gather traffic information from field devices – traffic sensors, environmental sensors, cameras, and other devices deployed along the roadside to monitor traffic conditions. The system enables control center managers to detect traffic incidents and congestion rapidly, and subsequently dispatch resources to the incident scene. It also disseminates real-time information to commuters using devices such as Dynamic Message Signs (DMS) and Highway Advisory Radio (HAR).

These are the major data terminators for the Statewide ATMS:

- TOC operators and other VDOT staff that interface with ATMS.
- VDOT Safety Service Patrols (SSP) and maintenance vehicles.
- Virginia State Police (VSP), Computer Aided Dispatch (CAD), and Local Public Safety Access Point (PSAP) systems.
- Other local/regional transportation systems.

- ITS field devices.
- ICM system.
- Maintenance and asset management system.
- VDOT traffic signal system.
- Customer Service Center (CSC) portal.
- Transportation Video and Data (TV&D) distribution center.

4.2 Transportation Assets

This section provides an overview of the ITS infrastructure for the various modes of travel operating in the RM3P region. This infrastructure includes devices deployed in the field along freeways and arterials, technology deployed on transit vehicles and at park-and-ride lots, as well as backend supporting systems, and data feeds available for use by third parties and the public.

4.2.1 Freeway and Arterial ITS Infrastructure

Various ITS devices have been deployed by VDOT and other jurisdictions within the RM3P region, including CCTV cameras, dynamic message signs (DMS), traffic sensors for counting and classifying vehicles, and roadside weather information system (RWIS) devices. Table 11 provides a high-level overview of counts of these ITS devices deployed along various freeways and arterials in the NoVA region by VDOT. Note that Arlington County also has CCTV deployed throughout the County, as well as DMS along major corridors which post travel times collected by Bluetooth sensors.

Table 2: Approximate Counts of VDOT ITS Devices in NoVA

Route	CCTV Camera	Dynamic Message Signs (DMS)	Traffic Sensor System (TSS)	RWIS
I-495	40	15	24	1
I-66	64	78	141	0
US-15	1	1	0	1
US-29	5	4	0	1
US-50	6	2	0	0
SR 7	12	6	0	2
SR 267/Dulles Toll Road/ Dulles Greenway	2	0	1	1
SR 123	8	2	0	0
SR 286	2	4	1	1
SR 28	6	2	11	0

4.2.1.1 Hard-Shoulder Running and Active Traffic Management (ATM)

Historically, I-66 experienced frequent heavy congestion along nearly the entire length of the interstate that falls withinthe project area. Previously, between US 50 (Exit 57) and I-495 (Exit 64), a consistently congested segment in both directions and on weekends, VDOT utilized lane control signals to designate whether the painted hard shoulder was open to vehicular traffic as an additional lane. Prior to 2015, the lane control signals for the hard shoulder were activated according to a fixed schedule only; the shoulder lane was opened eastbound during the weekday AM peak period and westbound during the weekday PM peak period.

In 2015, VDOT deployed lane control signals across all lanes between US 29 in Centreville (Exit 52) and I-495 (Exit 64) as part of a new Active Traffic Management (ATM) system. ATM components included:

- Expanded use of the shoulder lanes between I-495 and US-50. These lanes were opened to traffic when congestion built, regardless of the time of day or day-of-week.
- Lane control signals across all lanes between US-29 and I-495, which allowed motorists to see which lanes were usable or blocked in advance of incidents. These gantries were also utilized for employing variable speed limits along segments of the corridor.
- Expanded camera and DMS coverage between US-29 in Gainesville (Exit 43) and the Washington, D.C. line.
- Upgrades to the ramp metering system east of I-495.

As part of the expansion of I-66 Outside the Beltway (west of I-495), the lane control signals have now been removed. More details on this project are described below.

4.2.2 Hard-Shoulder Running Outside of I-66

There are multiple other locations in the project area in which hard-shoulder running is utilized. Along the SR-267 spur east of I-495 that connects to I-66, buses are permitted to run along the shoulder in the eastbound direction approaching the West Falls Church Metrorail station during peak periods, bypassing frequent queues. Along I-495 northbound, north of Tysons Corner approaching the American Legion Bridge into Maryland, hard-shoulder running was deployed and is signed via lane-use gantries.

4.2.2.1 Arterial ITS Infrastructure

The following VDOT initiatives are ongoing in regard to ITS infrastructure within the RM3P region:

- **Traffic Signals Central System Upgrade.** VDOT is in the process of upgrading its traffic signals central system statewide to the KITS system. The deployment of KITS in the NoVA District is anticipated by mid-2021 and for the Fredericksburg District by the end of 2021. The RM3P system will interface with the KITS systems in both districts to obtain all VDOT traffic signal data.(The descriptions presented below identify additional VDOT initiatives related to traffic signals that have an impact on the capabilities of the data that the KITS system will provide.)
- **Signal controller and communications upgrade.** The type 170 controller was the most advanced controller available when installed in 1996; in the intervening 20 years, advances have been made in controllers that provide more features and ability to respond to traffic. To take advantage of all the features available, high-speed communication with the central system is essential. VDOT is in the process of upgrading the traffic signal controllers and communications to type 2070 ATC controllers and TCP/IP-based communications.
- **Transit Signal Priority (TSP).** VDOT and local jurisdictions have expressed strong interest in deploying Transit Signal Priority (TSP) in Northern Virginia; however, the type 170 controller limits the ability to quickly restore the programmed signal timing after TSP is triggered. With the new controller upgrade at all signals, VDOT has partnered with WMATA to deploy TSP along SR-7 as an operational strategy that facilitates the movement of in-service transit vehicles through traffic signals with modified green time. TSP has been implemented by WMATA at fifteen intersections along SR-7 between Fairfax Square in Tysons and Carlin Springs Road in Bailey's Crossroads, where NRO set a high priority to upgrade controllers and communications at these intersections.
- **Adaptive Control Systems (ACS).** VDOT initiated a feasibility study to identify potential opportunities to improve traffic operations and reduce delays along key arterial roadways using Adaptive Control System technology. VDOT has piloted two ACS in the I-66 corridor: one along Braddock Road and another along SR-236. While no two adaptive systems are the same and handles traffic operations optimizations in a unique fashion, the review determined which systems are best suited for the operational traffic conditions on the project arterials. VDOT has put a temporary hold on implementing the recommended ACS until the agency is fully migrated onto the new statewide central signal management system.
- **Proactive Signal Timing Optimization and Operations.** The VDOT Signal Operation team proactively monitors and adjusts signal timings in real-time using a central signal system; performs signal optimization by developing and implementing new timings; responds to internal and external customer concerns and requests; coordinates with local jurisdictions; and manages incidents and special events. Upgrade of the VDOT central signals system to the KITS Smart City Software Solution is substantially completed. About 63 intersections in NoVA have Automated Traffic Signal Performance Measure (ATSPM).
- **Arterial CCTV deployment.** While VDOT had deployed hundreds of CCTV cameras along interstate facilities for many years with nearly 100 percent viewing

coverage, the camera deployment at signalized intersections to aid arterial operations was only started in FY12. While approximately 80 intersections were identified as higher priority out of over 1,400 signalized intersections for the camera deployment, VDOT has completed the deployment of these cameras in FY17 with available resources. These cameras not only are used for supporting signal/arterial traffic management and incident management, but also for aiding special events as well as snow and emergency weather operations. These feeds are available for the general public's viewing via 511.

Arlington County, which manages and maintains its own roadway and signal network, has CCTV deployed along arterials throughout the County and is continuing to deploy more cameras. Arlington has been upgrading its communication backbone to fiber throughout the County to support its ITS deployments. Arlington has DMS deployed along US-29 and US-50 to show travel times within the County; these travel times are collected using Bluetooth sensors along the corridors within the RM3P Region.

Within Metropolitan Fredericksburg, there are both closed-loop signal systems and independent signals; the central traffic control is able to communicate with, and monitor all, traffic signals. The VDOT Fredericksburg District Signal System is responsible for controlling signals in all counties, including Metropolitan Fredericksburg, with a shared control between District Traffic Engineering and the TOC (this system primarily takes control in emergency situations.

4.3 Statewide Advanced Traffic Management System (ATMS)

VDOT has nearly completed its transition to its upgraded Statewide ATMS platform, Open TMS. The platform allows for ITS device management, roadway network monitoring, CAD feeds from the Virginia State Police and local police dispatch, and incident response plans that can be sent to operators based on the CAD feeds. Four of the five VDOT regions are actively utilizing the new ATMS, including the Northern and Central regions. The Eastern Region is in the process of cutting over to the new system.

4.4 Rail Transit ITS Systems

4.4.1 WMATA Metrorail

WMATA utilizes a smart-card fare payment system known as SmarTrip. SmarTrip cards are permanent, reloadable fare media that can be purchased and reloaded online, at any Metrorail station, and at many other locations in the Washington, D.C. area. Riders scan their cards to enter a Metrorail station and must scan them again to exit the station; fares are calculated on a station-to-station basis (as opposed to one system-wide fare or a zone fare structure). SmarTrip cards are also accepted by Metrobus and all other local bus transit providers in the Northern Tier, allowing riders to pay for multiple modes using the same media and, in some instances, obtain discounts for transfers. WMATA

aggregates this fare payment data into origin-destination data that it occasionally releases to the public.

WMATA Metrorail riders can access real-time train arrival information and trip-planning information through tools on WMATA's website, as well as a variety of third-party mobile applications. WMATA's online Rider Tools platform also provides elevator/escalator status and service alerts. Riders can sign up for MetroAlerts, which notify subscribers of Metro service disruptions via email or text messages; when additional information about an incident is available, a link to the website describing the information in more detail is sent as well.

WMATA provides real-time information on parking availability status, based on real-time entry and exit at Metro lots and garages. The availability status feature provides commuters with an estimate of available spaces, not an exact count. It uses a color-coded method to show available spaces; for example, green denotes ample parking spaces available, yellow denotes limited parking spaces, whereas red denotes the lot/garage is full and no spaces are available. The parking availability feature is currently offered for Metro-operated parking lots and garages only.

WMATA provides a suite of developer resources for creating third-party applications on the desktop, web, and mobile devices:

- The Metro Transparent Data Set's API includes the sequence and location of rail stations by line, train arrival predictions for each station, service alerts, and elevator/escalator status. WMATA also includes real-time train positions as part of this developer portal.
- The General Transit Feed Specification (GTFS) download provides the same official schedule data that supports Metro's online trip planner.
- RSS feeds provide subscriptions to Metro advisories and news releases and GTFS schedule releases.

4.4.2 Virginia Railway Express

VRE does not participate in the SmarTrip system, as its fare structure is aligned differently than that of Metrorail and the various local bus providers. VRE riders can purchase single-ride passes, day passes, five-day passes, ten-trip, and monthly passes; fare payment is inspected prior to boarding or on-board trains. Since 2015, VRE has offered a mobile ticketing platform in which riders can purchase fares and store them electronically on their mobile devices. VRE also provides an online interactive map for users to tracktrain locations (via GPS) and on-time arrival status. A developer page offers GTFS, GTFS-RT, and alert messages.

4.5 Bus Transit ITS Systems

All bus transit providers in the RM3P Northern Tier have their buses equipped with SmarTrip-compatible fare boxes. Riders can pay for trips with their SmarTrip cards or cash. WMATA's online trip planning tool is integrated with the other transit providers' static schedules and can suggest bus transfers to and from the Metrobus and Metrorail systems. Most agencies allow bus riders to reload value onto their SmarTrip cards while on board the bus.

4.5.1 WMATA Metrobus

WMATA has automated passenger counters (APCs) on all buses recording passenger boarding and alighting. APC can be coupled with its automatic vehicle location (AVL) system on all buses, which tracks the location of a bus along its route, to provide ad-hoc analysis of boarding and alighting by stop. WMATA does not currently monitor bus loads in real-time via a real-time integration of these systems. WMATA also does not currently record crowding at bus stops.

4.5.2 Fairfax Connector

Fairfax Connector has upgraded to a new, fully integrated on-board ITS system to enhance operational performance. As part of this system, automatic passenger counters (APCs) are deployed on all buses and integrated with a CAD/AVL system for tracking vehicle locations and monitoring vehicle loads in real-time. With this new ITS system, Fairfax Connector is able to track bus loads over time between stops and can tie ridership data to individual stops and time-of-day.

4.5.3 Loudoun County Transit

Loudoun County (LC) Transit has installed AVL on most of its buses. Riders can use the website from the transit agency's AVL vendor to track its buses. Riders can also use WMATA's trip planner, based on LC Transit's static bus GTFS schedule, to plan trips.

LC Transit does not have APCs on buses; however, ridership is tracked using the fare box counts and manual count data which is used as a check on fare box counts. LC Transit releases 120-day summaries of ridership for commuter trips to the Wiehle-Reston East Metrorail station and to destinations in Arlington and Washington, D.C.

LC Transit is currently not able to monitor passenger loads in real-time or near-real-time, as this would require its passenger-counting system to be integrated with its AVL system in real-time. LC Transit does monitor passenger loads on all runs each day, enabling them to add buses in when and where needed (assuming that new equipment is available). They use fare box data along with GPS data from the AVL system to determine where the buses fill up and where passengers are ultimately destined.

LC Transit has two forms of message notification for its passengers:

- Bus Biz is an email notification system for sending information to riders about the service, such as surveys for holiday schedules to changes in parking at park-and-ride lots.
- LC Alert is a real-time text-messaging system used when service is disrupted based on unanticipated road closures, detours, or major traffic delays. The alerts are sent if a bus is anticipated to be more than 10 minutes late. These are powered by the AVL system. Potomac and Rappahannock Transportation Commission (PRTC)

4.5.4 Potomac and Rappahannock Transportation Commission (PRTC)

PRTC has implemented a CAD/AVL system to its Omni bus fleet, including APCs. PRTC does not track on-time performance as a performance measure but is currently working on it. At present, ridership is derived from the electronic fare box data. For commuter routes defined by one major boarding and one major alighting location, monitoring passenger loads is straightforward. In conjunction with the deployment of its CAD/AVL system, PRTC has developed a real-time passenger information notification system, with a text or email being sent to riders according to preferences. PRTC's website has a trip-planning tool and transit information is available on Google. Their static GTFS feed is available through PRTC's website for third-party development. In addition to serving the public in the Prince William County, PRTC has extended commuter bus service south to Stafford and Spotsylvania counties as well.

4.6 Park-and-Ride Lot ITS Infrastructure

Many VRE lots in the project area feature systems that share information in real-time on parking occupancy.

The Washington Metropolitan Area Transit Authority (WMATA) operates parking facilities at 44 Metrorail stations, of which all 44 stations offer daily or hourly parking, motorcycle and bicycle parking, and accessible priority parking. Reserved parking is

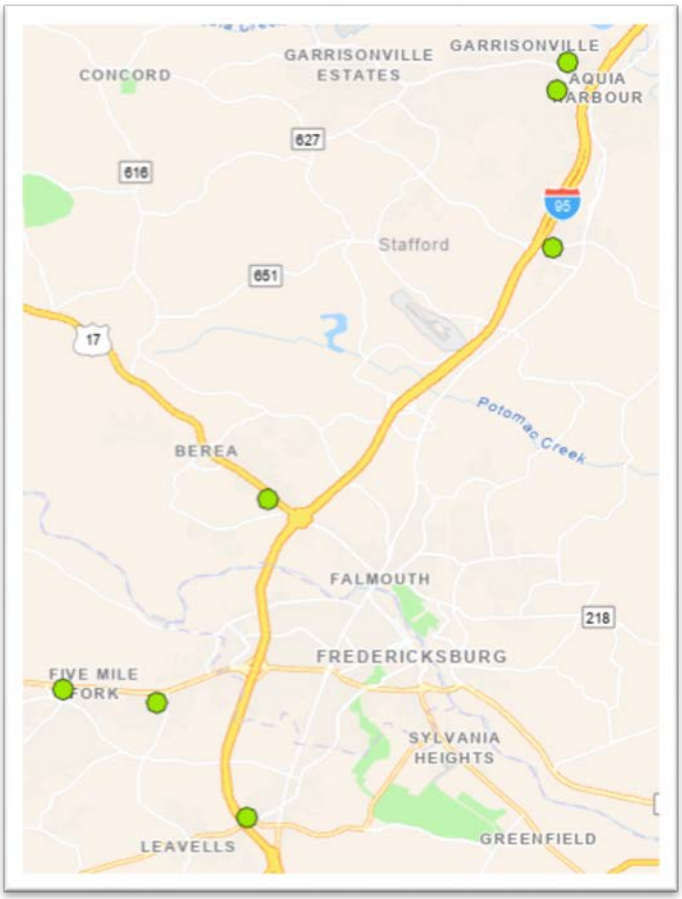

Figure 3: VDOT Owned Park-and-Ride Lots in Metropolitan Fredericksburg

offered at 36 stations. The parking availability status is based on the real-time entry and exit at Metro lots and garages, reflecting an estimate of available spaces (not an exact count) by using a color-coded scheme (i.e., green – ample parking spaces available, yellow – limited parking spaces available, red – lot/garage is full) at all their lots. The parking availability information is accessible to customers through the Metro website. WMATA also conducts monthly manual counts at several Metro parking locations to verify and reset the entry-exit counts.

VDOT provides an interactive online tool in which users can search for park-and-ride lots by region, by city/zip code, or via an interactive map. This mobile-friendly website provides information, such as the number of spaces including handicapped spaces, associated fees, whether the lot is served by transit service, and amenities such as whether the lot is paved and has bicycle accommodations. WMATA also provides detailed information about the lots it operates on its website, including real-time parking availability information. Similarly, VRE has data for the parking lots it owns; VDOT on the other hand, provides real-time parking availability information for the Park-and-Ride (P&R) facility at Haymarket only.

The Fredericksburg parking project will initially focus on the seven (7) VDOT-owned parking lots which consists of approximately 7,300 parking spaces as shown in Other non-VDOT owned (e.g., VRE, locality, private, university) parking facilities are not part of the current scope of work.

Table 3, below. Other non-VDOT owned (e.g., VRE, locality, private, university) parking facilities are not part of the current scope of work.

Table 3: VDOT Park-and-Ride Lots along I-95 Corridor in Metropolitan Fredericksburg

Priority	Lot Name	Owner	Jurisdiction	Total Spaces	Occupancy	Transit Service	Designated Slugging/ Carpool/Kiss-and-Ride
1	South Commuter Lot (Mine Rd)	VDOT	Stafford	750	100%	Yes	Yes
2	Staffordboro Blvd	VDOT	Stafford	1863	57%	Yes	Yes
3	Route 3 West/Gordon Rd	VDOT	Spotsylvania	1061	36%	No	Yes
4	Old Salem Church	VDOT	Spotsylvania	667	59%	Yes	No
5	Courthouse Road/Rt. 630	VDOT	Stafford	1100	N/A	No	No
6	Falmouth/Rt. 17	VDOT	Stafford	1034	43%	No	No
7	Houser Drive	VDOT	Spotsylvania	821	46%	No	No

4.7 Bicycle Network ITS Infrastructure

Arlington County provides a crowd-sourced “rack spotter” online tool to allow riders to locate nearby bike racks. This tool provides an interactive map with addresses of bike racks, types of racks and number of spaces, and photos and descriptions when available. This tool has been expanded well beyond Arlington County and shows bike racks throughout the Washington, D.C. area, including many within the RM3P Region.

Arlington County also provides an online and print “Level of Comfort” map for riders showing which facilities in the County are recommended for various rider levels of experience, as well as locations of hills and Capital Bikeshare stations. This map is currently available in a static format.

Capital Bikeshare (CaBi) offers a variety of publicly available data to developers for real-time applications as well as transportation planning purposes. It provides a live station status feed in XML and Generalized Bikeshare Feed Specification (GBFS) formats; this feed shows the number of bikes currently available at each station in the system. CaBi provides an archive of trip history data for download. CaBi also provides a dashboard for analyzing various performance metrics, including:

- Ridership by month,
- Trip O-Ds by municipality and station,
- Trips per time interval and percentage of trips per time interval,
- Miles travelled per month,
- Fleet performance metrics, such as bicycles in service, number of bikes inspected/repaired per month, and bicycles damaged per month,
- Customer service metrics, such as the number of instances customers have reported stations full or empty, and
- Membership metrics, including the total number of users and new members.

5 Need for RM3P Concept

This section describes the current issues with the system that the RM3P project will be addressing, the safety issues, congestion, impact of tourism, and information challenges.

NoVA is one of the most congested areas in the country. Although it has only 10 percent of the state's land area, NoVA accounts for nearly 37 percent of the population in the state, 22 percent of the registered vehicles, 29 percent of employment, 21 percent of the highway/road lane miles, and 21 percent of the total daily vehicle miles traveled (VMT). Significantly, more than 55 percent of the total vehicle hours of delay (VHD) on interstate highways across the state occur in NoVA. The area also boasts the second most utilized peak-hour public transportation network in the country that includes an extensive Metrorail & Metrobus system, seven local and regional bus systems, and the VRE commuter rail system. In addition, there are two international airports in the region that handle both commercial and freight traffic. Key safety, mobility, and reliability statistics for the region are summarized below.

Metropolitan Fredericksburg – comprised of Stafford and Spotsylvania counties and the City of Fredericksburg – occupies less than 2 percent of the state's area, but accounts for nearly 4 percent of the state's population. Because of the area's pivotal location along the I-95 corridor, traffic volumes in and through the area are significant.

Safety. Reducing the number of traffic crashes in the region remains a challenge, given increases in population, vehicle miles traveled (VMT), and the number of licensed drivers. According to the 2017 *Virginia Traffic Crash Facts Report by Department of Motor Vehicles*, a total of 127,375 crashes were reported in Virginia. Of these, 40,551 crashes (32 percent) occurred in Northern Virginia, while 5,638 crashes (4 percent) happened in Metropolitan Fredericksburg. The crash rate (per 100 million VMT) in NoVA of 152.2 is marginally higher than the statewide crash rate of 149.3 – both, however, are considerably lower than the national crash rate of 200.8.[4]

Table 4. 2017 Crash Statistics

Region	Total Crashes	Total Injuries	Total Fatalities	Crash Rate	Injury Rate	Fatality Rate
U.S.	6,452,000	1,889,000	37,133	200.8	58.8	1.16
Virginia	127,375	65,306	839	149.3	76.6	0.98
NoVA*	40,551	19,246	164	152.22	72.6	0.62
Metropolitan Fredericksburg Region	5,638	2,687	23	-	-	-

[4] https://www.dmv.virginia.gov/safety/crash_data/crash_facts/crash_facts_17.pdf

Source: NHTSA Highway Safety Statistics; 2017 Virginia Traffic Crash Facts Report; *Based on preliminary data

Mobility. Over the last three decades, Northern Virginia has diversified from a "residential-based" economy into one that is technology-intensive and knowledge-based. These factors, coupled with dispersion of major employment centers across the region, have contributed to significant growth in traffic congestion.

Nationally, drivers lost an average of 97 hours in congestion, wasting approximately 26 gallons of fuel, for an average of $1,348 per driver, and costing an aggregate $87 billion annually in time. Commuters in NoVA lost an average of 155 hours in congestion, wasting approximately 41 gallons of fuel, equating to a cost of $2,161 per commuter, and costing nearly $4.6B, as reported in the *2018 INRIX Global Traffic Scorecard*. The total hours lost in congestion in the region is more than 60 percent when compared nationwide, contributing approximately 5.3 percent of the overall nationwide cost of congestion and making it one of the top-ranked regions in terms of impact and time lost due to congestion.[5] Table 5 compares congestion values regionally and nationwide.

Table 5. Comparison of Congestion Metrics

Region	Time Lost in Congestion (Hours)	Delay per Commuter (Hours)	Excess Fuel per Commuter (Gallons)	Cost of Congestion per Commuter	Areawide Cost of Congestion (Dollars)
Nationwide *(2018)*	97	61	26	1,348	87B
NoVA *(2018)*	155	96	41	2,161	4.6B
NoVA *(2015)*	132	82	35	1,834	3.9B

Source: INRIX, 2018 Global Traffic Scorecard; TTI, 2015 Urban Mobility Scorecard; Represents Annual Data

Per the U.S. Census Bureau, average travel times in Northern Virginia are among the longest in the U.S., averaging more than 30 minutes when compared to the national average of 26 minutes. The travel time index (a ratio of actual travel time to travel time in free-flow conditions) across the region often exceeds 2.5, meaning the trips that should take 30 minutes under free-flow conditions require 75 minutes to complete. Traffic incidents on these roadways also contribute significantly to the congestion. Table 6 shows the annual vehicle hours-of-delay (VHD), crash and disabled vehicle incidents, and daily vehicle miles traveled (DVMT) across I-66, I-95, and I-395.

Table 6. VHD and Incidents on I-66, I-95 and I-395

Interstate	Vehicle Hours of Delay (Weekday AM)	Vehicle Hours of Delay (Weekday PM)	Crash & Disabled Vehicle Incidents (Weekday AM)	Crash & Disabled Vehicle Incidents (Weekday PM)
I-66	751,820	1,074,535	1741	2310
I-95	521,022	2,216,138	3142	3876
I-395	37,447	45,038	715	1054

[5] INRIX, 2018 Global Traffic Scorecard, pg. 9.

Represents annual 2018 Data, with Weekday AM between 5-10 and Weekday PM between 3-8

Reliability. Travel time reliability is an increasing concern for Northern Virginia commuters, particularly during peak driving times. Commuters typically adjust their schedules and build in a time cushion to their trip planning to account for variability due to traffic delays. These circumstances are routinely validated by the NoVA region residents, 65 percent of whom ranked "reliability" as their top priority in a long-range regional planning effort (*Visualize 2045*) survey.

The planning time index and buffer index are effective methods for measuring travel time reliability. VDOT has been aiming to improve travel times and safety through increased performance monitoring and management, so that travelers can more effectively determine the time needed to complete individual trips. Table 7, below, presents 2018 mobility metrics (travel time and travel time index). It shows congestion data on key segments of the three major interstates in the region, in both the directions.

The extent of reliability issues in the region is evident from the planning time index values of greater than 4 along some sections of I-95 and I-66. This means for a trip that ought to take 15 minutes, a commuter should budget 60 minutes to ensure on-time arrival 95 percent of time.

Interstate	Segment	Buffer Index (AM)	Buffer Index (PM)	Planning Time Index (AM)	Planning Time Index (PM)	Travel Time Index (AM)	Travel Time Index (PM)
I-95N	Exit 126 to	0.27	0.65	1.32	1.73	1.03	1.06
I-95N	Exit 133 to	0.17	0.17	1.77	1.21	1.11	1.02
I-95N	Exit 143 to	0.04	0.72	1.09	1.80	0.99	1.08
I-95N	Exit 152 to	1.04	0.86	2.89	2.09	1.55	1.13
I-95N	Exit 160 to	1.00	1.06	2.72	2.43	1.42	1.23
I-95N	Exit 170	0.34	1.73	1.51	5.89	1.11	2.67
I-95S	Exit 126 to	0.02	0.30	1.02	1.49	0.96	1.12
I-95S	Exit 133 to	0.02	1.28	1.02	3.46	0.96	1.79
I-95S	Exit 143 to	0.07	1.84	1.07	4.47	0.96	1.69
I-95S	Exit 152 to	NA	NA	0.99	1.34	0.90	1.06
I-95S	Exit 160 to	0.09	0.96	1.10	4.08	1.00	2.23
I-95S	Exit 170	0.04	0.32	1.06	1.53	0.98	1.14
I-395S	I-95 to GW	0.07	1.00	1.07	3.85	0.98	2.03
I-395N	I-95 to GW	1.23	1.42	4.01	3.08	1.76	1.50

Table 7: Mobility and Reliability Index

Represents 2018 Data, with Weekday AM between 5-10 and Weekday PM between 3-8

6 System Operational Concept

This section describes the operational concept for RM3P. It explains how things are expected to work once the RM3P initiative is operational; it also identifies the responsibilities of the various stakeholders for making this happen. Included are the goals and objectives, the user needs, and operational description.

6.1 RM3P Goals and Benefits

The overall RM3P goals are to:

- **Optimize transportation system performance by improving the efficiency of agency responses to travel disruptions**. Advanced prediction capabilities will forecast travel conditions some minutes into the future. Travel time estimates will be based on current and projected travel conditions, helping to improve the reliability of the information.
- **Enhance travel time reliability**. Current travel information using advanced prediction capabilities will give people a better understanding of how long a trip is likely to take, so they can plan when and where to travel accordingly. It will also result in more reliable travel times.
- **Support on-demand, multi-modal trip choices for travelers.** The availability of real-time data and partnerships with the public and private sectors will provide travelers with informed choices across multiple modes and routes.

Key benefits expected to accrue from RM3P include the following:

- **Coordinated responses to travel disruptions**. RM3P will help local, regional, and state agencies work together to more quickly and effectively resolve disruptions that slow travelers down by using decision-support technology and improved coordination. For example, if a Metrorail train derails, a temporary system of shuttle buses (known as a “bus bridge”) can be deployed more quickly, and train signals can be retimed, reducing the length of delays.
- **Improved safety**. RM3P has the potential to better orchestrate multi-agency responses to safety-related incidents. By removing road hazards more quickly, agencies responsible for roadway operations can reduce the number of crashes. Predictive technology, piloted in Las Vegas, has demonstrated crash reduction of nearly 20 percent.
- **Collaborative planning.** RM3P will provide transportation planners across the region access to better data and new analysis tools. This facilitates collaborative planning of their short-term operations and long-term planning to meet travelers’

needs. This is supported by FHWA's ICM Findings Report, which states that collaborative operational decisions benefit the corridor as a whole.

- **More reliable commute.** RM3P will provide the region's transportation network operators and private partners with real-time and predictive information about travel conditions (such as delays on roads and transit, and parking availability). This information, when shared with their customers, will help people make more informed choices about how and when to travel.
- **Enhanced connections.** Travelers in the region have different transportation service needs when events impact the region (such as major Metrorail track maintenance or a forecasted snowstorm). The increased availability of travel data will enable public and private transportation service providers, such as local buses, rail, bikeshare, and ride-sharing companies, to collectively address changes in travelers' needs.
- **Incentives for individual travelers.** RM3P will offer travelers incentives that vary based on current conditions, such as the encouraged use of routes or modes that maximize the efficiency of the transportation network. By making this choice, individual travelers help reduce congestion for all and allow everyone to get around more quickly and safely.

6.2 User Needs

User needs identify the high-level system needs; these user needs are developed to focus on the operational aspects of the project and to define the functional requirements of the proposed system. These needs are based upon the system goals, delineated above, and future operational conditions and scenarios. The user needs will be utilized during the requirements development of the next phase of the systems engineering process to prepare the high-level system requirements document.

6.2.1 User Needs Development

The following user needs pertain to the ATCMTD-sponsored components of RM3P:

Table 8: User Needs

Need ID	Need Statement	Priority (H, M, L)	Description
DS-N1	Need to predict incidents within the region	H	In order to be more proactive with incident management, predictions of when incidents are likely to occur needs to be provided to regional agencies for various incident types.
DS-N2	Need to predict recurring congestion within the region	H	To be more proactive with incident management, predictions of when congestion is likely to occur needs to be provided to regional agencies.
DS-N3	Need to predict non-recurring congestion within the region	H	To be more proactive with incident management, predictions of when congestion is likely to occur needs to be provided to regional agencies.

Need ID	Need Statement	Priority (H, M, L)	Description
DS-N4	Need to predict durations for incidents detected within the region	H	To be more proactive with incident management, predictions of when and how long an incident is likely to take and its impact on the network needs to be provided to regional agencies.
DS-N5	Need to predict impacts of the incidents	H	To be more proactive with incident management, predictions of how long an incident is likely to take and its impact on the network needs to be provided to regional agencies.
DS-N6	Need to evaluate and respond to recurring congestion within the region	H	To respond to congestion more effectively, regional agencies need to understand the likely impact and the best way to respond based on regional operating procedures.
DS-N7	Need to evaluate and respond to non-recurring congestion within the region	H	To respond to congestion more effectively, regional agencies need to understand the likely impact and the best way to respond based on regional operating procedures.
DS-N8	Need to evaluate and respond to events within the transit network within the overall network	M	To respond to events more effectively, regional agencies need to understand the likely impact and the best way to respond to transit events based on RM3P agency operating procedures (current procedures may need updating based on RM3P goals).
DS-N9	Need to evaluate and respond to events within the freeway network within the overall network	H	To respond to events more effectively, regional agencies need to understand the likely impact and the best way to respond to freeway events based on regional operating procedures.
DS-N10	Need to evaluate and respond to events within the arterial network within the overall network	M	To respond to events more effectively, regional agencies need to understand the likely impact and the best way to respond to arterial events based on regional operating procedures.
DS-N11	Need to store pre-agreed incident response plans	M	Regional agencies need a means to collect and store pre-agreed response plans to allow corridor agencies to understand collective roles and responsibilities communicate effectively and improve response times in reacting to events within the corridor.
DS-N12	Need to coordinate incident responses among agencies to ensure that conflicting responses are not enacted	H	Regional agencies need to coordinate responses and understand roles and responsibilities as well as jurisdictional boundaries, such that conflicting responses are not enacted, and the correct information is being provided to the public.
DS-N13	Need to coordinate incident responses among agencies to ensure prompt response to events	H	Regional agencies need to coordinate responses such that agencies understand roles and responsibilities and jurisdictional boundaries to ensure prompt response to events and accurate information is provided to the public.
DS-N14	Need to provide alternate route options to travelers	M	To reduce congestion and improve efficiency of the entire corridor, alternate route options need to be provided to the traveling public to allow them to make informed decisions about their trips. This information could be provided pre-trip or upstream of events.

Need ID	Need Statement	Priority (H, M, L)	Description
DS-N15	Need to provide detour route options to travelers	H	To reduce congestion and improve efficiency of the entire corridor, detour routes need to be provided to the public to allow them to make informed decisions about their trips due to the roadway closures. This information would be provided near events (within queue or approaching a queue).
DS-N16	Need to provide information on alternate modes of transportation to travelers	M	To reduce congestion and improve efficiency of the entire corridor, alternate modes of travel options need to be provided to the public to allow them to make informed decisions when planning trips or en-route.
DS-N17	Need to track and store history of enacted response plans	M	Regional agencies need to be able to track and store history of actions associated with pre-approved response plans after they have been enacted, to determine, if any changes are required to improve the response plans.
DS-N18	Need to assess the impact of an enacted response plan on the transportation network	M	During the response to an event in the corridor, the corridor agencies need to be able to determine whether the pre-planned response is effective and if the response is having the intended effect. This includes verifying what conditions exist after implementation of the response. If the operators of the systems determine that their response is not effective, they should be able to change components of their response plans or implement a new response plan.
DS-N19	Need to maintain and modify enacted response plans	H	As an event progresses and conditions change, agency operators should be able to modify the current response and communicate changes to other agencies within the corridor to effectively adjust to changing conditions and improve conditions in the corridor.
DS-N20	Need to maintain and modify stored pre-approved response plans	H	Regional agencies need to be able to make recommendations and modify pre-approved response plans, and communicate ideas with other agencies within the corridor, to improve response to conditions that will impact the corridor.
CP-N1	Need to gather static parking information including lot locations, names, capacity, available services, etc.	H	Static parking information will be collected as part of the RM3P project.

Need ID	Need Statement	Priority (H, M, L)	Description
CP-N2	Need to develop consistent format for parking lot static information and naming conventions for dissemination to data consumers.	H	Consistency in format of the parking lot static information will support the dissemination of parking location, capacity, typical usage, and available services information via multiple navigation apps and search engines and makes it easier for the public to search for parking lot information. This will require collaboration with stakeholders.
CP-N3	Need to standardize real-time information data feeds for dissemination from the RM3P parking system.	M	Several sources of real-time parking data exist in the region. Coordination with the agencies will be needed to determine the data integration requirements and specifications for integrating the data with the RM3P DEP.
CP-N4	Need to collect typical parking occupancy trend information.	H	Public agencies in the region periodically collect parking lot occupancy data at the P&R lots. The data can be analyzed by applying algorithms within the parking system to estimate typical lot usage information and provide it to the customers. Additional data collection will be required to analyze typical parking usage and trends manually, using temporary data collection technology or satellite image analysis.
CP-N5	Need to collect real-time parking information.	M	Real-time parking information from existing sources and high priority lots will be needed to optimize the use of parking capacity in the region.
CP-N6	Need to collect real-time parking availability data under a range of weather and lighting conditions.	L	This need relates to the deployment of real-time data technology at high-priority parking lots at VDOT- and locality-owned lots in the region. The data collection system should be able to collect reliable data under normal and adverse travel and weather conditions.
CP-N7	Need to collect parking availability data for parking lots of various layouts, access configurations, sizes, etc.	L	If deployed, the field data collection technology will need to provide reliable information independent of the lot size, layout, location, etc.
CP-N8	Need to integrate static, historic, and real-time parking information in a secure, redundant, and reliable system environment.	H	The static, historic, and real-time parking information will be integrated within the RM3P DEP.

Need ID	Need Statement	Priority (H, M, L)	Description
CP-N9	Need to process static, historical, and real-time parking data from different sources.	H	A processing system will be needed to calculate parking availability for specified lots based on the historic and real-time data, if available.
CP-N10	Need for an attractive parking data source for integration by private-sector data aggregators/providers and stakeholders operating in the region and customers.	H	In addition to the technical capabilities, the parking system should attract public- and private-sector data providers to integrate with it.
CP-N11	Need to exchange data with other RM3P element systems.	M	The AI-Based DSS, Multi-Modal Analytical Planner (MMAP), and Dynamic Incentivization will leverage data from the parking system.
CP-N12	Need to store and archive parking data.	H	Archived parking data can be used for planning and evaluation purposes, and to continue to refine algorithms for historic data analysis.
CP-N13	Need to monitor the status and reliability of the parking system.	H	The parking system will require monitoring to verify the data outputs and that the system is meeting accuracy and reliability requirements.
CP-N14	Need to provide specified performance metrics for system evaluation.	M	The system needs to archive specific information about the parking lot for post-deployment evaluation.
CP-N15	Need to predict parking availability	H	The real-time and historic data available from the RM3P initiative can be leveraged for AI-based parking availability prediction in the region.

While VDOT and its partner agencies do have some additional needs for operational improvements and efficiency, they are not included here since they do not relate directly to the needs of the RM3P initiative.

6.3 Concept Operational Description

RM3P will leverage the collaborative use of real-time data from Virginia's public- and private-sectors to improve travel safety, reliability, and mobility; as well as give the public tools to make more informed travel choices. RM3P will leverage artificial intelligence (AI) and machine learning to extract information from large data sets and develop intelligence on gaps and anomalies, and present information in real-time to transportation operators and the public to make better-informed decisions. The non-real-time information will be used by agencies for planning and supporting investment decisions. This is synonymous with RM3P's tagline: "Travel Decisions Powered by Data."

As noted previously, RM3P encompasses five interdependent and synergistic program elements:

- Data-Exchange Platform (DEP),
- AI-Based Decision Support System (AI-DSS),
- Commuter Parking Information System (CPIS),
- Multi-Modal Analytical Planner (MMAP), and
- Dynamic Incentivization (DI).

Although these program elements could each be implemented independently, by bundling them together into a thoroughly coordinated, fully-unified programmatic package, it is anticipated that the utility – and benefits – of the RM3P concept will be optimized. Note that the implementation of these coordinated strategies will almost certainly necessitate the development of a new and potentially complex set of inter-jurisdictional cooperative agreements/understandings and operating procedures.

The relationships among the key elements comprising RM3P are depicted in Figure 4. Those program elements that are ATCMTD-sponsored are highlighted by the use of blue-filled boxes.

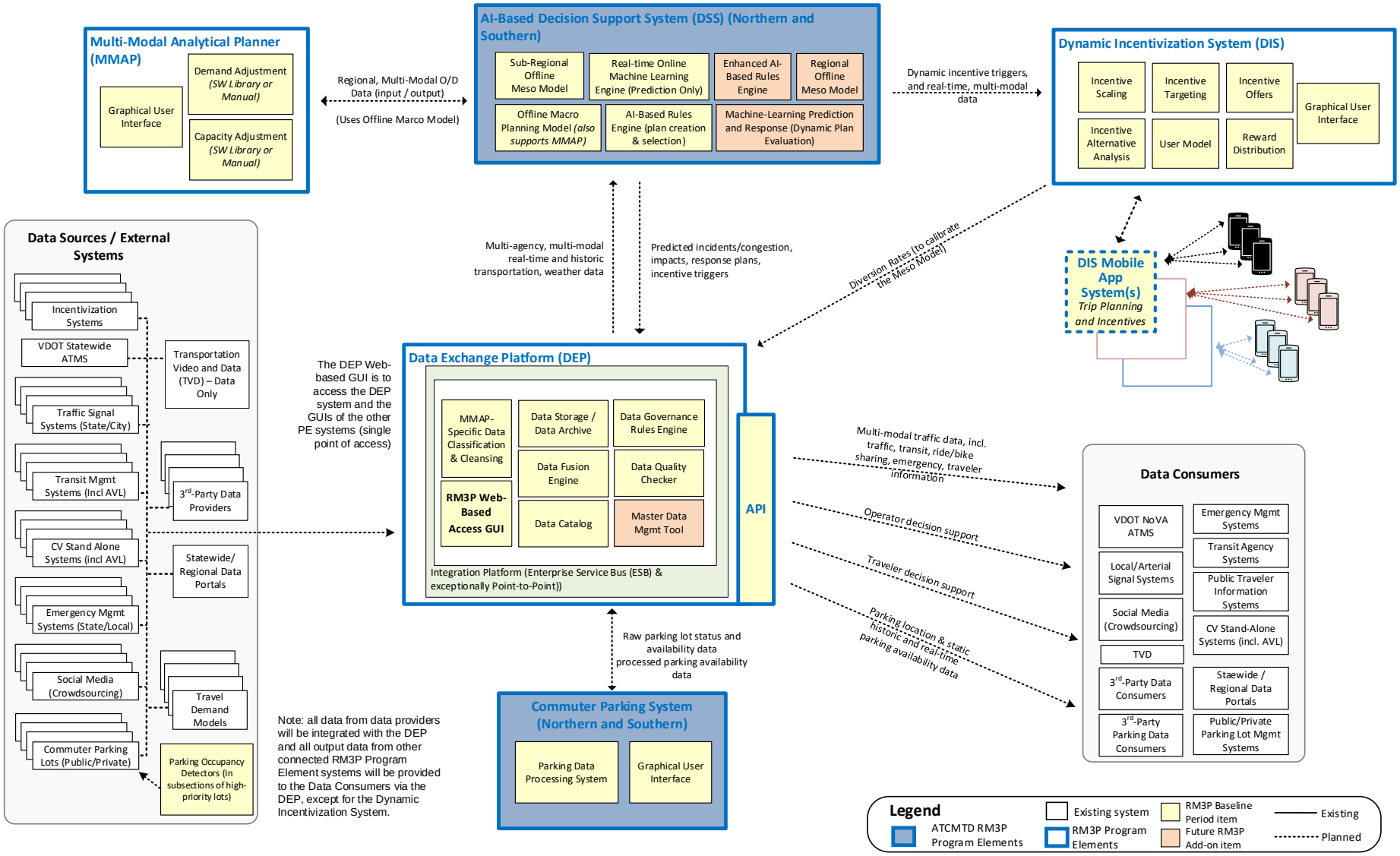

Figure 4: RM3P Logical Architecture

7 User Story Scenarios

In systems development and product management, a user story is an informal, natural language description of one or more features of a system. Typically, a user story is a very high-level definition of a requirement, containing just enough information so that system developers and integrators can reasonably estimate of the level-of-effort necessary to implement the concept. User stories are often written from the perspective of the end-users of a system.

The following user stories offer views of RM3P systems and services from the vantage points of different RM3P stakeholders. The focus is on AI-DSS and CPIS since these are the program elements sponsored, in part, by the ATCMTD.

7.1 AI-Decision Support System User Stories

Operational agencies within the region will have the ultimate decision-making responsibility and must have the ability to accept, reject, or modify actions suggested by the DSS during events and non-recurring congestion. Operators in each agency will be aware of the readiness of their system to carry out the response plans and will be responsible for communicating their actions to the other partner agencies, whether through the DSS or through other forms of communication.

Incident response teams and emergency services will be notified pre-emptively with incident prediction capabilities to pre-position response vehicles and other equipment to potential incidents. The functional areas that will use the DSS include:

- Bus Operations (Local, Commuter/Express) (i.e., PRTC, Fairfax Commuter Express, WMATA)
- Traffic Signal Operations
- Toll Operations (public, and private)
- Freeway Operations
- Emergency Services (Police, Fire, EMS)
- Safety Service Patrol
- Commuter Rail Operations (i.e., VRE)
- Subway/ Rail Operations (i.e., Metro)
- Parking Availability Management
- Incentivization Program Providers
- Mobility Gap Analyst System
- Tow-and-Recovery Services

7.1.1 User Story: Managing an Incident on I-395

Overview: Emergency and operating agencies within the region cooperatively manage an accident on
I-395 supported by predictive analytics and a decision support system.

Concepts and Services Included: Data Fusion, Decision Support, Prediction, Coordinated Signal Control, Regional Traveler Information.

Story:

1) Based on historical incident data, current traffic conditions, and time-of-day, the Virginia State Police (VSP) pre-positions police vehicles along I-395 near potential crash zones, as calculated by the prediction system.
2) From cellular or landline 911 reports, VSP is alerted to a possible incident on I-395 within Arlington County. The VSP dispatch creates a new incident and transfers the incident to a dispatcher for response. In the event of injuries or possible injuries, paramedic units (typical response is one paramedic truck and a transport ambulance) are notified via telephone.
    a) An incident reporting source may be transit dispatchers receiving reports from bus drivers on routes. These reports become transit “incidents” in the RM3P system and are passed to the Data-Exchange Platform (DEP) for further dissemination via 511 and agency websites.
3) The Data Fusion System acquires the incident data from the VSP CAD System Feed, and the DSS analyzes the incident information, time-of-day, location, and current traffic conditions to select a coordinated response plan. The VDOT Traffic Operations Center (TOC) operator receives an automatic incident notification from the DSS via the RM3P System. The RM3P System disseminates law enforcement data (traffic-related only) to all subscribed stakeholders as an “external” event for information only (until notified otherwise).
4) The VSP dispatcher confirms the existence of the incident, exact incident location, and associated supplementary information as received from investigating officers through online systems or other means. The Data Fusion System receives periodic CAD updates as they occur. Tow-and-recovery resources are called based on agreements.
5) Local jurisdictions exchange congestion and field device status information throughout the incident duration (via the RM3P system), including nearby incidents that might exacerbate the arterial incident or impact alternative roadway routing used in detours.
6) The DSS provides local stakeholders with current congestion information from surrounding roadways, detours, and roadway device activation and associated messages.

7) Filtered information concerning the arterial incident and the response actions may be disseminated to 511, mobile applications, and local websites (3rd Party websites, local agency websites, etc.)
8) The following additional actions may be taken for major incidents – the specific need for and order of action depend on the specific incident situation.
    a) VSP may activate emergency road closures to isolate the incident. This, in turn, requires coordination with the local police departments, city traffic signal operators along detour routes and impacted arterials, VDOT, and other local operating agencies.
    b) For extended blockages or closures (major incident), pre-computed Signal Timing Plans may be activated on diversion routes by individual jurisdictions within the region.
9) The event information is received by the incentivization vendor through the DEP API, and the incentivization program, in turn, provides users with incentives through the mobile app to change their route, their modes, or delay their trip in order to reduce the impact of the incident on the local transportation network.

7.1.2 User Story: Managing an Incident on the Franconia-Springfield Parkway

Overview: Emergency and operating agencies within the region cooperatively manage an accident on Franconia-Springfield Parkway supported by predictive analytics and a decision support system.

Concepts and Services Included: Data Fusion, Decision Support, Prediction, Coordinated Signal Control, Regional Traveler Information.

Story:

1) A vehicle traveling towards I-95 on the Franconia-Springfield Parkway overheats and catches on fire near the entrance to the Springfield Town Center. The fire closes the Parkway in both directions, limiting access to I-95 and to the Franconia-Springfield Metro Station.

2) From cellular or landline 911 reports, local police are alerted to the possible incident in Springfield. Due to the closure on the local road, the I-95 exit ramps begins to back up onto I-95. The local fire department arrives on scene and assumes control of the event. Local police are contacted to assist with traffic control, and the event is recorded in the data store from the 911 CAD system.

3) The DSS receives the event and evaluates the impact to the other nearby networks. A response plan request is provided to agency operators to close the ramp from I-95 to Franconia-Springfield, reroute local traffic around the Parkway into and out of the Franconia-Springfield Metro stop, and adjust signal timings at affected intersections. Metro is notified that the Blue Line may be impacted due to the fire response and the local congestion. The Fairfax Connector is notified of the incident and its potential

impact on local bus service, which in turn modifies its services, if possible, to increase capacity of the bus service to offset the reduced Metro service.

4) VSP arrives on-scene to close the I-95 ramps. VDOT updates DMS messages and 511 to notify drivers of the closure. Safety Service Patrol is also on-scene to assist with traffic control.

5) The local traffic signal timing plans are adjusted to account for the ramp closure, and transit signal priority is activated for the buses exiting the Metro station.

7.1.3 User Story: Managing a Transit Incident

Overview: Transit service is disrupted due to a derailment, which impacts the service and requires a bus bridge. The RM3P AI-DSS provides a coordinated response to assist with the bus bridge by activating transit signal priority and activating detour routing of vehicles near the derailment location.

Concepts and Services Included: Data Fusion, Decision Support, Prediction, Coordinated Signal Control, Regional Traveler Information.

Story:

1) A westbound train is involved in a derailment near the East Falls Church Station. The Train Engineer notifies the Rail Operations Center of the incident.

2) Local police are dispatched to the incident. The Data Fusion System receives notification of the incident from the Rail Management System with the location, description, and estimated duration. The stakeholders in the vicinity are also notified via the RM3P AI-DSS.

3) Since both directions of the rail line are shut down for an extended period, WMATA Bus Operations is notified to provide a bus bridge between the stations north and south of the crossing. Arlington County's traffic signal systems receive notification through RM3P AI-DSS to change to a specific signal timing plan and/ or provide transit signal priority to facilitate the bus bridges.

4) WMATA and local agencies provide information about the Rail delays to local media, and VDOT updates the 511 system with the relevant information.

7.1.4 User Story: Managing a Special Event During Inclement Weather

Overview: Pre-planned special event with real-time changes needed due to a weather event. The Prediction Engine determines a potential weather event, which requires some coordinated response via the Decision Support System.

Concepts and Services Included: Data Fusion, Decision Support, Prediction, Coordinated Signal Control, Regional Traveler Information.

Story: The distinguishing characteristic of a special-event scenario is the elevated need for coordination between regional networks. A Joint Traffic Operations Center (JTOC)

may be formed well in advance for centralized coordination of transportation and public safety operations during the special event. The VDOT Situation Room, VSP Situation Room, and EOC would be activated. Typical special events affecting the I-95 corridor would include 4th of July celebration in DC, among many others.

1) The Event Coordinator and other affected agencies develop a special event plan which outlines traffic control strategies, security needs, etc. Special events are entered into the DSS from multiple sources, depending on event needs.

2) The DSS disseminates planned special event data to affected public safety agencies, transit agencies, VDOT, and local jurisdiction traffic control systems.

3) The DEP receives special event inputs from affected agencies (public safety, transit, and traffic), which are sent to the DSS for evaluation and potential additional response plans.

4) VDOT, transit, and local traffic agencies implement event services and traffic control strategies including field device activation and portable sign deployment, etc.

5) VDOT and local jurisdictions use the DSS to exchange device control, and real time congestion and incident data as agreed by the plan.

6) The DEP provides special event data and traffic plans to the ATMS system. The regional operators disseminate real-time traffic conditions to the motoring public and other subscribers.

7) During the 4th-of-July celebration, a weather event unexpectedly begins, with heavy rain and wind. The prediction system calculates the impact to speed and congestion levels due the weather and sends the prediction to the DSS for evaluation against a special set of rules for the special event.

8) The DSS recommends changes to ramp closures and signal timing plans to reduce congestion and potential for crashes on the roadways during the weather event.

Special events require well-coordinated plans for managing expected traffic as well as emergency response plans.

7.1.5 User Story: Managing an Incident Outside of the RM3P Region

Overview: Emergency and operating agencies within the region cooperatively manage the impact of an incident which occurs outside the RM3P region.

Concepts and Services Included: Data Fusion, Decision Support, Regional Traveler Information System.

Story:

1) Through regional center-to-center (C2C) systems, VDOT and TOC receive an incident report for an incident that has occurred on I-495 Eastbound in Maryland

2) The DEP acquires the incident data from the regional C2C data feeds, and the RM3P DSS analyzes the incident information, time-of-day, location, and current traffic conditions. Since the incident does not occur within the RM3P region, and currently has not impact on the RM3P area, the DSS does not select a response plan.

3) As the incident progresses, it begins to cause congestion and backup on I-495 into the RM3P region. Based on the updated information, the DSS re-evaluates the conditions every 15 minutes, until the conditions meet the rules within the DSS to enact a response plan.

    a) The Rules Engine selects a pre-defined response plan to be enacted based on the conditions, time of day, and location of the incident. The response plan directs VDOT to update DMS messages with incident information, and recommended detours for drivers traveling towards Maryland.

4) Other strategies include to provide pre-trip information through 511, and recommendations to travels to either use a different route, or to delay their trips. The event information is received by the incentivization vendor through the DEP Store API, and the incentivization program, in turn, provides users with incentives through the mobile app to change their route, their modes, or delay their trip in order to reduce the impact of the incident on the local transportation network.

7.2 Commuter Parking Information System User Stories

The user stories described in this section are as follows:

- Static parking information to a navigation application,
- Historic parking occupancy data for typical usage information dissemination,
- Real-time parking information,
- Predicted parking information, and
- Interrelationship with other RM3P program elements from an operator perspective.

The user stories include information on system background for additional context.

7.2.1 CPIS User Story #1: Static parking information to navigate application

System Background:

- VDOT conducts manual data-collection at all commuter parking lots in the region biennially to verify the number of spaces and estimate parking occupancy. The occupancy is based on point-in-time manual data-collection once every two years and does not provide detailed occupancy for different times-of-the-day. Some localities in the region collect parking occupancy data more frequently.
- VDOT provides park-and-ride location information to its customers via an interactive online map.[6]

[6] http://www.virginiadot.org/travel/parkride/home.asp

- The datasets that support this information are made available to the RM3P project team for analysis.
- As a first step, the team collaborates with VDOT, VRE, WMATA, and localities to develop a consistent format for the parking lot attributes, including common lot names based on locations. The dataset standards for static information are documented and made available for new commuter lots to follow.
- The dataset is updated to reflect the naming and format conventions for parking lot attributes and stored in the DEP.
- The RM3P team works with popular navigation application providers and search engine providers to understand their requirements for integrating the parking lot dataset with their apps.
- Refinements are made to the dataset based on their inputs.
- The static parking information data feed is shared with the navigation app providers and parking reservation system providers via a parking API hosted within the DEP.
- The navigation providers successfully integrate the feed with their applications.

Story:

1) Around 6:30AM on a Tuesday morning, Sara is getting ready for work and checking traffic conditions on her favorite navigation app. She lives near Dale City and commutes to Alexandria.
2) The navigation app is showing a major traffic backup North of Dale City. As she is exploring her options, Sara notices that the map user interface is showing the PRTC Transit Center parking lot nearby. Details about the lot include a link to the location, parking capacity, transit services provided, and an estimated overall lot occupancy (based on typical conditions) of 66%.
3) This data is not real-time, but still provides basic information to help Sara decide which lot may have spaces available. She reviews morning and afternoon bus schedules from the PRTC Transit Center and the bus stop near her office, and double checks that she has her SmartTrip card with her. She taps on the parking icon on her phone to get directions to the lot.
4) On arrival at the lot, she finds a space to park and takes the PRTC bus to her destination. The bus takes advantage of the less congested Express Lanes to get her to Alexandria on time.
5) When Sara rides the bus, she sees a poster about a mobile fare payment app; she downloads the app and plans to give it a try on her return trip in the afternoon.

7.2.2 CPIS User Story #2: Historic Parking Occupancy Data for Typical Usage Information Dissemination

System Background:

- In addition to the overall occupancy estimates, the RM3P project team needs detailed occupancy data to analyze parking patterns. The team gathers the needed data once every two weeks using temporary data-collection devices, manual counting, and non-real-time satellite image processing, etc. at high-priority lots on

Tuesdays, Wednesdays, and Thursdays for a period of 4 months spread across different seasons to account for seasonal changes in parking occupancy patterns.

- The team develops basic algorithms as part of the RM3P parking processing system to analyze the parking patterns at the lot and a time range for when the lots may have spaces available, a limited number of spaces available, or virtually no spaces at all (because the lot is nearly full).
- The data from the RM3P system is categorized based on availability level and can be provided as a color-coded parking availability status (red, yellow, green) with a note that the information is based on historic data. The data algorithms will be refined over time using data that will be archived by the DEP.
- The data is shared with search engines and navigation app companies via a parking API hosted within the DEP.

Story:

1) Jacob lives in Aquia and works at the Pentagon. He has two options for his commute – drive against morning rush hour traffic to park at the Staffordboro commuter lot and take Omni Express bus to the Pentagon or drive the general purpose/Express Lanes to the Pentagon.
2) Jacob is a planner and is interested in having a few more commuting options available in case his typical route is impacted by a major event. One weekend he uses a trip planning tool and comes across the option to park at the Dumfries Road commuter lot to take the Omni Express bus to the Pentagon. On further Internet search, he finds that the lot fills up around 7AM. He notes down the information and bus schedule for future use.
3) Jacob is about to leave for work one Wednesday morning, when his navigation app alerts him that Garrisonville Road is flooded due to a water main break, causing major traffic backups in the area, and slowing access to the Staffordboro lot. Luckily, it is only 6:00AM and he had already planned for this scenario.
4) He checks the route to the Dumfries Road lot – it will take him 30 minutes to drive there. The navigation app also shows that, based on historic information, the lot should have spaces available and typically fills up around 7:00AM.
5) Jacob leaves his house at 6:15AM to make sure he arrives at the lot on time and finds a parking space.
6) Jacob had never used slug lines in the past. While he waits for the bus at the lot, he observes how slug lines work. He searches online during his bus ride to find out that Dumfries is one of the destinations for Pentagon sluggers. He decides to give it a try on his return trip from work.
7) At the end of his day, Jacob waits at the Pentagon slug line pickup location to find a ride back to the Dumfries Commuter lot. During his carpool ride, he chats with the other passengers and learns about an app-based pre-scheduled carpool option, He thinks to himself that he has one more commuting tool to explore next time.

7.2.3 CPIS User Story #3: Real-Time Parking Information

System Background:

- The RM3P Commuter Parking Information System has integrated real-time parking data from existing sources, including WMATA and VRE and new RM3P data sources. The data is shared with the public- and private-sector via a parking API.

Story:

1) David, a regular commuter from Gainesville to Arlington, is driving along I-66 East. He is alerted to an emergency work zone near the West Falls Metro Station that is blocking the right lane, causing major congestion.
2) David pulls up a navigation app to check whether parking is available at the closest Metro station, which is Vienna. The icon on the map is showing red, i.e., the lot is full, but Dunn Loring is showing the parking availability status as green, meaning there are spaces available. The map is also showing the real-time schedule for the trains from the Dunn Loring Metro.
3) From experience, David knows that the WMATA/RM3P parking information is reliable, so he drives to the Dunn Loring parking lot and takes the Metro to his destination.

7.2.4 CPIS User Story #4: Parking Prediction Information

System Background:

- The RM3P Commuter Parking Information System has integrated real-time parking data from existing sources, including WMATA and VRE and new RM3P data sources. An AI-based parking prediction system uses the available data to predict the parking availability and share with the public- and private-sector via a parking API.

Story:

1) Liz commutes from Fredericksburg to Arlington. After being alerted to a major incident on I-95, she decides to take VRE from Spotsylvania station.
2) Liz pulls up a navigation app to check whether parking is available at Spotsylvania. The icon on the map is showing green, i.e., there is space available in the lot, but Liz is not sure if parking will still be available when she arrives.
3) Using RM3P's AI-based parking prediction technology, the app is able to provide her estimates for parking availability 15 minutes and 30 minutes in future. With this information, Liz is confidently able to drive to the parking lot and find a parking spot.

7.2.5 CPIS User Story #5: Interrelationship with Other RM3P Program Elements from an Operator Perspective

System Background:

- The 5 RM3P program elements are interrelated.
- The DEP will serve as a hub for integrating parking data from available sources and disseminating consolidated data using an API.
- The parking information system will support the Decision Support System (DSS) response actions, MMAP, and Incentivization elements.

Story:

1) It is around 6:00AM and Sam, an operator at PSTOC, just started her morning shift. She receives an alert that a major incident closed 2 lanes of I-395 NB near Duke Street during the morning rush hour.
2) Sam checks the RM3P DSS and, based on the incident location and traffic conditions data from the DEP, the DSS recommends a response plan that includes several response actions.
3) Part of the multi-modal response plan is to shift demand from the roadway to transit. This includes using data from the parking information system to identify commuter parking lots South of the incident that may have available parking. This information is sent to the DI system.
4) Drivers upstream of the incident receive an alert through the popular incentivization apps of their choice, offering them credit to their SmartTrip card (equivalent to the train or Metro fare) and 50 reward points (equivalent to $5), if they park at the Lorton commuter parking lot and take either the VRE train or Metro train.

8 List of Acronyms and Glossary

- ACS – Adaptive Control System
- AI – Artificial Intelligence
- APCs – Automatic Passenger Counters
- API – Application Programing Interface
- ATCMTD – Advanced Transportation and Congestion Mitigation Technologies Deployment
- ATIS – Advanced Traveler Information System
- ATMS – Advanced Transportation Management System
- ATSPM – Automated Traffic Signal Performance Measure
- AVL – Automatic Vehicle Location
- C2C – Center-to-Center
- CAD – Computer-Aided Dispatch
- CCTV – Closed Circuit Television
- CIA – Central Intelligence Agency
- CPIS – Commuter Parking Information System
- ConOps – Concept of Operations
- CSC – Customer Service Center
- CVs – Connected Vehicles
- DDOT – DISTRICT Department of Transportation
- DEP – Data-Exchange Platform
- DI – Dynamic Incentivization
- DMS – Dynamic Message Sign
- DRPT – Department of Rail and Public Transportation
- DSS – Decision Support System (also Decision Support Subsystem)
- DVMT – Daily Vehicle Miles Traveled
- EMS – Emergency Medical Services
- EOC – Emergency Operations Center
- FAMPO – Fredericksburg Area Metropolitan Planning Organization
- FHWA – Federal Highway Administration
- FTA – Federal Transit Administration
- FTP – File Transfer Protocol
- GIS – Geographic Information System
- GPS – Global Positioning System

- HAR – Highway Advisory Radio
- HOV – High Occupancy Vehicle
- HTTP – Hypertext Transfer Protocol
- HTTPS – Hypertext Transfer Protocol Secure
- ICD – Interface Control Document
- ICM – Integrated Corridor Management
- IEEE – Institute of Electrical and Electronics Engineers
- INCOSE – INternational Council on System Engineering
- ITS – Intelligent Transportation System
- ITTF – Innovative Technology and Transportation Fund
- LC – Loudoun County
- MATOC – Metropolitan Area Transportation Operations Coordination
- MDOT – Maryland Department of Transportation
- MMAP – Multi-Modal Analytical Planner
- MSA – Metropolitan Statistical Area
- MWCOG – Metropolitan Washington Council of Governments
- NoVA – Northern Virginia
- NRO – Northern Regional Office
- NVTA – Northern Virginia Transportation Authority
- OEM – Office of Emergency Management
- PRTC – Potomac and Rappahannock Transportation Commission
- PSAP – Public Safety Access Point
- PSTOC – Public Safety and Transportation Operations Center
- RITIS – Regional Integrated Transportation Information System
- RM3P – Regional Multi-modal Mobility Program
- SOC – Signal Operations Center
- SR – State Route
- SSP – Safety Service Patrols
- SysRS – System Requirement Specification
- SSL – Secure Sockets Layer
- TCIP – Transit Communication Interface Protocol
- TCP – Transmission Control Protocol
- TLS – Transport Layer Security
- TMDD – Traffic Management Data Dictionary
- TOC – Traffic Operations Center
- TSP – Transit Signal Priority
- TV&D – Transportation Video and Data
- USDOT – United States Department of Transportation

- USGS – United States Geological Survey
- VDOT – Virginia Department of Transportation
- VHD – Vehicle Hours of Delay
- VITA – Virginia Information Technologies Agency
- VMT – Vehicle Miles Traveled
- VRE – Virginia Railway Express
- VSP – Virginia State Police
- WMATA -Washington Metropolitan Area Transit Authority

Appendix C – RM3P/ATCMTD Evaluation Plan – Draft

Project Overview

The Virginia Department of Transportation (VDOT) and its state, regional, and municipal partners are transforming multi-modal transportation in Northern Virginia. The *Regional Multi-Modal Mobility Program* (RM3P) initiative implements a host of priority projects based on the plans that were previously developed for integrated corridor management (ICM). The RM3P initiative has three program goals, namely: (1) optimize performance, (2) enhance reliability, and (3) support traveler choice; and is being funded through the Commonwealth's Innovation and Technology Transportation Fund (ITTF). Key elements of the RM3P concept are depicted in Figure 1.

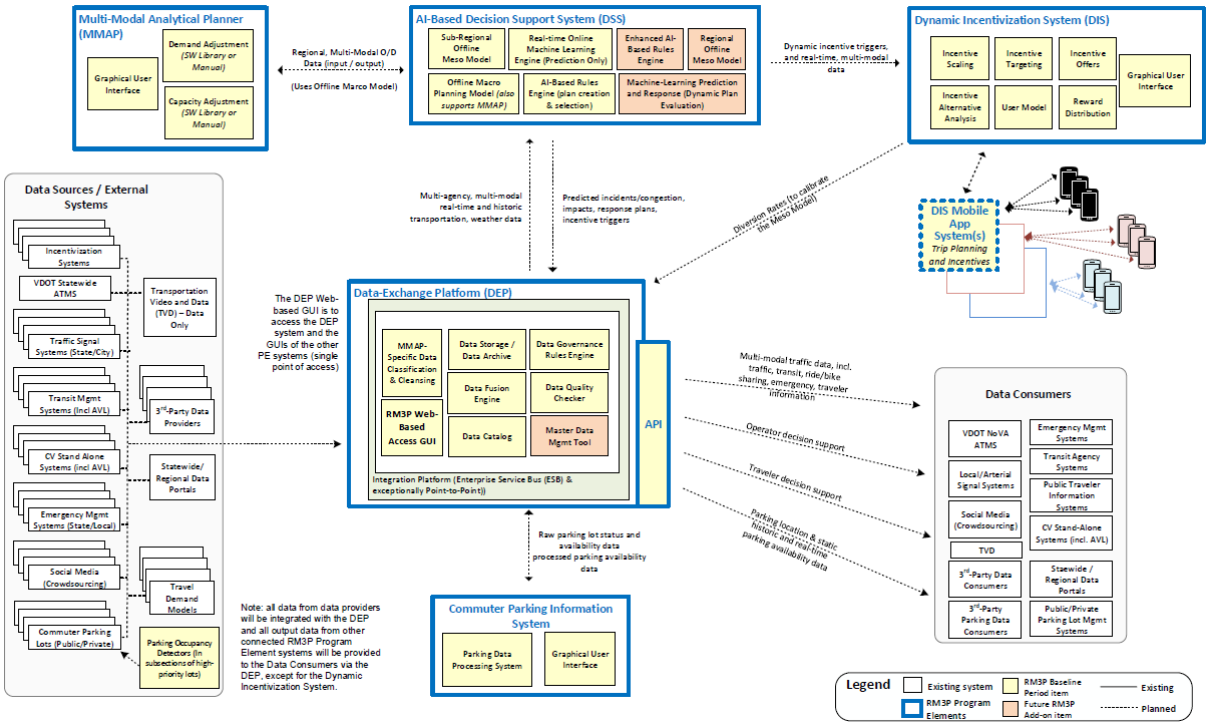

Figure 1. RM3P Concept (ATCMTD extension to Fredericksburg consists of parts of AI-based DSS and CPIS, along with the necessary DEP components)

VDOT's Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD) projects will leverage the investment in RM3P by expanding elements of RM3P south to the Fredericksburg area. The two projects that will be funded using ATCMTD grant funds are described below.

ATCMTD Project 1: Develop and Deploy Predictive Parking Availability Information Using Artificial Intelligence (AI) in Northern Virginia and Fredericksburg

Optimizing parking supply and demand – and communicating parking availability to commuters – is an important component towards improving transportation system performance across the region. The availability of real-time parking information can influence commuter mode choice and mobility. In addition

to the commuter parking project being implemented under RM3P, two parking technology projects are planned for Northern Virginia and Fredericksburg using ITTF funds as follows:

- In Arlington County, a performance parking program involves deploying value-pricing technology to on-street parking in Crystal City-Pentagon City and the Rosslyn-Ballston corridors. This technology will automatically raise parking prices on busy blocks and, conversely, lower prices on blocks where parking vacancies are abundant.
- VRE has deployed sensors and electronic signs in support of real-time parking data-collection and data-dissemination at eight VRE commuter lots in Stafford County, the city of Fredericksburg, and Spotsylvania County. In addition, the Commonwealth's investment in collecting real-time parking data at the commuter Park & Ride lots in Fredericksburg, with an emphasis on the I-95 corridor, will enrich the quality and prevalence of parking information for the area.

The ATCMTD effort will enhance these two sets of projects by implementing AI-based technologies to use a combination of historical data, samples of real-time parking data, and crowdsourcing information to more effectively predict parking availability status. The parking data will be made available to Virginia 511 and private third-party providers for integration with their mobile applications and delivery to customers. The data will also be furnished to partner agencies for dissemination to their respective customers. By alerting commuters to the existence of unoccupied parking spaces, this project is expected to optimize the use of commuter parking spaces and to promote ridesharing and public transportation for improved mobility in the region.

ATCMTD Project 2: Expand AI-Based Decision Support System Capabilities to the Fredericksburg Area along the I-95 Corridor

Individual agencies operating in the region already perform regular traffic operations and incident/event response operations. However, coordinated responses between regional agencies have typically been performed manually and on an ad-hoc basis. The region has lacked a comprehensive decision support system (DSS) to assist with coordinated responses to events and conditions that impact mobility in Northern Virginia. Under RM3P, ITTF funds are used to implement a sophisticated DSS that employs advanced machine-learning techniques and artificial intelligence to automatically generate incident and congestion management responses based on real-time conditions. The ATCMTD effort will extend the advanced DSS capabilities southward, along the I-95 corridor, to Fredericksburg.

To summarize, the following major technologies will be deployed for the ATCMTD projects:

- AI-based technologies to effectively predict availability of commuter parking.
- Comprehensive AI-based Decision Support System (AI-DSS) that will employ simulation, artificial intelligence, and/or advanced machine-learning techniques to automatically generate incident and congestion management responses based on real-time conditions.

Project stakeholders, roles, and responsibilities

The main project stakeholders are the Virginia Department of Transportation (VDOT) and three partners – the Virginia Department of Rail and Public Transportation (DRPT), the Northern Virginia Transportation Authority (NVTA), and the Fredericksburg Area Metropolitan Planning Organization (FAMPO). The recipient and administrator of this grant will be the VDOT Office of Strategic Innovation (OSI). A total of nearly 50 stakeholder organizations are participating in implementation of the broader RM3P initiative. Arlington County parking manager has co-lead with VDOT for developing the concept and high-level requirements for the Commuter Parking Information System while Virginia Railway Express (VRE) and

other agency stakeholders were actively involved. A wider set of agencies (operations, transit, public safety, engineering, academia) participated in the AI-DSS concept and high-level requirements developments.

The executive management organization for the project is depicted in Figure 2. The VDOT Director of Innovation and Research oversees the overall project effort for VDOT, with guidance and decision-making from the Executive Committee, which includes the four partners (VDOT, DRPT, NVTA, and FAMPO) and FHWA. The VDOT Office of Strategic Innovation, serving as the RM3P Program Managers, will manage the day-to-day project, with assistance from five senior program and technology specialists within VDOT, DRPT, NVTA, and FAMPO. The PM contractor will report directly to the VDOT Program Manager. VDOT will function as the administrative and technical manager for the project. DRPT will serve as the liaison/advocate to the region's transit community. NVTA and FAMPO will oversee regional planning, funding, and implementation activities and serve liaisons/advocates to their respective localities. An independent third party evaluator will be contracted to perform the evaluation of system effectiveness. This document will discuss the evaluation methodology that will be used by that evaluator.

The project evaluation committee structure and members are shown in Figure 3. The evaluation committee reports directly to the program principal, and has been directly involved with the overall project planning and execution from the beginning. The evaluation committee met in February 2020 for a formal kick-off, and has been meeting virtually since to determine the overall scope and timeline of the evaluation, identify performance measures of interest, and data availability/needs/constraints etc. The data elements needed from the RM3P vendors have been specifically identified and shared with the program manager for incorporation into individual program element vendor contracts. To reap the highest benefits of evaluation with the lowest cost, the independent evaluator will be brought onboard once RM3P program elements start to be deployed.

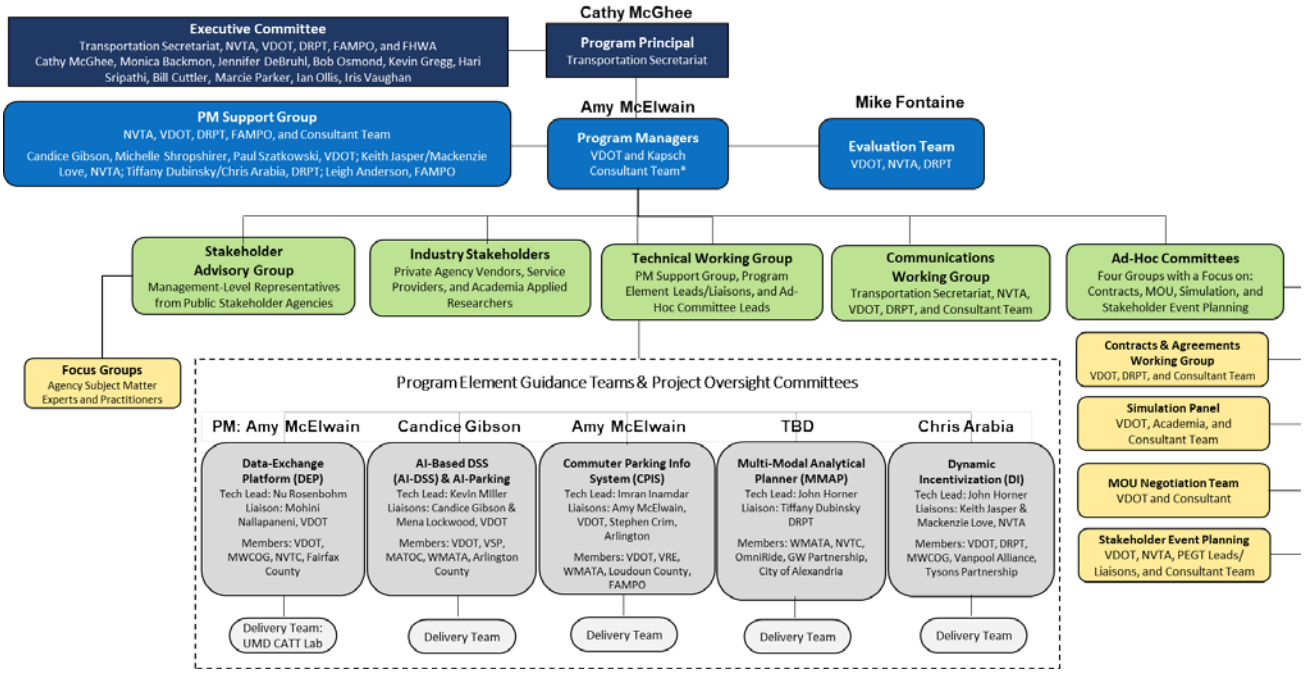

Figure 2. RM3P Organization Chart

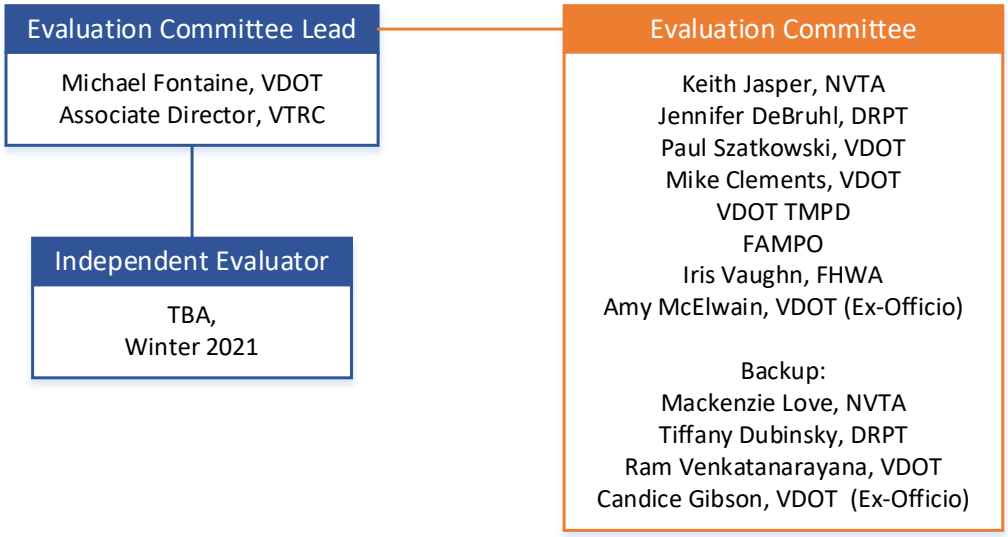

Figure 3. RM3P Evaluation Organization Chart

Project Success Metrics

The ATCMTD projects are anticipated to provide the following benefits:

- *ATCMTD Project 1: Deploy Predictive Parking Availability Information Using Artificial Intelligence (AI) in Northern Virginia and Fredericksburg*
  - Gathering real-time parking information using a crowd-sourcing and infrastructure-light approach reduces the cost of implementation and maintenance:
  - For motorists in urban areas, parking information reduces the stress of finding parking spots and, consequently, the chances for crashes. It also improves mobility and travel-time reliability because cruising for parking spaces will be minimized and drivers will know where to locate parking, respectively.
  - Parking information for commuter lots will encourage mode choice and carpooling.
- *ATCMTD Project 2: Expand Decision Support System to the Fredericksburg Area*
  - The extension of the DSS to Fredericksburg will help improve incident response times and potentially reduce secondary crashes. Overall coordination across transportation agencies in the region will positively impact mobility, safety, and reliability.

Deployment and evaluation schedule

Table 1. Schedule of the ATCMTD Projects and their Evaluation

Activity	Start Date	End Date	Key Deliverables
Solutioning and Project Management	Apr. 19, 2021	Dec. 31, 2023	• Project Schedule • Stakeholder Engagement· • Reports: Quarterly & Annual
ATCMTD Initial Report Deliverables	Apr 19, 2021	May 18, 2021	• Systems Engineering Management Plan (SEMP) due as applicable • Data Management Plan • Project Evaluation Plan
Project Communications	Apr. 19, 2021	Dec. 31, 2023	• Ongoing communications among initiative partners, other stakeholders and travelers.
Refinements to RM3P Documentation to include Proposed ATCMTD Projects	Apr 19, 2021	Jun 30, 2020	• Updated Scope, Needs, Features, and High-level Requirements (Draft and Final)
System Development for Project #1 and Project #2 (bundled procurement):*	Oct. 2021 or vendor NTP date, whichever is earlier	Oct 2023	• Predictive Parking Availability Information System & Decision Support System Expanded to Fredericksburg • Base service: 2 months of vendor NTP • Expanded service: 18 months of vendor NTP • Full Service: 24 months of vendor NTP
Operate and Maintain	Oct 2023	Oct 2024	• 1st Year operation support after development is part of the project contract initial term, funded by VDOT.
Final (Evaluation) Report	Oct 2023	Jan 2024	
Project Close Out	Jan 2024	Apr 2024	

***** With the Agile process, there will be many iterative testing/acceptance/launch during the project development. It will not happen at the end of development.

Evaluation Goals/Objectives, Evaluation Questions, and Performance Measures

The evaluation goals, objectives, questions along with the performance measures, data sources, data elements of interest, and limitations/constraints are presented in Tables 2 and 3. It should be noted that the limitations and constraints presented in Table 3 pertain to normal data source and calculation constraints. A different, abnormal and overarching confounding factor for project delivery and consequently the evaluation is the presence and evolution of COVID-19 impacts on the transportation industry as well as the entire society.

COVID-19 related health concerns and public policies have significantly altered teleworking, transit use, economy, tourism, schools etc. in recent times compared to their historical trends from previous years. As the roadway and transit traffic demand patterns in the next few years are difficult to forecast, targets are not specified for the performance measures in this section. Instead, trends over time will be monitored and reported towards project evaluation. The ATCMTD evaluation will be closely coordinated with the larger RM3P evaluation.

Table 2: Evaluation Goals, Objectives, and Evaluation Questions

Goal Area (Technology)	Objective	Evaluation Question
Improve Effectiveness of Real-Time Integrated Transportation Information (Predictive parking using AI)	Provide motorists with access to real-time and forecasted parking information to make more informed travel decisions	How satisfied are commuters with the predictive parking deployment (includes ease of decision making in start-time/route/mode, time saved in finding parking spot, reduced commuting stress)?
		Has travel associated with searching for parking been reduced on roads near parking lots/garages?
		How much are parking lots utilized and how accurate is the predicted parking information? (these two questions are interrelated)
Improve Effectiveness of Real-Time Integrated Transportation Information (expanded DSS)	Provide an integrated data platform for all agencies to efficiently respond to and clear incidents	Did incident responders from different agencies feel increased efficiency in communication and coordination?
		How accurate is the predicted DSS information?
Reduce Congestion/ Improve Mobility (Predictive parking using AI and expanded DSS)	Improve travel times and travel time reliability	What impact did predictive parking and DSS have on vehicle hours of delay?
		What impact did DSS and predictive parking have on travel time reliability?

Goal Area (Technology)	Objective	Evaluation Question
		What impact did DSS have on incident duration?
Improve Safety (Predictive parking using AI and expanded DSS)	Reduce traffic crashes	To what extent has predictive parking using AI and DSS reduce traffic crashes along I-95 NB and SB?
Cost Savings and Improved Return on Investment (Predictive parking using AI and expanded DSS)	Provide cost savings to transportation agencies	What was the benefit-cost ratio of predictive parking using AI and DSS?
Share Institutional Insights (Predictive parking using AI and expanded DSS)	Lesson Learned	What lessons learned did project managers identify to facilitate future successful deployments of predictive parking using AI and DSS?

Table 3: Evaluation Performance Measures and Methodology

Evaluation Question	Performance Measure	Information Source/ Method	Data Element	Limitations/ Constraints
How satisfied are commuters with the predictive parking deployment?	% of respondents who feel parking information was helpful for making commuting decisions	Survey	Survey response in post-survey or in app	Low sample sizes and response rates may be an issue
Has travel associated with searching for parking been reduced on roads near parking lots/garages?	Average reduction in traffic volumes and VMTs (vehicle miles traveled)	ATCMTD and VDOT datasets	Traffic volume and segment lengths	Increasing VMT and construction; pandemic induced demand changes; separating effects of different technologies and RM3P vs. ATCMTD areas not possible
How much are parking lots utilized and how accurate is the predicted parking information?	Trends in % parking utilization and % error between predicted and	Field data collected for ATCMTD and ATCMTD logs	Number of parking spaces available; Predicted	Low sample sizes

Evaluation Question	Performance Measure	Information Source/ Method	Data Element	Limitations/ Constraints
	actual parking availability		number of available parking spaces	
Did incident responders from different agencies feel increased efficiency in communication and coordination?	Qualitative responses of agency staff of what worked well and what can be improved	Surveys, focus groups or interviews	Staff response to survey/interview questions	Low sample sizes; Increasing VMT and construction; pandemic induced demand changes;
How accurate is the predicted DSS information?	% error between DSS predictions and actual conditions in field	Field data collected for ATCMTD and ATCMTD logs	Predicted and actual traffic volumes and speeds/travel times	Possible low sample sizes depending on when DSS is activated
What impact did predictive parking and DSS have on vehicle hours of delay?	Average reduction in vehicle hours of delay, normalized by VMT	VDOT dataset; RM3P and ATCMTD Data Lake/Store	Probe speed data and VDOT traffic volumes	Increasing VMT and construction; pandemic induced demand changes; separating effects of different technologies and RM3P vs. ATCMTD areas not possible
What impact did DSS and predictive parking have on travel time reliability?	Average reduction in PTI80 on I-95NB and SB sections	VDOT dataset	Probe speed data	Increasing VMT and construction; pandemic induced demand changes; separating effects of different technologies and RM3P vs. ATCMTD areas not possible
What impact did DSS have on incident duration?	Reduction in average incident duration, for comparable before-after incidents using case studies	RM3P and ATCMTD Data Lake/Store Case study	Incident details and logs	Increasing VMT and construction; pandemic induced demand changes; separating effects of different technologies and

Evaluation Question	Performance Measure	Information Source/ Method	Data Element	Limitations/ Constraints
				RM3P vs. ATCMTD areas not possible
To what extent has predictive parking using AI and DSS reduce traffic crashes along I-95 NB and SB?	Reduction in total crashes in the corridor	RM3P and ATCMTD Data Lake/Store	Crash data	Increasing VMT and construction; pandemic induced demand changes; separating effects of different technologies and RM3P vs. ATCMTD areas not possible
What was the benefit-cost ratio of predictive parking using AI and DSS?	Net present value	Benefit-cost analysis	Monetized estimates of project impacts	Increasing VMT and construction; pandemic induced demand changes; Incomplete data; Some impacts are difficult to quantify; separating effects of different technologies not possible, limited "after" data set available for evaluation
What lessons learned did project managers identify to facilitate future successful deployments of predictive parking using AI and DSS?	Lessons Learned	Interviews	Responses to questions about lessons learned	Findings for one project may not generalize to other locations

Data Collection Procedures and Data Management

The data-exchange platform (DEP) shown in Figure 1 is a significant and foundational component of the RM3P and the ATCMTD projects, and will be described in full detail in the data management plan (DMP). This section explains the data management from an evaluation perspective. Most of the evaluation data will be part of this foundational data platform, and will be managed as an integral part of the projects themselves. Some evaluation data will be collected via surveys and interviews, as noted in Table 3. Some data such as parking ground truth and DSS ground truth will be manually collected during select times of the project (or in select situations). Probe based speed data and traffic volume data are already collected and archived by individual agencies. Benefit-cost estimation will require the monetizing of benefits using standard rates of benefits (such as dollars saved per incident duration) in the literature.

For agency surveys, key staff will be identified by the stakeholders during the project. For user surveys, app subscribers will be approached within the app, or separately. The survey questions will mirror the evaluation questions and performance measures in Tables 2 and 3. Further details of data collection will be developed by the independent evaluator, in conjunction with the project stakeholders including the FHWA, to ensure the highest levels of validity and usefulness within the budget available and the future circumstances.

Data storage

The RM3P and ATCMTD data will be stored in the DEP. Other individual agency data such as travel time, volumes, crashes will be stored in other agency data sets and accessed as needed for this project. All these agency datasets have independent quality checks and flags built in already. The DEP will be developed and managed by the vendor, UMD CATT Lab, who will share the data with the evaluator.

Privacy

Surveys are the only instruments in this evaluation plan that have a direct correlation to individual staff or users. Privacy will be maintained for all user data by using only anonymous data to the independent evaluator. Staff responses will be dissociated from individuals on an as-needed basis to increase the value of the lessons learned (especially negative ones) for others. Wherever such concerns do not exist, individuals will be attributed with qualitative responses, both for transparency and for further potential follow-up interviews by other, future ATCMTD developers.

Data fusion

Wherever the performance measures in Table 1 require the fusion of multiple datasets, the individual evaluator will fuse (or conflate) all the relevant data based on timestamp and location or other fields, as needed.

Appendix D – State Corporation Commission Form

NOTE: This form is to be completed and included in the EOI response to the RFQ.

Virginia State Corporation Commission ("SCC") registration information. **The Supplier:**

☐ is a corporation or other business entity with the following SCC identification number: _____ **-OR-**

☐ is not a corporation, limited liability company, limited partnership, registered limited liability partnership, or business trust **-OR-**

☐ is an out-of-state business entity that does not regularly and continuously maintain as part of its ordinary and customary business any employees, agents, offices, facilities, or inventories in Virginia (not counting any employees or agents in Virginia who merely solicit orders that require acceptance outside Virginia before they become contracts, and not counting any incidental presence of the Supplier in Virginia that is needed in order to assemble, maintain, and repair goods in accordance with the contracts by which such goods were sold and shipped into Virginia from Supplier's out-of-state location) **-OR-**

☐ is an out-of-state business entity that is including with this proposal an opinion of legal counsel that accurately and completely discloses the undersigned Supplier's current contacts with Virginia and describes why those contacts do not constitute the transaction of business in Virginia within the meaning of § 13.1-757 or other similar provisions in Titles 13.1 or 50 of the Code of Virginia.

****NOTE** >>** Check the following box if you have not completed any of the foregoing options but currently have pending before the SCC an application for authority to transact business in the Commonwealth of Virginia and wish to be considered for a waiver to allow you to submit the SCC identification number after the due date for proposals (the Commonwealth reserves the right to determine in its sole discretion whether to allow such waiver):

☐

Appendix E – DBE/SWaM Business Subcontracting Plan

NOTE: This appendix is provided for informational purposes only. A formal DBE/SWaM Subcontracting Plan does not have to be included in the EOI response to the RFQ. However, your RFQ response must detail out your plans for DBE and SWaM participation in the project. See RFQ Section 1.E and Section 3.D.2.

All DBE and small/micro businesses must be certified by the Commonwealth of Virginia, Department of Small Business and Supplier Diversity (DSBSD) by the due date of the solicitation to participate in the DBE/SWAM program. Certification applications are available through DSBSD online at www.DSBSD.virginia.gov (Customer Service).

Definitions:

"Disadvantaged Business Enterprise (DBE)" means a for-profit small business concern that is at least 51 percent owned by one or more individuals who are both socially and economically disadvantaged or, in the case of a corporation, in which 51 percent of the stock is owned by one or more such individuals; and whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.

"Small business" means a business, independently owned and controlled by one or more individuals who are U.S. citizens or legal resident aliens, and together with affiliates, has 250 or fewer employees, or average annual gross receipts of $10 million or less averaged over the previous three years. One or more of the individual owners shall control both the management and daily business operations of the small business. (Code of Virginia, §2.2-4310)

"SWaM Business" is an entity certified as a Small, Woman-Owned, or Minority business by DSBSD.

"Micro Business" is a certified Small Business under the SWaM Program and has no more than twenty-five (25) employees AND no more than $3 million in average annual revenue over the three-year period prior to their certification. (Code of Virginia, § 2.2-4310)

"Women-owned business" means a business that is at least 51% owned by one or more women who are U.S. citizens or legal resident aliens, or in the case of a corporation, partnership, or limited liability company or other entity, at least 51% of the equity ownership interest is owned by one or more women who are U.S. citizens or legal resident aliens, and both the management and daily business operations are controlled by one or more women.

"Minority-owned business" means a business that is at least 51% owned by one or more minority individuals who are U.S. citizens or legal resident aliens, or in the case of a corporation, partnership, or limited liability company or other entity, at least 51% of the equity ownership interest in the corporation, partnership, or limited liability company or other entity is owned by one or more minority individuals who are U.S. citizens or legal resident aliens, and both the management and daily business operations are controlled by one or more minority individuals. (*Code of Virginia*, § 2.2-4310)

Proposer Name: _____

Preparer Name: _____ **Date:** _____

Instructions:

A. I**f you <u>are certified</u> by the Department of Small Business and Supplier Diversity (DSBSD) as a DBE/SWaM business, complete <u>only Section A</u> of this form.** This shall not exclude DSBSD-certified women-owned and minority-owned businesses when they have received DSBSD small business certification.

B. **If you are <u>not</u> a DSBSD-certified DBE/SWaM business, <u>complete Section B</u> of this form.** For the offer to be considered and the offeror to be declared responsive, the offeror shall identify the portions of the contract that will be subcontracted to DBE/SWaM businesses.

<u>Section A</u>
If your firm is certified by the Department of Small Business and Supplier Diversity (DSBSD), are you certified as a (**check only one below**)

_____Disadvantaged Business Enterprise/Women-owned
_____Disadvantaged Business Enterprise/Minority-owned
_____Micro Business
_____Small and Women-owned Business
_____Small and Minority-owned Business

Certification Number: _____ Expiration Date _____ _____
(Micro/SWaM only)

<u>Section B</u>
DBE/SWaM Business Subcontracting Plan
All Disadvantaged Business Enterprises (DBE) and small businesses must be certified by the Commonwealth of Virginia, Department of Small Business and Supplier Diversity (DSBSD) by the due date of this solicitation to participate in the DBE/SWaM Business Program. Certification applications are available through DSBSD online at www.sbsd.virginia.gov.

It is the goal of the Commonwealth of Virginia that more than 42% of its purchases be made from small businesses. All offerors are required to submit a DBE/SWaM Business Subcontracting Plan for this solicitation with their bid/offer.
If there is a DBE goal for this solicitation, offerors must meet the DBE goal with DBE certified firms or demonstrate good faith efforts. Many DBE firms are also SWaM certified firms; however, only certified DBE firms may be used to meet the DBE goal.

If the DBE goal is 0%, offerors which are small businesses themselves will receive the maximum available points for the small business participation plan evaluation criterion, and do not have any further subcontracting requirements.

Offerors which are not certified small businesses will be assigned points based on proposed expenditures with DSBSD certified small businesses for the contract period in relation to the offeror's total price for the contract period.

Points will be assigned based on each bidder's/offeror's proposed subcontracting expenditures with DSBSD certified small businesses for the initial contract period as indicated in Section B in relation to the offeror's total price.

The Contractor shall not receive credit both toward its DBE goal and toward its SWaM Business Subcontracting Plan for utilizing the same subcontractor(s) to perform or provide the same goods and/or services. The Contractor can use the same subcontractor to perform or provide different goods and/or services and receive credit both towards the Contractor's DBE goal and the SWaM Business Subcontracting Plan.

1. Disadvantaged Business Enterprise (DBE) Requirement

Populate Table 1 to show your firm's plan for the utilization of DBE certified firms to be utilized on the contract. The offeror shall indicate the description of the category (S, M SP, H) and the type of work that each DBE firm will perform and the allowable credit per work item to be performed.

Note: The amount of allowable credit for a DBE supplier is 60% of the total cost of the materials or supplies obtained and 100% for a DBE Manufacturer of the materials and supplies obtained. An offeror may count 100% of the fees paid to a DBE hauler for the delivery of materials and supplies to the project site, but not for the cost of the materials and supplies themselves.

The DBE Goal for this procurement is 12%.

Table 1: DBE Requirement

DBE Firm Name & Certification No.	**Indicate if: Women-owned (W) or Minority–owned (M) and SWaM (S)**	**Contact Person, Telephone & Email**	**Indicate if: Subcontractor (S), Manufacturer (M); Supplier (SP), Hauler (H)**	**Type of Work, Goods, and/or services**	**Amount of allowable credit**
	☐W ☐M ☐S				
	☐W ☐M ☐S				
	☐W ☐M ☐S				
	☐W ☐M ☐S				

Total $_____

Total Contract Value_____ x DBE Requirement _____% = $_____

Percent Attained By Offeror _____%

2. Micro/SWaM Subcontracting Plan

Populate Table 2 to show your firm's plans for utilization of DSBSD certified small businesses in the performance of this contract for the initial contract period in relation to the offeror's total price for the initial contract period. Certified small businesses include but are not limited to DSBSD certified women-owned and minority-owned businesses that have also received the SBSD small business certification. Include plans to utilize small businesses as part of joint ventures, partnerships, subcontractors, suppliers, etc. It is important to note that the proposed participation will be incorporated into the subsequent contract and will

be a requirement of the contract. Failure to obtain the proposed participation percentages may result in breach of contract.

Plans for Utilization of DSBSD-Certified Micro/SWaM Businesses for this Procurement

Table 2: Micro/SWaM Subcontracting Plan

Micro/SWaM & Address Certification No.	**Indicate if: Women-owned (W) or Minority–owned (M)**	**Contact Person, Telephone & Email**	**Type of Goods and/or Services**	**Planned Involvement During Initial Period of Contract**	**Planned Contract Dollars During Initial Period of the Contract ($ or %)**
	☐W ☐M				
	☐W ☐M				
	☐W ☐M				
	☐W ☐M				
Total $					

Appendix F – Enterprise Cloud Oversight Service (ECOS) and Assessment Questionnaire

NOTE: This appendix is provided for informational purposes only. The attached ECOS Assessment Form does not have to be completed and included in the EOI response to the RFQ. However, offerors down-selected under the RFQ process may be required to furnish this information as part of their proposals.

Enterprise Cloud Oversight Service (ECOS) provides oversight functions and management of cloud based services, specifically focused on software as a service (SaaS). The service assures compliance and improved security by providing transparency through VITA oversight.

The service assures consistent performance from suppliers through service level and performance monitoring. Agencies benefit from flexibility with growing business demands by ensuring adequate security controls are in place for the protection of data, proper utilization of resources and compliance with regulations, laws and timely resolution of audit recommendations.

ECOS minimizes the need for exceptions in obtaining external SaaS services. ECOS provides a flexible and custom option for obtaining SaaS services which meet the specific needs of the agency. The service offers guidance and oversight activities for agencies in the following areas:

- Meeting commonwealth requirements, such as SEC 501 and SEC 525
- Incorporating appropriate contract terms and conditions to mitigate risk
- Completing Annual SOC2 Type II assessment reviews
- Ensuring vulnerability scans and intrusion detection are conducted
- Patching compliance of suppliers environment
- Ensuring architectural standards are met
- Monitoring performance against Service Level Agreements (SLAs)

ECOS is a service specifically created for third party vendors offering **software as a service (SaaS) applications**.

SaaS is the capability to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The provider manages or controls the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user specific application configuration settings.

SaaS Characteristics include:

- Network-based access to, and management of, commercially available software
- Access to provider's services through an internet connection to a third party hosted facility
- A one-to-many model (single instance, multi-tenant architecture) for service delivery
- A common architecture for all tenants, usage based pricing, and scalable management
- Third party management of the service including functions such as patching, upgrades, platform management, etc.
- A multi-tenant architecture with a single, centrally maintained, common infrastructure and code base shared by all users and applications
- Subscriber/user managed access for the application
- Provider-based ***data custodianship and server administration*** for the service

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Attachment A for Standard Form 1-003: ECOS Assessment			
Work Request #	xxx	**Date**	
Notes & Comments			
Please ensure every section in this document is fully completed and you do not simply reply with Yes, No, or Not Applicable (NA) response. It is expected that there will be enough information provided to ensure that VITA is able to determine how the security objective is being met. This will help assist with streamlining the process.			
Please complete the below fields for agency name, supplier name and requested Cloud service/product name.			

Requesting Agency	Supplier Name	Supplier Product/Service Name	Approved PGR#

Note:

1. An answer of 'Yes' to all questions or answering 'No' to any of the questions in the assessment does not automatically constitute an approval, nor will the latter constitute automatic disqualification. Each response will be assessed and reviewed.
2. This assessment does not address all of the requirements outlined in the "Hosted Environment Information Security Standard", as the security standard contains both agency and supplier requirements. This assessment addresses supplier specific requirements that typically raise concerns from the Vendor and/or VITA.
3. As this is just an assessment, all Vendors still need to comply with all applicable Commonwealth Security Standards located at http://www.vita.virginia.gov/library/default.aspx?id=537
4. **Supplier**: When responding to questions contained within this questionnaire you **must** submit copies of the supporting policies or procedures or screen grabs of the applicable section of the supporting policies and procedures to support your responses where applicable.

Agency & Supplier: Please acknowledge by entering the authorized name(s) below and current date that you have read and understand the above 'Note' and all of the applicable security standards.

Agency Authorized Contact:		**Date**	
Supplier Authorized POC:		**Date**	

SEC 525 Mapping Document for SaaS Control Group	CGID	525 CID	525 Mapping	Control Specification	Assessment Question	WR Number		xxx	
						Assessment Response			
						Yes	No	N/A	Explanation of response
Cloud Classification & Configuration	CCC-1	CCC-1.0	EC -1	Ensures appropriate information security guards are established.	Is the cloud solution you are proposing a Software as a Service, Platform as a Service, or Infrastructure as a Service Delivery Model				
Cloud Classification & Configuration	CCC-2	CCC-2	EC - 2	Establishing, monitoring, and operating IT systems in a manner consistent with COV Information Security policies and standards	Are you offering Public, Private or government cloud? Please describe the solution support model.				
Access Control: *Policies & Procedures*	ACP-1	ACP-1.1	AC-1	Develops, documents, and disseminates to all organization personnel, contractors, and service providers with a responsibility to implement access controls:	Does the provider have access control policies and procedures that are reviewed and/or updated at least annually or required due to environmental changes?				
Access Control - Account Management	ACP-2	ACP-2.1	AC-2	User access policies and procedures shall be established, and supporting business processes and technical measures implemented, for restricting user access as per defined segregation of duties to address business risks associated with a user-role conflict of interest.	Does the solution have the capability to identify and select the following types of accounts: Individual, group, System, Service, Application, Guest/anonymous and temporary?				
		ACP-2.2			Does the provider have the capability to segment and identify administrative accounts by tenant?				
		ACP-2.3			Are controls in place to prevent unauthorized access to your application, program or object source code, and assure it is restricted to authorized personnel only?				
		ACP-2.4			Does provider document how access to tenant data is granted and approved?				
		ACP-2.5			Is timely deprovisioning, revocation or modification of user access to the organizations systems, information assets and data implemented upon any change in status of employees, contractors, customers, business partners or involved third parties?				
		ACP-2.6			Do you provide tenants with documentation on how segregation of duties within proposed cloud service offering are maintained? Please provide copy of procedure(s)				
		ACP-2.7		Control Enhancements for Sensitive Systems Removal of Temporary/Emergency Accounts.	Does the provider or solution automatically terminate temporary and emergency accounts after a predetermined period which is not to exceed 30-days in accordance with sensitivity and risk? Please provide copy of procedure(s)				
					Do you provide open encryption methodologies (3.4ES, AES, etc.) to tenants in order for them to protect their data if it is required to move through public networks (e.g., the Internet)?				

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					Do you require at least annual certification of entitlements for all system users and administrators (exclusive of users maintained by your tenants)?				
					If users are found to have inappropriate entitlements, are all remediation and certification actions recorded/documented? If different actions are taken for Admin and User Accounts, please provide information on both.				
		ACP-2.8		Disable Inactive Accounts	Does the provider or solution automatically disable inactive accounts after 90 consecutive days of non-use?				
		ACP-2.9		Inactivity logout	Does the solution logout users automatically when the session inactivity time has exceeded 30 minutes?				
Access Control - Access Enforcement	ACP-3	ACP-3.1	AC-3	The information system enforces approved authorizations for logical access to information and system resources in accordance with applicable access control policies.	Are policies and procedures established for labeling, handling and the security of data and objects that contain data?				
Access Control - Separation of Duties	ACP-4	ACP-4.1	AC-5	User access policies and procedures shall be established, and supporting business processes and technical measures implemented, for restricting user access as per defined segregation of duties to address business risks associated with a user-role conflict of interest.	Are controls in place to prevent unauthorized access to your application, program or object source code, and assure it is restricted to authorized personnel only? Provide documentation on controls in place to prevent unauthorized access.				
					Are controls in place to prevent unauthorized access to tenant application, program or object source code, and assure it is restricted to authorized personnel only? Provide documentation on controls in place to prevent unauthorized access.				
Access Control - Least Privilege	ACP-5	ACP-5.1	AC-6	The organization employs the principle of least privilege, allowing only authorized accesses for users (or processes acting on behalf of users) which are necessary to accomplish assigned tasks in accordance with organizational missions and business functions.	Do you document how you grant and approve access to tenant data? Please procedure for doing this.				
		ACP-5.2			Do you have a method of aligning provider and tenant data classification methodologies for access control purposes?				
		ACP-5.3			Will you share user entitlement remediation and certification reports with your tenants, if inappropriate access may have been allowed to tenant data?				
Access Control - Unsuccessful Logon Attempts	ACP-6	ACP-6.1	AC-7	Enforces a limit of 3 consecutive invalid logon attempts by a user during a 15 minute period;	Do you allow tenants/customers to define password and account lockout policies for their accounts? Provide system password requirements and policies.				
		ACP-6.2		Automatically locks the account/node for a minimum of a 30 minute period when the maximum number of unsuccessful attempts is exceeded.	Do you support password (minimum length, age, history, complexity) and account lockout (lockout threshold, lockout duration) policy enforcement? Please provide policies for both standard and admin accounts.				
		ACP-6.3		Password Policy must meet or exceed current password policy defined in SEC 501.	Do you support tenant defined password complexity policies? Specify your password length and complexity requirements in the notes field				

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Awareness and Training - Policy and Procedures	ATP-1	ATP-1.1	AT-1 AT-2 AT-2-COV AT-3 AT-4	Employment agreements shall incorporate provisions and/or terms for adherence to established information governance and security policies and must be signed by newly hired or on-boarded workforce personnel (e.g., full or part-time employee or contingent staff) prior to granting workforce personnel user access to corporate facilities, resources, and assets.	Do you specifically train your employees regarding their specific role and the information security controls they must fulfill?				
		ATP-1.2			Do you document employee acknowledgment of training they have completed?				
		ATP-1.3			Are all personnel required to sign NDA or Confidentiality Agreements as a condition of employment to protect customer/tenant information?				
		ATP-1.4			Is successful and timely completion of the training program considered a prerequisite for acquiring and maintaining access to sensitive systems?				
		ATP-1.5			Are personnel trained and provided with customer defined awareness programs at least once a year?				
Audit and Control -Audit and Accountability	AUC-1	AUC-1.1	AU-1	Audit plans shall be developed and maintained to address business process disruptions. Auditing plans shall focus on reviewing the effectiveness of the implementation of security operations. All audit activities must be agreed upon prior to executing any audits.	Do you produce audit assertions using a structured, industry accepted format (e.g., Cloud Audit/A6 URI Ontology, Cloud Trust, SCAP/CYBEX, GRC XML, ISACA's Cloud Computing Management Audit/Assurance Program, etc.)?				
		AUC-1.2			Are your audits performed at least annually? if no, please describe in the comments section.				
		AUC-1.3		Independent reviews and assessments shall be performed at least annually to ensure that the organization addresses nonconformities of established policies, standards, procedures, and compliance obligations.	Do you allow tenants to view your SOC2/ISO 27001 or similar third-party audit or certification reports?				
		AUC-1.4			Do you conduct network penetration tests of your cloud service infrastructure regularly as prescribed by industry best practices and guidance?				
		AUC-1.5			Do you conduct application penetration tests of your cloud infrastructure regularly as prescribed by industry best practices and guidance?				
		AUC-1.6			Are the results of the penetration tests available to tenants at their request?				
		AUC-1.7			Are the results of internal and external audits available to tenants at their request?				
Audit and Control: *Audit Events*	AUC-2	AUC-2.1	AU-2	An event is any observable occurrence in an organizational information system. Organizations identify audit events as those events which are significant and relevant to the security of information systems and the environments in which those systems operate in order to meet specific and ongoing audit needs.	Is the solution capable of auditing the following events? Successful and unsuccessful account logon events, account management events, object access, policy change, privilege functions, process tracking, and system events.				
		AUC-2.2		Audit events on Web Applications	Is the solution capable of auditing the following events, for Web applications? All administrator activity, authentication checks, authorization checks, data deletions, data access, data changes, and permission changes.				

Audit and Control: Audit Review, Analysis, and Reporting	AUC-3	AUC-3.1	AU-6	Audit Review, Analysis, and Reporting	Is the solution capable of automated mechanisms to centrally review, analyze and correlate audit and log records from multiple components of the solution to support organizational processes for investigation, alerting and response to suspicious activities? is the information available to your tenants?				
Audit and Control:	AUC-4	AUC-4.1	AU-11		Is the solution capable of maintaining all audit records in accordance with commonwealth record retention policies found at the following URL? http://www.lva.virginia.gov/agencies/records/				
Control Assessment and Authorization	CAA-1	CAA-1.1	CA-1 CA-3 CA-7	Risk assessments associated with data governance requirements shall be conducted at planned intervals and shall consider the following: • Awareness of where sensitive data is stored and transmitted across applications, databases, servers, and network infrastructure • Compliance with defined retention periods and end-of-life disposal requirements • Data classification and protection from unauthorized use, access, loss, destruction, and falsification	Do you provide security control health data in order to allow tenants to implement industry standard Continuous Monitoring (which allows continual tenant validation of your physical and logical control status)?				
		CAA-1.2			Do you conduct risk assessments associated with data governance requirements at least once a year?				
Configuration Management - Policy and Procedures	CMP-1	CMP-1.1	CM-1	Organization shall follow a defined quality change control and testing process (e.g., ITIL Service Management) with established baselines, testing, and release standards which focus on system availability, confidentiality, and integrity of systems and services	Do you provide your tenants with documentation that describes your quality assurance process?				
		CMP-1.2			Is documentation describing known issues with certain products/services available?				
		CMP-1.3			Are there policies and procedures in place to triage and remedy reported bugs and security vulnerabilities for product and service offerings? Are tenants provided with documentation on remedied issues?				
		CMP-1.4			Are mechanisms in place to ensure that all debugging and test code elements are removed from released software versions? Are there technical controls in place to prevent?				
	CMP-2	CMP-1.1	CM-2 CM-2-COV CM-3 CM-3-COV CM-7	The organization develops, documents, and maintains under configuration control, a current baseline configuration of the information system.	Do you have a capability to continuously monitor and report the compliance of your infrastructure against your information security baselines?				
		CMP-1.2			Do you have controls in place to restrict and monitor the installation of unauthorized software onto your systems?				
		CMP-1.3			Can you provide evidence that the proposed solution adheres to a security baseline, which is based on least functionality?				
		CMP-1.4			Are all changes to proposed solution authorized according to change management policies?				

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Contingency Planning - Information System backup	CP-1	CP-1.1	CP-2 CP4 CP-6 CP-7 CP-9 CP-9-COV CP-10 SA-9-COV	A consistent unified framework for business continuity planning and plan development shall be established, documented, and adopted to ensure all business continuity plans are consistent in addressing priorities for testing, maintenance, and information security requirements. Requirements for business continuity plans include the following: • Defined purpose and scope, aligned with relevant dependencies • Accessible to and understood by those who will use them • Owned by a named person(s) who is responsible for their review, update, and approval • Defined lines of communication, roles, and responsibilities • Detailed recovery procedures, manual work-around, and reference information • Method for plan invocation	Do you provide tenants with geographically resilient hosting options?				
		CP-1.2			Do you provide tenants with infrastructure service failover capability to other providers?				
		CP-1.3			Are business continuity plans subject to test at planned intervals or upon significant organizational or environmental changes to ensure continuing effectiveness?				
		CP-1.4			Can the solution provide and maintain a backup of commonwealth data that can be recovered in an orderly and timely manner within a predefined frequency consistent with recovery time and recovery point objectives?				
		CP-1.5			Can the solution store a backup of commonwealth data, at least daily, in an off-site "hardened" facility, located within the continental United States, maintaining the security of commonwealth data?				
		CP-1.6			Can the solution partition, in aggregate for this proposal, all commonwealth data submitted into the solution by the data owner in such a manner that it will not be impacted or forfeited due to E-discovery, search and seizure or other actions by third parties obtaining or attempting to obtain records, information or commonwealth data for reasons or activities that are not directly related to the business of the data owner?				
Identification and Authentication; Organizational Users	IDA-1	IDA-1.1	IA-1	Vendor should have An identification and authentication policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance	Does your management provision the authorization and restrictions for user access (e.g., employees, contractors, customers (tenants), business partners and/or suppliers) prior to their access to data and any owned or managed (physical and virtual) applications, infrastructure systems and network components?				
		IDA-1.2							
		IDA-1.3		Procedures to facilitate the implementation of the identification and authentication policy and associated identification and authentication controls	Do you require at least annual updates and reviews of your access policies for all system users and administrators (exclusive of users maintained by your tenants)?				
		IDA-1.1		Internal agency or customer (tenant) user account credentials shall be restricted as per the following, ensuring appropriate identity, entitlement, and access management and in accordance with established policies and procedures: • Identity trust verification and service-to-	Do you support use of, or integration with, existing customer-based Single Sign On (SSO) solutions to your service?				
		IDA-1.2			Do you support identity federation standards (SAML, SPML, WS-Federation, etc.) as a means of authenticating/authorizing users?				

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Identification and Authentication; Authenticator Management	IDA-2	IDA-1.3	IA-2 IA-2-COV IA-5	service application (API) and information processing interoperability (e.g., SSO and Federation) • Account credential lifecycle management from instantiation through revocation • Account credential and/or identity store minimization or re-use when feasible • Adherence to industry acceptable and/or regulatory compliant authentication, authorization, and accounting (AAA) rules (e.g., strong/multi-factor, expireable, non-shared authentication secrets)	Do you have an identity management system (enabling classification of data for a tenant) in place to enable both role-based and context-based entitlement to data?				
		IDA-1.4			Do you provide tenants with strong (multifactor) authentication options (digital certs, tokens, biometrics, etc.) for user access?				
		IDA-1.5			Do you allow tenants to use third-party identity assurance services?				
		IDA-1.6			Do you support password (minimum length, age, history, complexity) and account lockout (lockout threshold, lockout duration) policy enforcement?				
		IDA-1.7			Do you support the ability to force password changes upon first logon?				
		IDA-1.8			Do you have mechanisms in place for unlocking accounts that have been locked out (e.g., self-service via email, defined challenge questions, manual unlock)?				
Incident Response	IR-1	IR-1.1	IR-4 IR-5 IR-6	Identify immediate mitigation procedures, including specific instructions, based on information security incident categorization level, on whether or not to shut down or disconnect affected IT systems. Establish procedures for information security incident investigation, preservation of evidence, and forensic analysis.	Do you have a documented security incident response plan?				
		IR-1.2			Do you integrate customized tenant requirements into your security incident response plans?				
		IR-1.3			Do you publish a roles and responsibilities document specifying what you vs. your tenants are responsible for during security incidents?				
		IR-1.4			Have you tested your security incident response plans in the last year?				
		IR-1.5		The organization tracks and documents information system security incidents.	Do you monitor and quantify the types, volumes and impacts on all information security incidents?				
		IR-1.6			Will you share statistical information for security incident data with your tenants upon request?				
		IR-1.7		Requires personnel to report suspected security incidents to the organizational incident response capability within 24 hours from when the agency discovered or should have discovered their occurrence; and Reports security incident information to designated authorities.	Do you have a defined and documented incident notification process for reporting suspected security incidents within 24 hours?				
		IR-1.8			Does your security information and event management (SIEM) system merge data sources (app logs, firewall logs, IDS logs, physical access logs, etc.) for granular analysis and alerting?				
		IR-1.9			Do you maintain liaisons and points of contact with local authorities in accordance with contracts and appropriate regulations?				
		IR-1.10			Do you enforce and attest to tenant data separation when producing data in response to legal subpoenas?				
Media Protection Policy and Procedures;	MPP-1	MPP1.1	MP-6	Policies and procedures shall be established with supporting business processes and technical measures implemented for the secure disposal and complete removal of data	Do you support secure deletion (e.g., degaussing/cryptographic wiping) of archived and backed-up data as determined by the tenant?				

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Procedures: *Media Sanitization*	MPP-1	MPP1.2	MP-6-COV	from all storage media, ensuring data is not recoverable by any computer forensic means.	Does supplier meet all data disposal requirements as outlined in the current Removal of Commonwealth Data from Electronic Media Standard (SEC514-04)?				
Physical and Environmental Protection: Physical Access Authorizations	PEP-1	PEP-1.1	PE-2(1) PE-2(3)	The organization authorizes physical access to the facility where the information system resides based on position or role.	Can you provide a published procedure for exiting the service arrangement, including assurance to sanitize all computing resources of tenant data once a customer has exited your environment or has vacated a resource?				
Physical and Environmental Protection: *Physical Access Control*	PEP-2	PEP-2.1	PE-3	Ingress and egress points such as service areas and other points where unauthorized personnel may enter the premises shall be monitored, controlled and, if possible, isolated from data storage and processing facilities to prevent unauthorized data corruption, compromise, and loss.	Do you restrict physical access to information assets and functions by users and support personnel?				
		PEP-2.2			Are ingress and egress points, such as service areas and other points where unauthorized personnel may enter the premises, monitored, controlled and isolated from data storage and process?				
Physical and Environmental Protection: *Physical Location*	PEP-3	PEP-3.1	PE-18-COV SA-9-COV-1	All information system components and services remain within the continental United States. All physical components associated with an information system or service classified as sensitive with respect to confidentiality or integrity must be housed within the same storage location dedicated for the exclusive use of the organization and are clearly marked. Each hypervisor can only host one tier of the application architecture and no hypervisor may host the application interface and the data storage component for any information system, even if the components in question do not interact within the same information system.	Do you allow tenants to define acceptable geographical locations for data routing or resource instantiation?				
		PEP-3.2			Can you provide the physical geographical location of the storage in advance for a tenants data?				
		PEP-3.3			Can you provide the physical geographical location of a tenants data upon request?				
		PEP-3.4			Can you ensure that data does not migrate beyond a defined geographical residency?				
		PEP-3.5			Do you have the capability to restrict the storage of customer data to specific countries or geographic locations?				
		PEP-3.6			Does the solution have the capability to set affinity on tiered systems, no one hypervisor can host the application and the data storage?				
System and Information Integrity: *Vulnerability / Patch Management (Flaw Remediation)*	SII-1	SII-1.1	SI-2 RA-5 RA-5-COV	Policies and procedures shall be established, and supporting processes and technical measures implemented, for timely detection of vulnerabilities within organizationally-owned or managed applications, infrastructure network and system components (e.g., network vulnerability assessment, penetration testing) to ensure the efficiency of implemented security controls. A risk-based model for prioritizing remediation of identified vulnerabilities shall be used. Changes shall be managed through a change management process for all vendor-supplied patches, configuration changes, or changes to the organization's internally developed software. Upon request, the	Do you conduct network-layer vulnerability scans regularly as prescribed by industry best practices? Provide the frequency.				
		SII-1.2			Do you conduct application-layer vulnerability scans regularly as prescribed by industry best practices? Provide the frequency				
		SII-1.3			Do you conduct local operating system-layer vulnerability scans regularly as prescribed by industry best practices? Provide the frequency				
		SII-1.4			Will you make the results of vulnerability scans available to tenants at their request?				
		SII-1.5			Do you have a capability to rapidly patch vulnerabilities across all of your computing devices, applications and systems?				

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		SII-1.6		provider informs customer (tenant) of policies and procedures and identified weaknesses especially if customer (tenant) data is used as	Will you provide your risk-based systems patching time frames to your tenants upon request?				
System and Information Integrity: *Malicious Code protection*	SII-2	SII-2.1	SI-3 SI-3-COV	Policies and procedures shall be established, and supporting business processes and technical measures implemented, to prevent the execution of malware on organizationally-owned or managed user end-point devices (i.e., issued workstations, laptops, and mobile devices) and IT infrastructure network and systems components.	Does the provider ensure that they will utilize industry standard malware protection, incorporating both signature and non-signature-based detection mechanisms, on all systems with access to commonwealth data?				
		SII-2.1			Does the provider ensure that malware protection will be centrally managed and receive regular automatic updates to malicious code protection mechanisms and data files from the software vendor?				
System and Communications Protection: *Boundary Protection*	SCP-1	SCP-01.1	SC-7	Policies and procedures shall be established, and supporting business processes and technical measures implemented, for the use of encryption protocols for protection of sensitive data in storage (e.g., databases) and data in transmission (e.g., system interfaces, over public networks, and electronic messaging) as per applicable legal, statutory, and regulatory compliance obligations.	Does the provider ensure that the solution will utilize industry standard firewalls regulating all data entering the internal data network from any external source which will enforce secure connections between internal and external systems and will permit only authorized data to pass through?				
		SCP-01.2			Does the offeror ensure that external connections incorporated into the solution have appropriate security controls including industry standard intrusion detection and countermeasures that will detect and terminate any unauthorized activity prior to entering the firewall maintained by offeror?				
System and Communications Protection; *Encryption*	SCP-2	SCP-02.1	SC-1 SC-8 SC-8-COV SC-23 SC-28		Do you encrypt tenant data at rest (on disk/storage) within your environment?				
		SCP-02.2			Do you use encryption for storing and transmitting email attachments?				
		SCP-02.3			Do you leverage encryption to protect data and virtual machine images during transport across and between networks and hypervisor instances?				
		SCP-02.4			Do you support tenant-generated encryption keys or permit tenants to encrypt data to an identity without access to a public key certificate (e.g., identity-based encryption)?				
		SCP-02.5			Do you have documentation establishing and defining your encryption management policies, procedures and guidelines?				
		SCP-3.1		The organization establishes and manages cryptographic keys for required cryptography employed within the information system in accordance with the organization-defined requirements for key generation, distribution, storage, access, and destruction. Platform and data appropriate encryption (e.g., AES-	Do you have platform and data appropriate encryption that uses open/validated formats and standard algorithms?				
		SCP-3.2			Do you support encryption keys being solely maintained by the cloud consumer or a trusted key management provider?				
		SCP-3.3			Do you store encryption keys in the cloud?				

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Systems and Communication Protection; *Cryptographic Key Establishment and Management*	SCP-3	SCP-3.4	SC-12 SC-12-COV SC-13 SC-13-COV	256) in open/validated formats and standard algorithms shall be required. Keys shall not be stored in the cloud (i.e. at the cloud provider in question), but maintained by the cloud consumer or trusted key management provider. Key management and key usage shall be separated duties.	Do you have separate key management and key usage duties?				
Data Security & Information Lifecycle Management *Nonproduction Data*	DS-01	DS-01.1	SA-11	Production data shall not be replicated or used in non-production environments. Any use of customer data in non-production environments requires explicit, documented approval from all customers whose data is affected, and must comply with all legal and regulatory requirements for scrubbing of sensitive data elements.	Do you have procedures in place to ensure production data shall not be replicated or used in non-production environments?				
VITA Governance - Portability Requirements									
Interoperability & Portability *APIs*	IPY-01	IPY-01	ECOS -1	The provider shall use open and published APIs to ensure support for interoperability between components and to facilitate migrating applications.	Do you publish a list of all APIs available in the service and indicate which are standard and which are customized?				
Interoperability & Portability *Data Request*	IPY-02	IPY-02	ECOS -2	All structured and unstructured data shall be available to the customer and provided to them upon request in an industry-standard format (e.g., .doc, .xls, .pdf, logs, and flat files).	Is customer data (Structured & Unstructured) available on request in an industry-standard format (e.g., .doc, .xls, or .pdf)?				
Interoperability & Portability *Policy & Legal*	IPY-03	IPY-03.1	ECOS -3	Policies, procedures, and mutually-agreed upon provisions and/or terms shall be established to satisfy customer (tenant) requirements for service-to-service application (API) and information processing interoperability, and portability for application development and information exchange, usage, and integrity persistence.	Do you provide policies and procedures (i.e. service level agreements) governing the use of APIs for interoperability between your service and third-party applications?				
		IPY-03.2	ECOS -4		Do you provide policies and procedures (i.e. service level agreements) governing the migration of application data to and from your service?				
Interoperability & Portability *Standardized Network Protocols*	IPY-04	IPY-04.1	ECOS - 5	The provider shall use secure (e.g., non-clear text and authenticated) standardized network protocols for the import and export of data and to manage the service, and shall make available a document to consumers (tenants) detailing the relevant interoperability and portability standards that are involved.	Can data import, data export and service management be conducted over secure (e.g., non-clear text and authenticated), industry accepted standardized network protocols?				
		IPY-04.2	ECOS - 6		Do you provide consumers (tenants) with documentation detailing the relevant interoperability and portability network protocol standards that are involved?				
Interoperability & Portability *Virtualization*		IPY-05.1	ECOS - 7	The provider shall use an industry-recognized virtualization platform and standard virtualization formats (e.g., OVF) to help ensure interoperability, and shall have	Do you use an industry-recognized virtualization platform and standard virtualization formats (e.g.., OVF) to help ensure interoperability?				

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	IPY-05	IPY-05.2	ECOS - 8	documented custom changes made to any hypervisor in use, and all solution-specific virtualization hooks, available for customer review.	Do you have documented custom changes made to any hypervisor in use, and all solution-specific virtualization hooks available for customer review?				
Security Framework - Organizational Security Framework	SF -01	SF-01.1	ECOS - 9	Design, acquisition, implementation, configuration, modification, and management of infrastructure and software are consistent with defined processing integrity and related security policies.	What Security Framework do you follow (.i.e. NIST, , ISO/IEC 27001, etc...,)?				

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Appendix G – Proprietary/Confidential Information Summary Form

SECTION/TITLE	PAGE NUMBER(S)	REASON(S) FOR WITHHOLDING FROM DISCLOSURE

*Identify the reason for withholding from disclosure in accordance with the Code of Virginia § 2.2- 4342F.