

Background and Introduction

The [North/West Passage \(NWP\) Transportation Pooled Fund Study](#) focuses on cross-border Intelligent Transportation Systems (ITS) coordination along the I-90 and I-94 corridors through the states of Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, and Minnesota. See **Figure 1**. These states are predominantly rural, however there are urban areas on each end of the corridor (Seattle and Minneapolis/St. Paul).

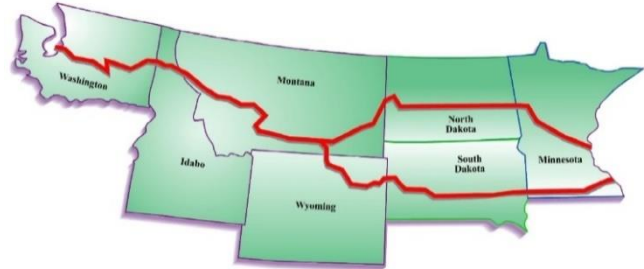


Figure 1: North/West Passage Members

Connected Vehicle (CV) applications and partially or fully Autonomous Vehicles (AV) applications are being developed by a number of public and private sector entities. While the timeline for full deployment is debatable, it is becoming increasingly clear that connected and autonomous vehicles will play a role in transportation in both urban and rural environments in the coming years. It is challenging to understand what activities a state or local departments of transportation (DOT) can begin to perform at the current time to prepare for future CV and AV deployments.

Individual North/West Passage states have started CV and AV activities. Two examples include:

- **Wyoming DOT (WYDOT)**

In September 2016, USDOT awarded 3 cooperative agreements to initiate design, build, and test phases of connected vehicles. WYDOT was selected as one of the 3 pilot sites. WYDOT will develop a system that supports the use of CV Technology along the 402 miles of I-80 in Wyoming. Approximately 75 roadside units (RSUs) that can receive and broadcast message using Dedicated Short Range Communication (DSRC) will be deployed along various sections of I-80. WYDOT will equip around 400 vehicles, a combination of fleet vehicles and commercial trucks with on-board units (OBUs). Of the 400 vehicles, at least 150 would be heavy trucks that are expected to be regular users of I-80. In addition, of the 400 equipped-vehicles, 100 WYDOT fleet vehicles, snowplows and highway patrol vehicles, will be equipped with On Board Units (OBUs) and mobile weather sensors.

- **Minnesota DOT (MnDOT)**

MnDOT plans to deploy Snow Plow Signal Priority (SPSP) along Trunk Highway (TH) 55 and I-394 to reduce signal wait times and improve freeway gang plowing activities. The SPSP deployment will use Signal Phase and Timing (SPaT) broadcasts via DSRC from intersection and ramp meter signal systems in these corridors, and DSRC responses from the snow plows to send the data

needed to determine signal timing adjustments as appropriate. This project will also mark MnDOT's participation in the national SPaT Challenge.

However, anticipating an increase in CV and AV deployments in the future, North/West Passage states have asked what they can do to begin to understand and prepare for connected and automated vehicles sharing their roadways.

The focus of this summary report is to provide North/West Passage members with direction to better use the vast amount of resources that have been developed regarding CV and AV technologies and preparation guidance.

Based on the review of the resources, a future project idea was also developed by the North/West Passage members and is included in this summary report.

Connected and Automated Vehicle (CAV) Resources

This section provides a table of resources currently available related to connected and automated vehicles. The information was gathered through an online search and input from the North/West Passage Steering Committee.

The resources found include:

- CV pilot deployments
- CV architecture
- Open source CV applications
- Smart City
- SPaT Challenge
- Training Opportunities
- Committees to Join
- Final Documents and Presentations
- Research efforts

The following table includes a link to the source, a description of the source, and provides a suggestion on how North/West Passage members could use each source.

Table 1: Connected and Automated Vehicle Resources

#	Source	Description	Use of Source
1	USDOT Intelligent Transportation System (ITS) Joint Program Office (JPO) Connected Vehicle Pilot Deployment Program ¹	<p>In September 2016, USDOT awarded 3 cooperative agreements to initiate design, build, and test phases of connected vehicles. This website includes detailed descriptions of the following selected pilot sites.</p> <ul style="list-style-type: none"> • New York City DOT Pilot² • Tampa-Hillsborough Expressway Authority Pilot³ • Wyoming DOT Pilot⁴ <p>The following resources are also available on the website:</p> <ul style="list-style-type: none"> • Technical Assistance Events for Concept Development Phase⁵ – Provides Pilot Sites Webinars, Presentation and Documents • Connected Vehicle Applications⁶ – Detailed application (e.g. V2I safety, environment, mobility) descriptions and supporting documentation. • Deployment Concepts⁷ – Examples of localities applying the pilot deployment concept development process. • Lessons Learned⁸ – Summary of lessons learned for the model deployment and recommendations for future CV activities. • Publications⁹ – Phase 1 concept development publications. <p>Key reports linked from the website include:</p> <ul style="list-style-type: none"> • Safety Pilot Model Deployment – Lessons Learned and Recommendations for Future Connected Vehicle Activities (September 2015) <p>High-Level Estimation of your Proposed Deployment Costs¹⁰ – Cost Overview for Planning Ideas and Logical Organization Tool (COPILOT) to support stakeholders considering connected vehicle pilot deployments</p>	<p>Follow the progress of one or more of the connected vehicle pilot sites, to understand the experiences and lessons learned.</p> <p>Tool to estimate costs for pilot connected vehicle deployments.</p>
2	USDOT ITS JPO Connected Vehicle Reference Implementation Architecture (CVRIA) ¹¹	CVRIA is being developed as the basis for identifying the key interfaces across the connected vehicle environment which will support further analysis to identify and prioritize standards development activities. CVRIA will also support policy considerations for certification, standards, core system implementation, and other elements of the connected vehicle environment.	Tool for reviewing, providing feedback, and using the connected vehicle architecture content for standards and project development.

#	Source	Description	Use of Source
3	USDOT-FHWA Open Source Application Development Portal ¹²	<p>A channel to provide access to and support the collaboration, development, and use of mobility and transportation-related applications that are federally funded or approved. Focus on research, development, planning, testing, and deployment of connected vehicle and travel-related applications and ITS.</p> <p>The Vehicle to Infrastructure (V2I) Hub is currently included in the Portal (source code and instructions). The V2I Hub is software developed by FHWA and Battelle to serve as the interface between DOT operated systems (e.g. signal controllers, TMCs) and the roadside unit (RSU). For example, the V2I Hub does the translation of the NTCIP 1202 objects that are output from traffic signal controllers into the J2735 standards required for broadcast at the RSU.</p>	<p>Users can upload, download and collaborate on open-source connected vehicle applications.</p> <p>The V2I Hub is an option for agencies participating in the SPaT Challenge, or disseminating infrastructure or traveler information messages (e.g. advisory speeds).</p>
4	USDOT Smart City Challenge ¹³	<p>In 2015 seventy-eight cities¹⁴ proposed ideas for an integrated, first-of-its-kind smart transportation system that would use data, applications, and technology to help people and goods move more quickly, cheaply, and efficiently. Seven finalists¹⁵ worked with their DOT to further develop their ideas and Columbus, Ohio¹⁶ was the ultimate winner.</p> <p>An overview of lessons learned for the Smart City Challenge is available: Smart City Challenge: Lessons for Building Cities of the Future¹⁷</p> <p>Smart Columbus Homepage¹⁸ - The City of Columbus developed this web page to provide details of the Smart Columbus effort. Resources¹⁹ provided include the applications developed by the City of Columbus to the USDOT as well as many presentations.</p>	<p>Learn what was gathered from the 78 applications on innovative approaches to tackling urban mobility challenges.</p> <p>Track the efforts of the Smart City development and assess any portions that might be appropriate for NWP members.</p>

#	Source	Description	Use of Source
5	USDOT Deployment Guidance	<p>The 2015 FHWA Vehicle to Infrastructure Deployment Guidance and Products is intended to assist FHWA staff and transportation system owner/operators deploy Vehicle to Infrastructure (V2I) technology not only in terms of the Federal-aid Highway program requirements but also practices to help ensure interoperability and efficient and effective planning/procurement/operations.</p> <p>Several quick reference web links to videos, slide presentations, and information modules related to the fundamental principles of connected vehicle technology are located in the appendix.</p> <p>The 2015 Deployment Guidance is the FHWA’s current publicly available version of the document. FHWA continues to update this document as technologies advance and has engaged stakeholders in review and updates.</p>	<p>NWP member agencies can use this document to guide their infrastructure deployment efforts.</p> <p>NWP may wish to participate in future review and commenting to USDOT on this document, to identify gaps and updates as agencies gain experience with deploying V2I technologies.</p>
6	USDOT NHTSA V2V Communications Notice of Proposed Rulemaking	<p>In January 2017, the USDOT’s National Highway Traffic Safety Administration issued a Notice of Proposed Rulemaking (NPRM) proposing a requirement for light duty vehicle manufacturers to install devices on all new cars to enable V2V communications via dedicated short range communication (DSRC) devices or similar technologies. While the rule is primarily aimed at automobile manufacturers, an important secondary effect would better enable Vehicle-to-Infrastructure (V2I) technologies and applications to occur.</p> <p>AASHTO hosted a webinar to educate its State DOT members on the NRPM:</p> <ul style="list-style-type: none"> • Webinar Slides: Opening Comments & Technical Overview of NPRM • Webinar recording 	<p>NWP could follow future developments of this proposed rulemaking, especially as it relates to implications for State DOT infrastructure, such as deployment of communications technology, maintenance, and security protocols.</p>

#	Source	Description	Use of Source
7	USDOT Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) ²⁰	<p>The FAST Act established the ATCMTD Program to make competitive grants for the development of model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment.</p> <p>The criteria for applicants (e.g. state or local government, transit agency) includes a number of factors including how the proposed deployment of technology will accelerate the deployment of V2V, V2I, autonomous, and other technologies.</p> <p>The ATCMTD is an annual process. \$60 million has been authorized in FY 2016, 2017, 2018, 2019 and 2020.</p>	To submit a technology deployment project for consideration in the ATCMTD annual process to fund transportation and congestion management projects.
8	Vehicle to Infrastructure Deployment Coalition SPaT Challenge ²¹	<p>The SPaT challenge is a challenge for state and local public sector transportation infrastructure owners and operators to cooperate together to achieve deployment of DSRC infrastructure with SPaT broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each of the 50 states by January 2020. This website includes:</p> <ul style="list-style-type: none"> • Map²² of agencies that have completed or are actively participating in the SPaT challenge • Resources²³ – Links to documents to support agencies with deploying SPaT in a series of high-level steps. <ul style="list-style-type: none"> ○ DSRC Licensing Information ○ Guidelines for Selecting Corridors ○ Implementation Guidance <p>Key reports linked from the website include:</p> <ul style="list-style-type: none"> • Recommended Practices for DSRC Licensing and Spectrum Management²⁴ (December 2015) • National Connected Vehicle Field Infrastructure Footprint Analysis – Deployment Scenarios²⁵ (December 2013) <p>A resource team meets monthly by webinar to develop/review resources to support agencies accepting the SPaT Challenge. A Tactical Working Group is developing an overall communications plan to conduct the outreach and peer exchange to agencies accepting the SPaT Challenge.</p>	<p>Provides guidance for agencies interested in participating in the SPaT challenge with guidance for the identification of appropriate corridors, standards, technologies, and the processes that will facilitate an efficient and cost-effective deployment.</p> <p>Links to USDOT guidance document for licensing DSRC devices for any connected vehicle application.</p> <p>NWP members may decide to participate in development of SPaT resources.</p>

#	Source	Description	Use of Source
9	Vehicle to Infrastructure (V2I) Deployment Coalition (DC) ²⁶	<p>An Executive Committee²⁷ serves as the leadership body of the Coalition and interacts with USDOT and the Connected Vehicle Leadership Team. The Executive Committee also oversees the following five Technical Working Groups (TWG)²⁸.</p> <ul style="list-style-type: none"> • TWG 1: Deployment Initiatives • TWG 2: Deployment Research • TWG 3: Infrastructure Operator, OEM, and Supplier Partnerships • TWG 4: Deployment Guidance • TWG 5: Deployment Standards <p>Key work²⁹ completed by the coalition includes four technical memorandums as well as workshops and webinars.</p>	<p>The V2I DC recently completed Phase 1 efforts, and is transitioning to Phase 2. The working groups are being simplified, and will now include an overall working group for peer exchange and outreach. NWP members may consider participating in the quarterly ‘peer exchange and outreach’ webinars to learn about V2I deployments, research advances, standards developments, and V2I guidance resources available.</p>
10	USDOT Federal Automated Vehicles Policy ³⁰	<p>Provides the Federal Automated Vehicles Policy – Accelerating the Next Revolution in Roadway Safety (September 2016)³¹.</p> <p>Fact sheets are provided for the following:</p> <ul style="list-style-type: none"> • Federal Automated Vehicles Policy³² • Vehicle Performance Guidance³³ • Model State Policy³⁴ • Current Regulatory Tools³⁵ • Modern Regulatory Tools³⁶ 	<p>The policy document indicates that NHTSA is seeking input on the policy statement and will conduct outreach. Updates to the policy are anticipated within the next year or sooner if appropriate.</p> <p>NWP member states could individually or collectively discuss providing feedback on this policy statement if they have feedback on key areas of interest (e.g. rural or multi-state corridor).</p>

#	Source	Description	Use of Source
12	AASHTO Subcommittee on Transportation Systems Management and Operations (STSMO) ³⁷	AASHTO STSMO has recently restructured into five focus areas. Focus Area 5, Connected and Automated Vehicles (CAV) ³⁸ has a dedicated focus to connected and automated vehicles.	<p>Provides connected and automated vehicle related meetings, summaries, and resources.</p> <p>If NWP members identify specific needs, these could be relayed to STSMO. In addition, NWP members could participate in the CAV focus area of AASHTO STSMO.</p>
13	AASHTO Special Committee on Wireless Communications Technology (SCOWCT) ³⁹	<p>SCOWCT has four technical working groups. Technical Working Group 4: Future and Emerging Technology⁴⁰ is focused on:</p> <ul style="list-style-type: none"> • Legacy ITS and New Technologies • Communications to support Connected and Autonomous Vehicles • CV Foot Print Analyses and Near Term CV Tools • Standards Development 	<p>Convenes technical communications personnel from State DOTs to share practices and contribute to resources for implementing CV/AV communications technology.</p> <p>NWP members could participate in AASHTO SCOWCT.</p>
14	Automated Vehicles Symposium ⁴¹	Convenes industry, government, and academia from around the world to address complex technology, operations, and policy issues.	<p>The fourth symposium will be held on July 11-13, 2017 dedicated to automated vehicles.</p> <p>NWP members could review the symposium proceedings online when they become available.</p>

#	Source	Description	Use of Source
15	Transportation Research Board ⁴²	<p>NCHRP 20-102: Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies--Task-Order Support⁴³</p> <p>The objectives of the NCHRP 20-102 task order are to (1) identify critical issues associated with connected vehicles and automated vehicles that state and local transportation agencies and AASHTO will face, (2) conduct research to address those issues, and (3) conduct related technology transfer and information exchange activities. The Task Order has initiated multiple projects that are in the process of developing numerous resources:</p> <ul style="list-style-type: none"> • 20-102(01) Policy and Planning Actions to Internalize Societal Impacts of CV and AV Systems in Market Decisions - will identify and describe policy and planning actions at the state, regional, and local levels that could help societal impacts of CV / AV.⁴⁴ • 20-102(02) - Impacts of Regulations and Policies on CV and AV Technology Introduction in Transit Operations – will describe the current regulatory landscape that may impact CV/AV technologies for transit and describe changes that may be necessary and the implications.⁴⁵ • 20-102(03) – Challenges to CV and AV Application in Truck Freight Operations – describes the various challenges, their implications and potentials changes needed for CV/AV deployment in commercial vehicles.⁴⁶ • 20-102(05) – Communications Plan - describes the plan for communicating the findings of 20-102.⁴⁷ • 20-102(06) – Road Marking for Machine Vision – develops information on the performance characteristics of pavement markings that affect the abilities of machine vision.⁴⁸ • 20-102(07) – Implication of Automation for Motor Vehicle Codes – provides DOTs and DMVs with guidance and resources to support legal changes resulting from CV/AV.⁴⁹ • 20-102(08) - Dedicating Lanes for Priority or Exclusive Use by CVs and AVs – provides guidance on dedicating lanes for CV/AV users, including policy actions needed.⁵⁰ 	Track connected and automated vehicle research efforts.

#	Source	Description	Use of Source
		<ul style="list-style-type: none"> • 20-102(09) - Providing Support to the Introduction of CV/AV Impacts into Regional Transportation Planning and Modeling Tools – provides guidance on changes required in modeling and forecasting tools resulting from CV/AV deployment.⁵¹ • 20-102(10) - Cybersecurity Implications of CV/AV Technologies on State and Local Transportation Agencies – serves as a primer on cybersecurity and privacy issues resulting from CV/AV deployment for agencies.⁵² • 20-102(11) - Summary of Existing Studies on the Effects of CV/AV on Travel Demand – provides information on the findings of the impact of CV/AV on trip making.⁵³ • 20-102(12) - Business Models to Facilitate Deployment of CV Infrastructure to Support AV Operations – is a project scheduled to begin in 2017 to develop guidance for decision makers on CV/AV deployment.⁵⁴ • 20-102(13) - Planning Data Needs and Collection Techniques for CV/AV Applications – provides guidance on data collection strategies for planning purposes.⁵⁵ • 20-102(14) – Data Management Strategies for CV/AV Applications for Operations – provides guidance on operational data management strategies.⁵⁶ <p>NCHRP 20-24(112) Connected Road Classification System (CRCS) Concept Development⁵⁷ This project will vet the concept of a Connected Road Classification System with a core set of stakeholders who have extensive experience with Connected and Autonomous vehicles, refine the concept as appropriate based on the input received, then present the concept to additional DOTs through various outreach mechanisms with the ultimate goal of reaching consensus and formally proposing the concept to FHWA.</p>	<p>Track connected and automated vehicle research efforts.</p> <p>NWP members may wish to participate in this panel, or provide input to the project to represent the unique rural and multi-state corridor perspective on road classifications for connected and automated vehicles.</p>

#	Source	Description	Use of Source
16	AASHTO Subcommittee on Traffic Engineering (SCOTE) ⁵⁸	<p>The subcommittee is tasked with assessing the effectiveness of traffic control practices and devices in terms of public safety, convenience, and cost. The 2017 SCOTE Annual Meeting⁵⁹ was held June 25-28 in Pittsburgh, Pennsylvania. The following presentations related to autonomous and connected vehicles.</p> <ul style="list-style-type: none"> • Automated Vehicles, Delphi, Dockemeyer⁶⁰ – provides a brief summary of the technology behind future AV and the support needs for future deployments • Connected and Automated Vehicle Initiative in Florida, Tillander⁶¹ – presents Florida’s Connected and Automated Vehicle history and environment as well as CV projects currently in the planning phase • Connected and Automated Vehicles, Knopp⁶² – discusses V2I infrastructure deployments and pilot CV and AV deployments. • Connected and Automated Vehicles: Real World Readiness, Smith⁶³ – identifies benefits and challenges of CV and AV in the real world • Embedded Sensor Markings, VDOT⁶⁴ – evaluates sensor embedded pavement markings by sharing an installation layout, experimental design, and experimental vehicle and summarizes the findings. • Road Markings for Machine Vision, NCHRP 20-102(6), Carlson⁶⁵ – identifies minimum performance levels for pavement markings to maintain reliable machine vision detection for ADAS such as LDW and LKA and provides data and recommendations that an AASHTO/SAE Working Group can use to quickly develop guidelines and criteria. • SPaT Challenge Update, Luszcz⁶⁶ – defines the SPaT Challenge, provides an overview of its background and benefits, and offers implementation support resources. • SPaT Deployment in PA, Rowe⁶⁷ – highlights current and planned PennDOT DRSC deployments, next steps, and lessons learned • State of Play of Connected and Autonomous Vehicles Overview Slides, Holder⁶⁸ – provides an update on ongoing CAV Activities related to Public Sector Initiatives. (Part 1 of a 2-part panel session) 	Receive updates on current CV/AV technology and road markings, past and future CV/AV deployments, and the benefits and challenges associated with CV/AV.

#	Source	Description	Use of Source
		<ul style="list-style-type: none"><li data-bbox="611 233 1451 401">• State of Play of Connected and Automated Vehicles, Mohaddes⁶⁹ – focuses on private sector perspectives including technology advancements in CAV activities to meet V2V and V2I needs of suppliers and services such as Cybersecurity, regulations, and testing. (Part 2 of a 2-part panel session)	

Future Project

During the May 2017 North/West Passage Annual Meeting in Bismarck, North Dakota the Steering Committee reviewed the resources summarized in Section 3.0. The committee agreed that many of the resources are focused on CV and AV applications in urban areas. Since, the majority of the North/West Passage states are rural focused, the members developed a project idea (included on the following pages) to help agencies anticipate the needs of connected vehicles on rural freeway corridors. The project idea was submitted to NCHRP 20-102 in July 2017. However, the project idea was not awarded funding.

It is simply a matter of time before Connected and Automated Vehicles become part of the existing transportation system in both urban and rural environments. State and local transportation agencies can ease the transition to sharing the roadways with Connected and Automated Vehicles by preparing now for additional CV and AV deployments and needs. The North/West Passage members will continue to identify mechanisms to pursue funding for the project idea to assist in providing additional rural CV resources for state DOTs.

Defining a Vision for Rural Connected Vehicle Corridors

NCHRP Project Statement

June 2017

RESEARCH PROBLEM STATEMENT

The National Connected Vehicle Field Infrastructure Footprint Analysis is a starting point for agencies that are looking ahead to a connected and automated vehicle environment. Connected vehicle research continues to progress, developing potential safety, mobility, and environmental applications for a variety of scenarios and users. Findings and lessons learned from the USDOT Connected Vehicle Pilot Deployments will be very helpful to inform other agencies planning for connected vehicle deployments in their jurisdictions.

However, given the fast-paced evolution of connected vehicle technologies, agencies need a vision now for long-term planning regarding deployments. To date, most connected vehicle research has focused on applications in urban areas, but agencies need to also plan for the responsibilities and resources required for deploying, operating, and maintaining infrastructure on rural freeways. The Wyoming Connected Vehicle Pilot Deployment serves as a logical example of applications on a rural freeway setting, yet a broader vision is needed on other rural freeways to address a wider variety of needs.

OBJECTIVE

The objective of this research is to help agencies anticipate the needs of connected vehicles on rural freeway corridors, including the anticipated roles and responsibilities of agencies in deploying, operating, and maintaining equipment and the associated needs related to staffing and resources.

RESEARCH OBJECTIVES

The research team will develop a vision to assist agencies in planning for the connected vehicle environment on rural freeway corridors. The developed vision shall address the following questions:

- What applications will be most relevant on rural freeway corridors? Given relatively higher percentages of long-distance freight and recreational travelers, the information and applications needed may differ from other locations with higher percentages of local and commuting traffic.
- How should an agency prioritize when and where infrastructure should be deployed? Some agencies have developed policies and warrants regarding the spacing and placement of cameras and dynamic message signs (DMS) along rural freeway corridors. How do these policies and the placement of other ITS deployments translate to the needs, prioritization, placement, and spacing for deploying equipment to support connected vehicles?

- What scale of deployments should agencies anticipate on rural freeway corridors within five, ten, and twenty years, respectively? Specifically, what density and types of equipment should an agency expect for rural freeway corridors?
- What level of multistate coordination may be required for connected vehicle applications on rural freeway corridors, given relatively high percentages of long-distance recreational and freight travelers? For example, freight traveling from Chicago to Seattle could be routed along I-90 in the event of poor travel conditions on I-94 in North Dakota, but would need that information to make that decision before leaving Wisconsin.
- How will connected vehicle deployments in rural areas change agency operations? What activities will be needed to support operations and maintenance, and what activities will no longer be needed? When could legacy ITS assets be de-commissioned?
- Will connected vehicle deployments on rural freeways create efficiencies or increase demands on agencies and transportation management centers (TMCs), as related to data needs, data processing and archiving capabilities, communications, staffing considerations, and software requirements? How will the agencies technical resource requirements evolve?
- How can rural data backhaul challenges be addressed?

WORK TASKS

Tasks anticipated in this project could include the following:

- 1) **Outreach, Research, and Synthesis of Rural Connected Vehicle Findings.** Conduct outreach to the rural transportation community to share the goals and activities of this project. Research the findings, conclusions, and results of previous research studies, demonstrations, and deployments of connected vehicles in rural areas or along multi-state corridors to capture any conclusions regarding the infrastructure needs. Suggested approaches include contacting representatives of agencies that have deployed, planned or prepared proposals for CV deployments in rural areas to discuss their planned or actual deployments, with particular emphasis on the preliminary and/or final results of the CV Pilot deployment in Wyoming. Work with existing CV groups (e.g. CV Pooled Fund Study, V2I Deployment Coalition, etc.) to the extent possible.

(Deliverables and Budget: Technical Memorandum 1; \$50,000)

- 2) **Rural Corridor Connected Vehicle Needs Assessment.** Conduct outreach and engagement with the state and/or local DOT representatives responsible for operating rural freeways, with an emphasis on multi-state corridors, to gather their input and perspective on at least two key issues:
 - a) To develop an understanding of the needs not currently addressed by other solutions that might be addressed by Connected Vehicles; and
 - b) To document the potential positive and negative impacts of rural corridor connected vehicle deployments on operations and maintenance of systems and technology

components (e.g. demands for staffing time and skills to perform operations, maintenance, troubleshooting)

Task 2 is proposed to be a detailed needs assessment to help understand the need for and potential of CV applications in rural areas. It is expected that multiple representatives would be involved from each of the DOTs contacted as part of this project, representing areas such as operations, maintenance, freight, planning, traveler information, safety, information technology (IT), etc. A considerable effort is anticipated to find and engage the appropriate individuals to allow for a broad discussion about the needs and possible impacts of CV application deployment. The activities to accomplish the outreach and needs assessment is expected to include a variety of in-person meetings (one-on-one or workshops) with a representative set of DOT staff who can offer input on the needs assessment. The exact format of outreach is to be proposed by the researcher.

(Deliverables and Budget: Completion of Outreach Meetings & Documentation of Findings into Technical Memorandum 2; \$100,000)

- 3) **Rural Corridor Connected Vehicle Scenario Development.** Develop a set of scenarios for connected vehicle deployments along rural corridors. Scenarios should include applications for connected vehicle deployments involving both fleet vehicles (e.g. freight, DOT operated vehicles) and passenger vehicles, and should describe:
- a. the most likely roadside infrastructure, backhaul communications, and centralized processing requirements
 - b. various scenarios for spacing of roadside equipment, and contributing factors that will define spacing between equipment
 - c. the maintenance and operations requirements most likely associated with the equipment and systems related to each application
 - d. specific requirements to support multi-state corridor operations of connected vehicle applications

(Deliverables and Budget: Technical Memorandum 3 Describing Rural Corridor Scenarios; \$100,000)

- 4) **Rural Connected Vehicle Workshop.** Organize, facilitate, and execute one workshop involving agencies responsible for operating rural corridors. The emphasis of the workshop will be on sharing the findings of Tasks 1-3 and receiving input and feedback on the scenarios developed and needs documented.

(Deliverables and Budget: Pre Workshop Webinar, Workshop read-ahead materials, Conduct workshop and Technical Memorandum 4; \$25,000)

- 5) **Final Report.** Efforts in Task 5 shall assemble all information gathered, revise scenarios based on Task 4 activities, and create and compile a Final Report and associated presentation materials describing the results of the project.

(Deliverables and Budget: Final Report; \$15,000)

URGENCY

The state and local DOTs that own and operate the transportation infrastructure are beginning to plan for a major investment of resources to prepare their infrastructure to integrate connected vehicles. While much of the emphasis has been dedicated to urban areas, connected vehicle deployments in rural areas hold tremendous potential for improvements in safety, mobility and efficiency. Rural areas typically have less ITS infrastructure than metro areas, and deploying the backhaul communications and roadside equipment will likely take longer. Therefore, it is critical that the agencies who operate the rural infrastructure have a vision towards their likely deployment scenarios as soon as possible.

FUNDING REQUESTED AND TIME REQUIRED

It is estimated that this research will take 18 months to complete and will require approximately \$290,000.

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List of Referenced Sources

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