US DOT FHWA 693JJ319NF00001, "Automated Driving System Demonstration Grants."

Proposal Title:

Demonstrating Automated Driving Systems (ADS) through Highly Automated Vehicles (HAV) Supporting Emergency Response Operations (ADS-HERO)

Proposing Agency: University of Maryland (State Controlled Institute of Higher Education)

Contractors:

Westat
WSP
Maryland Transportation Authority
Anne Arundel County Fire Department
Local Motors, LLC
Army Aberdeen Test Center

Technical Point of Contact:

Tom Jacobs
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Takeia Bradley, Contract Manager
Office of Research Administration, University of Maryland 3112 Lee Building, College Park, MD 20742
Phone: 301-405-6269, Fax: 301-314-9569, Email: oraa@umd.edu

Project Duration: Four Years, proposed from 10/01/2019 to 9/30/2023

UNIVERSITY OF MARYLAND
OFFICE OF RESEARCH ADMINISTRATION

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March 21, 2019

Ms. Sarah Tarpgaard
Agreement Officer
U.S. Department of Transportation
Federal Highway Administration
Office of Acquisition and Grants Management
1200 New Jersey Avenue, SE
Washington, D.C. 20590

Dear Ms. Tarpgaard:

The University of Maryland is pleased to submit this proposal for the Highly Automated Vehicle (HAV) Emergency Responder Operations (HERO) project. Our proposal represents a collaboration led by the University's Maryland Transportation Institute (MTI) and its affiliated Center for Advanced Transportation Technology (CATT). The lead public agency partners are the Maryland Transportation Authority (MDTA) and the MDTA Police as well as the Anne Arundel County Fire Department. With our key supporting Team members, Westat and WSP, this collaboration is uniquely qualified to carry out a demonstration of Automated Driving Systems (ADS) with a vision focused on the safe integration of ADS into emergency response and traffic incident management on the nation's roadway network.

MTI and CATT have been supporting national, state, and local efforts to solve important transportation mobility, safety, and security problems for many years. This is accomplished through innovative technology deployments and user-centered design of software and information visualization systems. Our work spans many disciplines including Connected Automated Vehicles (CAV), Intelligent Transportation Systems, law enforcement, network security, private business, defense, and homeland security. Our systems are used by more than 8,000 decision makers, researchers, planners, operations specialists, and homeland security officials in approximately 40-states. Our key research partner, Westat, brings extensive qualifications for participating in this important project based upon its previous and ongoing human factors research into automated vehicles, connected vehicles, driver and occupant behaviors, and in-vehicle instrumentation. Our program management support partner, WSP, has a history of over 130 years of professional services, including some of the most complex and innovative projects in the nation.

You will find that our proposal is fully responsive to the ADS grant goals to demonstrate how challenges to the safe integration of ADS into the nation's on-road transportation system can be addressed and will be focusing on an area where industry lacks adequate resources to participate in independent development work. Should the proposal be awarded, the University of Maryland is prepared to enter into an agreement under mutually acceptable terms and conditions and in accordance with the U.S. Department of Transportation policies and required certifications.

We look forward to working with you on this critically important project.

Sincerely,

Katie M. McKeon
Assistant Director

University of Maryland
Proposal for Automated Driving System Demonstration Grant
Notice of Funding Opportunity (NOFO) Number 693JJ319NF00001

PART 1. PROJECT NARRATIVE AND TECHNICAL APPROACH

Summary Table	
Project Name/Title	Demonstrating Automated Driving Systems (ADS) through Highly Automated Vehicles (HAV) Supporting Emergency Response Operations (ADS-HERO)
Eligible Entity Applying to Receive Federal Funding (Prime Applicant's Legal Name and Address)	University of Maryland College Park College Park, Maryland, 20741
Point of Contact (Name/Title; Email; Phone Number)	Takeia Bradley, Contract Admin., Office of Research Administration, University of Maryland. 301-405-6269. oraa@umd.edu
Proposed Location (State(s) and Municipalities) for the Demonstration	Harford County, Maryland; City of College Park, Maryland; Montgomery County, Maryland and Prince George's County, Maryland.
Proposed Technologies for the Demonstration (briefly list)	Highly Automated Vehicles (HAV), Connected Vehicle Technologies (V2V and V2X)
Proposed duration of the Demonstration (period of performance)	Four (4) Years
Federal Funding Amount Requested	$ 4,543,819
Non-Federal Cost Share Amount Proposed, if applicable	$ 951,631
Total Project Cost (Federal Share + Non-Federal Cost Share, if applicable)	$ 5,495,450

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1.1 EXECUTIVE SUMMARY

1.1.1 Vision, Goals, and Objectives

The Demonstrating Automated Driving Systems (ADS) through Highly Automated Vehicles (HAV) supporting Emergency Response Operations (ADS-HERO) project vision is the safe integration of ADS into emergency response and traffic incident management operations on the nation's roadway network. The ADS-HERO mission is to inform ADS technology advancement and the adaptation of transportation and emergency response procedures through demonstration tests of ADS interactions with emergency responders.

This project will fill a critical research gap in that, nationally, there has been little research done to inform the implication of ADS vehicles interacting with emergency response personnel and equipment at a traffic incident scene. This project will be managed and guided by a very unique and highly qualified team to ensure that all of the stated requirements of the ADS NOFO are met and/or exceeded. Support for the ADS-HERO project is demonstrated by the numerous support letters that we have received from state and federal legislators, and international associations representing law enforcement and Fire/EMS disciplines.

The ADS-HERO goals are to:

- Develop an increased understanding of emergency responder concerns regarding the integration of ADS into the nation's roadway network.
- Develop an increased understanding of ADS challenges when faced with emergency response and traffic incident management operations.
- Encourage development of ADS technology that addresses emergency response and traffic incident management operations.
- Encourage adaptation of emergency response and traffic incident management procedures to accommodate the safe integration of ADS into the nation's roadway network.

The ADS-HERO objectives are to:

- Establish a concise list of emergency responder ADS use case concerns.
- Engage at least five ADS developer stakeholders.
- Conduct at least three, week long demonstration scenario tests.
- Collect and share vehicle, infrastructure and human factors data to inform ADS technology development.
- Collect and share vehicle, infrastructure and human factors data to inform the adaptation of transportation and emergency response procedures for the advent of ADS on the nation's roadway network.
- Develop technology solutions for areas where emergency response and traffic incident management operations challenge ADS.
- Create a framework for collecting, processing, storing and sharing ADS data and associated TSMO performance measures.

1.1.2 Key Partners, Stakeholders, Team Members and Other Participants

The ADS-HERO Team is comprised of organizations with extensive experience in ADS, transportation systems management and operation, emergency response operations, big data, education, research, human factors analysis, real-world demonstration testing, and program management. The key team partners and stakeholders and the areas of work they will lead are shown on Figure 1. The committed public agency stakeholders include the Maryland Transportation Authority Police and Anne Arundel County Fire Department. Detailed information about the project team can be found in Part 2 Management Approach.

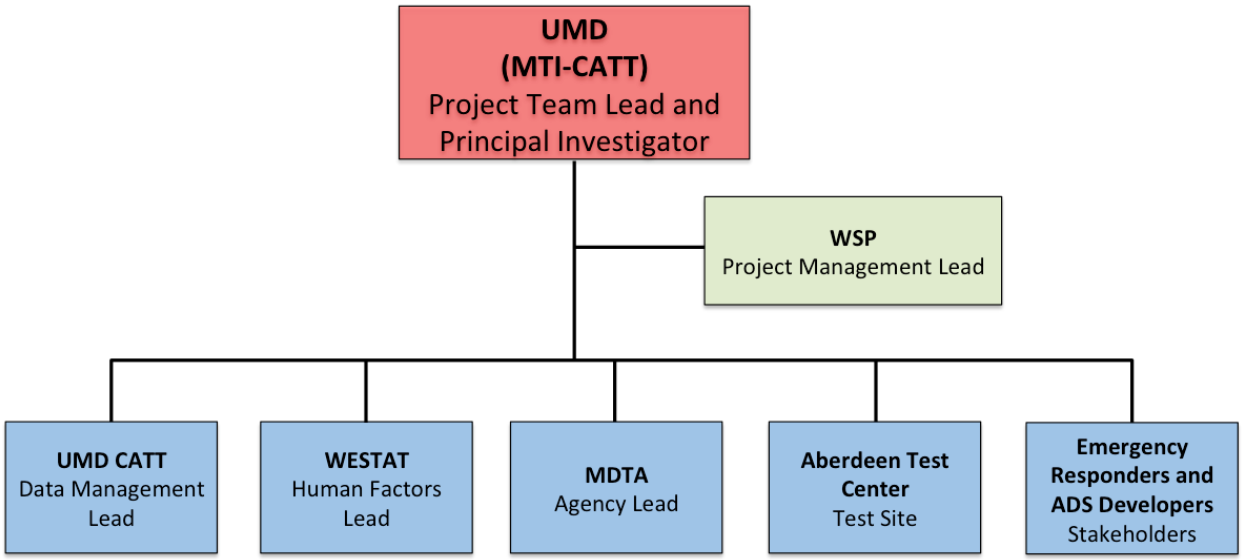

Figure 1. ADS-HERO Team

1.1.3 Issues, Challenges, Technology Demonstrations, Quantifiable Performance Improvement

The advent of ADS offers the potential to improve safety on the nation's transportation system. A critical element to safely integrating ADS into the nation's transportation system is to bring attention to ADS performance during on-road transportation and emergency response operations. Transportation and emergency response operations is an area that rarely sees private sector investment but provides a significant service and benefit to all communities - in every type of geographic area and population, whether using public or private transport for the movement of people or goods.

The ADS-HERO project is structured to work with ADS developers as well as transportation and emergency responder stakeholders to identify areas of concern and to build ADS demonstration scenarios that address these concerns. The ADS-HERO research partners will collect data during real-world demonstration scenario testing to verify areas of concern and to measure ADS and responder performance. Demonstration scenario evaluation reports will be used to facilitate the improvement of ADS technology as well as emergency response procedures and transportation system management and operations. Annual data and results sharing from

these demonstrations are expected to inform the following year's research and demonstration plans, which will result in a final evaluation report documenting identified areas of concern and recommended performance improvements.

1.1.4 Geographic Area or Jurisdiction of Demonstration

The primary testing area for the proposed ADS-HERO demonstration scenarios will be the U.S. Army Aberdeen Test Center (ATC) in Harford County, Maryland. The ATC has a looped test track that provides a unique facility for conducting comprehensive testing in a secure and controlled environment at various roadway speeds. In addition, portions of the ATC include extended shoulder areas that provide space to stage multiple stationary responder vehicles, such as fire engines and ambulances, as would be deployed at a typical roadway incident scene. The ATC site also has intersections where temporary signals could be installed for additional scenario and technology testing, including vehicle to everything (V2X) solutions. Finally, ATC has Soft Crash Targets representing vehicles and pedestrians that may be utilized as part of our demonstrations. Figures 2 depicts aerial views of the ATC test track.

The UMD College Park Campus roadways may be also utilized for demonstration testing. The University of Maryland Transportation Institute and its affiliate Center for Advanced Transportation Technology (CATT) has robust internal laboratory space where testing of hardware and software technologies, including V2V and V2X solutions can be prototyped. Finally, the UMD Department of Transportation Services manages several square miles of large, open space parking facilities, including areas up to one quarter mile in length. These facilities would accommodate testing of V2V and V2X prototype solutions outside of the annual week-long demonstration scenario testing at the ATC.

Importantly, as the ADS-HERO project develops and results in ADS technology advances to the point where real-world live system testing is appropriate, MDTA will consider making available limited sections of its controlled access roadways. MDTA is the owner/operator of a variety of facilities including MD 200, the Intercounty Connector (ICC). The ICC is a four to six-lane, access-controlled, managed highway that traverses Prince George's and Montgomery County, Maryland. A portion of the ICC and other MDTA facilities have previously been used for Intelligent Transportation System tests.

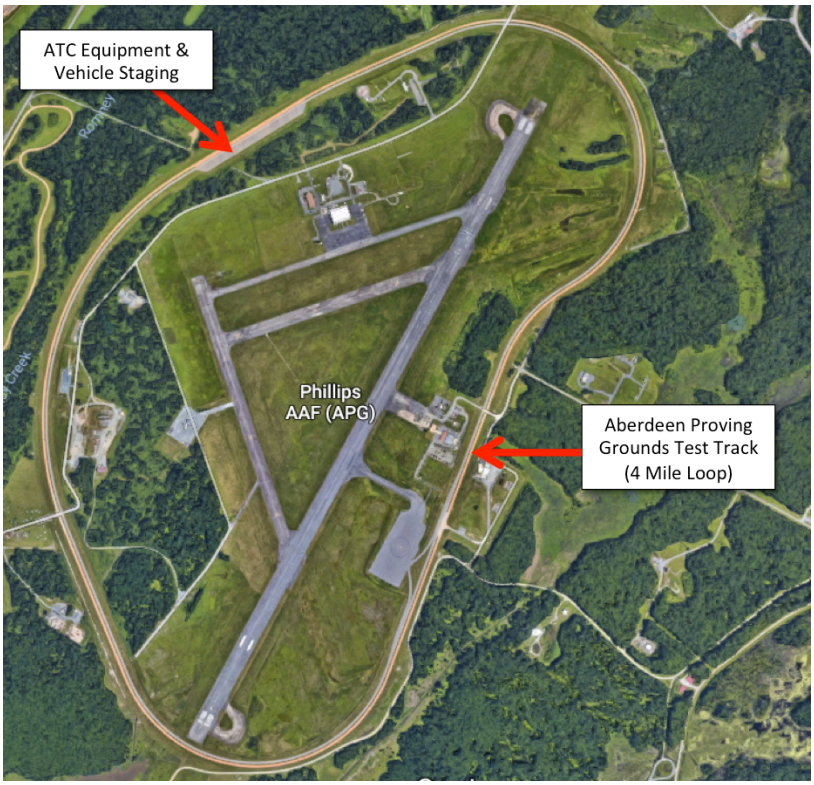

Figure 2. ATC High Speed Test Loop

1.1.5 Period of Performance, Schedule for Implementation and Evaluation

The Period of Performance for this project is four years. This includes four phases of outreach, project planning, technology assemblage, data collection, analysis and reporting as shown in Figure 3. Pursuant to the requirements of the ADS NOFO, UMD will ensure that all appropriate data will be accessible to USDOT and/or the public for a minimum of five years following the expiration of the period of performance.

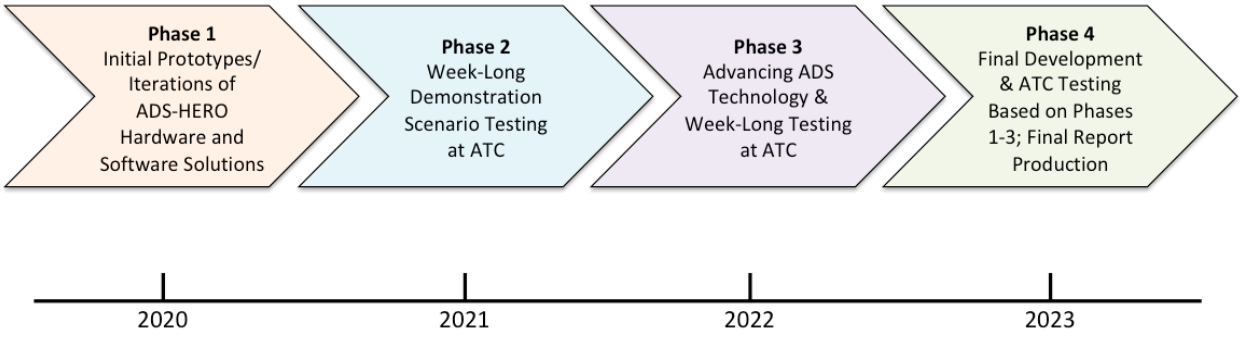

Figure 3. Project Phases and Period of Performance

1.2 GOALS

Traffic incident emergency response calls are rising, and the challenge is to safely manage the incident scene to protect emergency responders, victims and other users of the transportation system. In 2017, 10 law enforcement and 10 firefighter personnel were struck by vehicles,

according to the Law Enforcement Memorial Fund and the National Fire Protection Association. The numbers are significantly higher when all emergency responders and all vehicle involved deaths are considered. In a recent "Talking TIM" webinar hosted by the National Operations Center of Excellence, 25% of all congestion and 53-58% of all delay in urban areas was attributed to roadway incidents, indicating that the benefits of efficient TIM response goes beyond safety. ADS technologies have the potential to improve emergency response and transportation system safety and performance through crash avoidance, predictable vehicle movement and appropriate responses to roadway conditions. Specific goals and objectives for the ADS-HERO project are shown in the Executive Summary section of this document.

ADS-HERO focuses on the safe integration of ADS into the Nation's on-road transportation safety system, generally in relation to ADS interactions with emergency responder operations and specifically at roadway incident scenes. Through collaboration with the ADS developer and emergency responder communities, the ADS-HERO demonstrations and data collection will support the development of improved ADS responses at roadway incidents. In addition, ADS-Hero data may be used to support transportation incident and emergency response procedure modifications to safely integrate ADS into the Nation's transportation system.

The ADS-HERO project will also seek to reveal information on human responses to new and emerging ADS technologies, assess the impact of ADS on existing emergency response procedures and develop improved responses and procedures. The project will evaluate ADS impact on established national transportation and safety performance measures, identify methods to maintain and improve transportation network safety for travelers and emergency responders; and provide equipment manufacturers with critical information on ADS performance during interactions with emergency responders. In addition, the results can be applied to create new or update existing, national training programs for emergency responders such as police, fire, rescue, medical services and safety service patrols.

1.2.1 Safety

Emergency responders and others at the scene of an incident are vulnerable to approaching vehicle intrusions into the scene. Although automated driving system (ADS) technologies have demonstrated some promise in reducing collisions with vehicles, pedestrians, and other objects, these initial solutions are not infallible and potentially do not use connected vehicle technologies to improve performances. The human factors impact on persons traveling in an ADS equipped vehicle also remains unclear, especially in TIM scenarios. ADS technologies can significantly improve awareness of roadway hazards; but, they may also contribute to unwarranted technological reliance or inadvertently result in human occupant "over-reactions" or even reactions in direct contradiction to programmed ADS responses, which may result in secondary incidents. Research is needed to better understand the performance of ADS during traffic incident and work zone scenarios, and the related human factors implications for vehicle occupants and other highway users as well as emergency responders and other highway workers.

1.2.2 Data for Safety Analysis, Rulemaking, and Scaling Nationally

As denoted in the NOFO, the collection and sharing of near-real time data is critical for the analysis of the efficacy of ADS, and ultimately to aid in future government rulemaking, including the identification of potential governmental barriers that may impede the rapid and comprehensive deployment and adoption of ADS technologies in the marketplace. The ADS-HERO project will work to identify safety metrics (technological and human factors-based) that can characterize the risk of ADS integration into the transportation system, including working to identify indicators that can inform future safety analysis. These metrics will create the framework for evaluating ADS technologies in TIM environments which may inform Original Equipment Manufacturer (OEM) performance guidelines and regulations.

The ADS-HERO project will develop emergency responder use cases for ADS developers and provide human factors data on emergency responder interactions with ADS. For example, how close is too close for an ADS to approach an emergency responder or incident scene? How much time does it take for an ADS to navigate an incident scene? Will ADS reduce or extend the time to clear congestion queues near an incident scene?

Based on answers to these questions, data collected for safety analyses will be used to inform guidance and decisions by ADS providers as to the standard performance-based functionalities that all ADS vehicles should possess so as to improve the safety of ADS vehicle interaction with the emergency responder community. Scaling nationally requires safety data capture scaling and ADS vehicle performance function scaling. Nationwide safety data scaling is addressed in the data management plan. Performance function scaling includes functions such as detecting an emergency responder at a traffic incident management scene, detecting and responding to emergency responder hand/flagging motions or other traffic control devices, detecting and responding to emergency vehicles with lights and sirens, etc.

The scenarios and safety data collection and analyses under this ADS-HERO project will inform which specific emergency response functions should be included in ADS vehicles and how they can be objectively evaluated as well as how these functions can be scaled nationally. The ADS-HERO Team will also work with associations including the International Association of Fire Chiefs and the International Association of Chiefs of Police to ensure national support for required ADS functionality that will make emergency responders safer. In turn, the ADS-HERO Team stands ready to work with USDOT in supporting any related rule making process by using data and output from the scenario deployments to inform National Proposed Rulemaking and Final Rulemaking as required.

1.2.3 Collaboration

The University of Maryland (UMD) Maryland Transportation Institute (MTI) and its affiliated Center for Advanced Transportation Technology (CATT), in collaboration with the Maryland Transportation Authority (MDTA) and the Maryland Transportation Authority Police (MDTAP), the Anne Arundel County Fire Department, the U.S. Army Aberdeen Test Center (ATC), Westat an employee-owned research corporation, WSP a leading engineering and professional services

firm, and Local Motors an ADS developer - propose to conduct research on Automated Driving System (ADS) vehicle technologies to assess their response to, and impact on emergency incidents on our Nation's roadway network. The proposed demonstration test location at the ATC is ideally situated to ensure minimum impact on the public and on transportation challenged populations during the demonstration tests, while the anticipated project outcome of a safer ADS integration into emergency incident management on the transportation system will benefit all users of the Nation's roadway network.

The ADS-HERO Team will fully engage all relevant stakeholders across our member and partner networks to ensure that we "create collaborative environments that harness the collective expertise, ingenuity, and knowledge of multiple stakeholders." UMD has long-term and robust experience in developing extensive partnerships across education, local, state, and Federal governments, as well as commercial industries (domestic and multinational). The Center for Advanced Transportation Technology (CATT) maintains multidisciplinary partnerships with transportation, public safety and fire/EMS. CATT programs and software solutions are used by thousands of participants (operation center-based and emergency responders in the field) and hundreds of agencies on a 24/7/365 basis. CATT will be responsible for the data management plan and its execution.

1.2.4 Coordination and Integration with Maryland Connected and Automated Vehicles (CAV) Vision and Plans

The Maryland Department of Transportation (MDOT) is a multimodal agency with responsibility for and expertise in roadway and bridge design, tolling infrastructure, motor vehicle safety, transit, bicycle / pedestrian issues, aviation and ports. CAV is consistent with the MDOT mission and with many of the goals in the 20-year Maryland Transportation Plan. Goals applicable to this effort include: maintain a high standard and modernize Maryland's multimodal transportation system; ensure a safe, secure, and resilient transportation system; include specific strategies such as to implement CAV pilots and support CAV testing through partnerships; build CAV real world experience; and attract partner investment in Maryland.

In 2015, Maryland Transportation Secretary Pete Rahn established the "CAV Working Group" as the central point of coordination for the development and deployment of emerging CAV technologies in Maryland. The Working Group handles strategic planning for MDOT concerning connected and automated vehicles, and includes a diverse membership of transportation stakeholders, including elected officials, state and local agency representatives, highway safety organizations, and representatives from the private sector and automotive industry. Through the Working Group, a CAV Vision was founded that states in part, Maryland is open for business and eager to support the advancement of automated driving systems to realize the potential life-saving and economic benefits, while ensuring safety for all. MDOT maintains that collaboration at all levels is the key to realizing the benefits in the CAV space and to truly realize the potential to once again transform mobility.

The ADS-HERO Team includes members of the Maryland CAV Working Group and specifically members of the Emergency Responder SubGroup, which provides a mechanism to address emergency responder questions and concerns about operational responses of highly automated vehicles. Accordingly, the Team will share project activities, including specific development and testing milestones, with the Working Group in order to facilitate greater exchange among government and industry partners about CAV deployments in Maryland during the Quarterly Working Group meetings. Figure 4 provides an illustration of Maryland CAV Working Group Membership and functions.

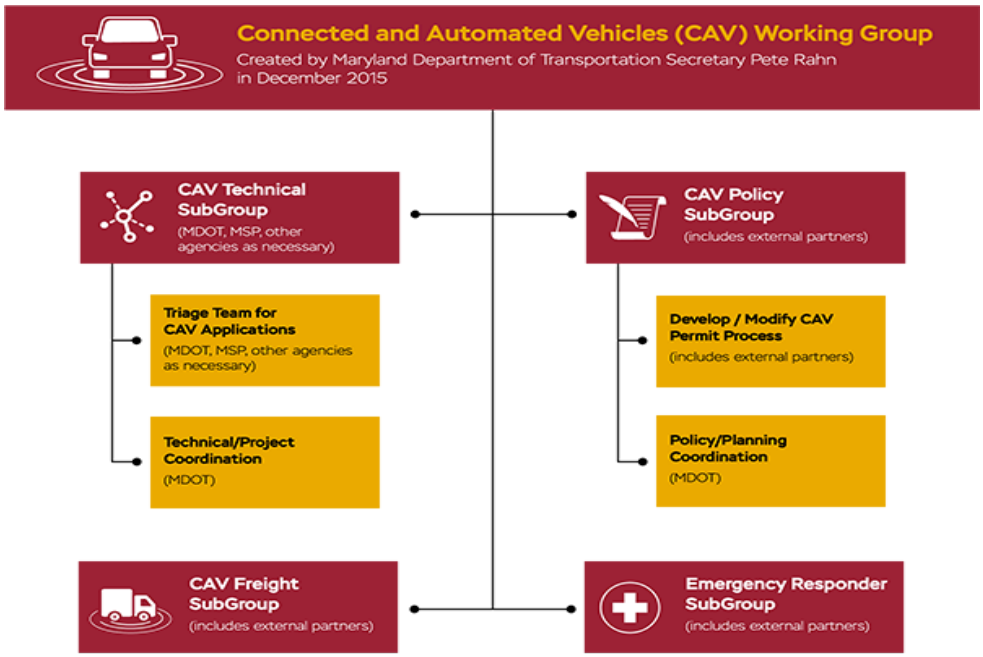

Figure 4. MD CAV Working Group

1.3 FOCUS AREAS

As ADS are integrated into the Nation's transportation systems, they will inevitably become a part of an approach to roadway incident management. From a disabled vehicle to a crash, a hazardous material spill to a natural disaster scene, an ADS equipped vehicle will encounter emergency responders serving the public interest to rescue people and property. The ADS-HERO project is designed to create a significant public benefit in an area of transportation operations (emergency response) that rarely sees private investment but provides a service to all communities – in every type of geographic area and population, whether using public or private transport for the movement of people or goods.

The objectives of the ADS-HERO project directly complement and inform the existing U.S. Department of Transportation's Development of Cooperative Automation Capabilities: Integrated Prototype II program (Contract DTFH61-16-D00030) CARMA3 platform. CARMA enables the research and development of cooperative automated driving systems (CADS) capabilities to support transportation systems management operations (TSMO). The proposed

demonstration scenarios will provide ADS developers and state and local agencies with relevant data to identify modifications to existing traffic incident management systems (TIMS) and vehicle capabilities that may be required as ADS vehicles become more prevalent on roadways. In addition, this novel research will address the concerns and knowledge gaps of the emergency responder community regarding the performance of ADS vehicles in traffic conflict scenarios.

ADS-HERO research priorities, which are consistent with the aforementioned objectives, include the following:

1. Providing a collaborative demonstration test site for ADS developers to demonstrate their design response capabilities to emergency road conditions.
2. Familiarizing emergency responders with the emerging ADS technology and the potential impact of these technologies on their operations in emergency situations.
3. Capturing detailed data on human (bystander, occupant and emergency responder) interactions with ADS technologies.
4. Capturing relevant data that will assist in recalibrating the TIMs and TSMO formulas for incident duration, delays and clearance times.
5. Sharing research findings with ADS developers, including data related to their particular vehicle design in order to facilitate advancement of ADS responses to emergency road conditions.
6. Documenting data to support ADS developer incorporation of connected vehicle concepts including applications supporting “smart work zone technologies” capable of alerting emergency responders of approaching vehicles as well as notifying upstream connected vehicles of changed roadway conditions such as the presence of emergency responders, temporary road or lane closure, need to merge, or the need to reduce speed.
7. Incorporating the testing of low-cost, “proof-of-concept” ideas for detecting vehicles, pedestrians, cyclists, and other objects in the roadway and in crosswalks, which may include the use of video cameras and open-source software for vehicle and object detection and sending basic safety messages (BSM) to connected vehicles.

The data also could be useful for predicting crash frequency/probability – e.g., modeling the likelihood of crashes based on a variety of input data, including work zone characteristics, road geometry, weather, traffic flow parameters, etc., and identifying risk factors in and around work zones and incident scenes. Furthermore, the data can be processed to enable decision support, e.g., Advanced Driver Assistance Systems (ADAS) and will be organized for long-term storage.

1.4 DEMONSTRATION REQUIREMENTS

The ADS-HERO project will include physical demonstration scenario testing of ADS vehicle performance at the ATC test track and may graduate to real-world on road testing. The demonstration testing will include ADS at Level 3 or greater and is intended to create opportunities for iterative (annual) test cycles to demonstrate improvements in the automation technology. All of the transportation performance and human factors data collected will be anonymized and shared with the USDOT through CATT. If the ADS-HERO Team is authorized by

ADS developers, anonymized ADS and vehicle data will also be collected and shared. The proposed data management plan and commitment to data sharing is discussed in Part 3 of this application. *Please note that under our data management plan, we are committed to providing USDOT with the required data accessibility as described in Amendment 1 to the ADS Notice of Funding Opportunity.*

In order to examine the performance of ADS vehicles during traffic incidents, the ADS-HERO project team proposes to use a looped course on a closed test track, with multiple demonstration (emergency roadway) scenarios through which a variety of ADS vehicles will proceed where human (emergency responder, occupant and bystander) and machine responses are recorded. Physical demonstration tests will be conducted at the ATC with SAE Level 2 through 4 ADS. Early in the development of ADS-HERO, invitations will be sent to ADS developers to increase the pool of participant ADS vehicles.

A combination of initial focus groups with emergency responders, recorded observation of ADS-emergency responder interactions during the demonstration scenarios, and structured interviews with participants following the demonstrations, will identify key factors that may need further attention on the part of ADS developers, TIMS and TSMO staff, and emergency responders in order to better protect responders and the public from unanticipated consequences of ADS integration in the nation's roadway system. Through the focus group discussions, observations, and structured interviews, the ADS-HERO project team will gain the opportunity to share with the ADS stakeholder community a deeper understanding of ADS occupant and emergency responder perspectives on safety, expected behavior of the vehicles, concerns about what aspects of the interactions might be problematic, and how training or operational procedures may need to be improved to accommodate this new type of interaction.

As the ADS-HERO project data set is enriched, the project team will be able to share the insights gained at a variety of national conferences to support discussions on potential use cases for ADS developers to investigate or potential emergency response procedures to be adapted. As the project nears its end, the individual ADS-HERO partners, participants and stakeholders may be able to incorporate the project results and lessons learned into the training programs and standard operating procedures of their specialty areas.

1.5 APPROACH

1.5.1 Technical Approach Summary

The ADS-HERO project plan is intended to advance ADS response to emergency roadway incidents with a focus on ADS interactions with emergency responders. Through the use of Focus Groups, the ADS-HERO project team will collaborate with ADS developers, transportation and emergency responders and other stakeholders to further explore the current state of knowledge, develop the proposed demonstration scenarios, identify areas of concern and the related data collection points which could be utilized to advance the state of knowledge and /

or develop ADS technology advancements. The Focus Group work will inform the development of the annual demonstration scenario test plan.

Each year, a detailed field plan of the test site will be created with a test course plotted through as many demonstration scenarios as are reasonable. The plan will be utilized to conduct safety reviews, to prepare equipment and material plans including vehicle and course instrumentation and to structure human participation plans. A use case proposal will be prepared and included in invitations for participation sent to ADS developers. The ADS-HERO project team has access to a number of ADS vehicles and will seek to expand the ADS test vehicle pool beyond those owned or under development by ADS-HERO partners.

Data collected during the week of field testing at ATC will be analyzed and follow up structured interviews will be utilized to identify areas where ADS performance at emergency incidents is appropriate, where it could be improved and where emergency response procedures could be modified to accommodate ADS limitations. The ADS-HERO Team will share the knowledge gained each year with emergency responder and ADS developer partners and stakeholders to structure ADS technology improvement proposals and to develop modified emergency response procedures. The ADS-HERO project cycle will be repeated up to three times during the period of performance.

The ADS-HERO Team will work with stakeholders to support the advancement of ADS technology. In addition, between the annual week-long demonstration scenario testing, the ADS-HERO Team will conduct work at Westat to guide improvements to the human and ADS interaction interface and at UMD CATT to develop V2V and V2X solutions that facilitate improved ADS responses to roadway incidents and emergency response operations. Throughout the year, laboratory and demonstration test tracks outside of the primary testing area at the U.S. Army Aberdeen Test Center will be available to the ADS-HERO Team for development testing of ADS technology solutions.

1.5.2 Focus Groups

Focus groups can provide critical information that researchers, manufacturers, and regulators need to better understand and define the concerns of emergency responders. The focus group effort has two broad objectives: (1) to provide a basis for the human factors data collected in the demonstration scenarios; and (2) to provide additional insight into issues that may not be fully addressed by observation alone. Regarding the first objective, the findings will address the state of knowledge of automated vehicles, and the concerns and experience of police and fire/rescue staff as they perform their duties. Regarding the second objective, we can explore in more detail peoples' specific approaches to their tasks, and how automated vehicle features may affect their approach or behaviors. By conducting focus groups prior to the observational studies conducted during the demonstration scenarios each year, we can also gauge changes in the levels of understanding of automated features, and emergency responders exposure to such features over time. This information will supplement what we subsequently collect in the observational studies each year and help in the interpretation of findings.

ADS-HERO Team Member Westat, with support from other ADS-HERO Team members, will be responsible for developing and implementing the focus groups, instrumenting the vehicles and environment during the demonstration scenarios, and conducting structured Interviews of participants. The focus group participants will be drawn from the ADS developers, transportation and emergency responder community. A total of nine participants from the community will be included in each of the two focus groups conducted each year.

A detailed moderator's guide will be developed including the question path to be used during the focus group sessions. As needed, the questions will be modified slightly to reflect concerns of a specific community focus such as transportation system, vehicle development or emergency response. The moderator's guide will be shared with the Contracting Officer's Representative (COR) and refined according to edits and suggestions.

A hotel conference room, or other suitable facility will be reserved near partner locations to assist in recruiting participants. Westat's normal pattern of ensuring reliable arrival for scheduled sessions includes emailing out a confirmation letter that includes the scheduled time and location of the focus group. It will also include directions to the site and a contact telephone number in case of cancellation or questions. Westat also makes reminder calls within 24 hours of the scheduled session to significantly boost the likelihood of subjects keeping their appointments. At the end of each focus group each eligible participant will be given an honorarium of $75 in order to compensate for their time.

The focus groups will be conducted by experienced focus group moderators from Westat's transportation research team. USDOT personnel will be invited to observe the sessions if desired. Each session is expected to last approximately 90 minutes.

Westat has found that audio and/or video recording is essential for accurately summarizing key issues discussed during the focus groups. Discussion will be coded off-line from the recordings and compiled along with notes from the moderator and other observers. Recordings will be destroyed at the conclusion of the project to keep participants' identities and personal responses confidential.

The focus group discussion will be coded and analyzed to identify key themes, responses to specific questions, and new issues raised. Review and interpretation of the findings will be documented and shared with the ADS-HERO Team as we complete planning for the observational phase. Westat also will participate in client meetings to discuss the implications of the findings with regard to the observational study methods and the overall levels of knowledge and concern of emergency responders.

1.5.3 Demonstration Scenarios

The ADS-HERO demonstration scenarios are structured to provide insight into ADS performance during everyday roadway incidents. These incidents may include lane or roadway obstructions, detours, or non-standard traffic control including the use of lights, sirens or hand signals by emergency responders. The ADS-HERO Team anticipates establishing a test course plotted

through as many demonstration scenarios as are reasonable on the ATC test track for at least one week each year, beginning in the second year of the project. Data from the focus groups, vehicle and infrastructure instrumentation and human factors results from each preceding year will inform the demonstration scenarios established on the test course for the following years.

The ADS vehicles currently available to the ADS-HERO partners include:

- Westat's Cadillac CT6, a Level 2 vehicle
- UMDs planned ADS test vehicle, a Level 3 vehicle
- Local Motors' Olli, a Level 4/5 vehicle, which carries eight passengers providing a rich potential source of human factors responses.

The ADS-HERO project team has access to a number of ADS vehicles and will seek to expand the ADS test vehicle pool beyond those owned or under development by ADS-HERO partners listed above. Westat's Cadillac CT6 is outfitted with human factors assessment equipment, including eye tracking, multiple cameras, GPS, rear radar, forward visual sensing, and processing of vehicle and target tracking CAN data. The CT6 provides a safe, instrumented, semi-autonomous, commercially available vehicle that will be useful for developing the data collection protocol for the other vehicles in the test scenarios. We anticipate that the levels of vehicle automation available to the Team will increase with each phase of the project, allowing for continuous testing with the most advanced technologies from commercial leaders in the ADS field.

In addition, ADS-HERO project team members have had conversations with multiple OEMs with ADS Level 3 or higher vehicles who have indicated their potential interest in working with us. Specifically, both Waymo and the Autonomous Vehicle (AV) Lead with the Ford Motor Company have indicated their willingness to work with us upon award. Discussions with OEMs have also included the potential demonstration of ADS in heavy-duty vehicles, including larger commercial vehicles.

The ADS-HERO Team anticipates a single ADS developer will be present during any individual test period to ensure that proprietary operation, configuration, and performance data are not revealed to competitive manufacturers. The ADS-HERO Team has extensive experience working with and masking manufacturers' confidential data (CBI). Preference will be made to include in the demonstration tests vehicles manufactured in America. The ADS-HERO Team does not anticipate requesting exemptions to the Buy American Act[1] as the purchase of ADS vehicles solely for use as part of the ADS-HERO project is not anticipated.

Demonstration scenarios will emphasize interaction of first responders and first responder equipment with ADS. The initial demonstration scenarios proposed include, but are not limited to, the following:

[1] Buy American Act, 41 U.S.C. §§ 8301-8305, as implemented at 48 C.F.R. Subparts 25.1-25.2

Scenario 1 – Leveraging ADS for Incident Scene "Approach" Demonstrations
Scenario 1 will involve an ADS-equipped vehicle approaching an incident scene where a lane of a multi-lane highway is occupied by a disabled vehicle (without an ADS) or other roadway obstruction (debris, pedestrian, vehicle/equipment). This approach will occur at varying speeds, including highway speeds. Both ADS responses/actions and human participant responses to the ADS will be documented. Supplemental scenarios include but are not limited to, the disabled vehicle(s) or emergency responder(s) on scene being capable of and/or the ADS being capable of V2V / V2X communications.

Scenario 2 – Leveraging ADS for "Move Over" Demonstrations
Scenario 2 will involve an ADS equipped vehicle being approached by an emergency vehicle with lights activated, sirens optional. Supplemental scenarios include, but are not limited to, the emergency vehicle and/or the ADS being capable of V2V/V2X communications.

Scenario 3 - Leveraging ADS for "Pull Over" Demonstrations
Scenario 3 will involve an ADS equipped vehicle being approached by a police vehicle with blue and red lights activated, sirens optional. Supplemental scenarios include, but are not limited to, the police vehicle and/or the ADS being capable of V2V/V2X communications.

Scenario 4 - Leveraging ADS for "Compliance" Demonstrations
Scenario 4 will involve an ADS vehicle approaching an incident scene and being directed by emergency responders with hand signals or other devices to proceed through or around the incident scene. Supplemental scenarios may include: ADS being directed to detour or go around in ways that would violate the "normal" rules of the road: deployment of full work zone traffic control as would be provided at long term incident scenes; and/or leveraging V2X "smart work zone technologies."

ADS technologies that may be tested during the demonstration scenarios include sensors, programmed responses and AI control responses to a variety of use cases:

- Object Recognition - emergency responders, emergency vehicles, other conditions
- Programmed Responses - move over, pull over, etc.
- Control Responses - obstructed roadway, hand signals, temporary traffic controls, etc.

The ADS-HERO Team anticipates that most ADS developers have instrumented their vehicles and control systems. If the participants agree to sharing their data or permitting the ADS-HERO Team to instrument their ADS vehicle(s), the ATC team is able to collect and store Controller Area Network (CAN) bus data and the CATT team is able to collect and store control system data. The ADS developer data that is not subject to a non-disclosure or proprietary agreement, will be shared with the USDOT as discussed in the Data Management Plan.

1.5.4 Institutional Review Board

For any research involving human subjects, approval of the plan must be provided from a qualified Institutional review Board (IRB), in order to ensure that the safety and privacy of research participants is protected. The UMD's IRB is a specially constituted review body

established to protect the rights and welfare of human subjects recruited to participate in any biomedical and behavioral research conducted by the university. The IRB is the entity responsible for ensuring that studies comply with all Federal regulatory and ethical standards issued by the Office of Human Research Protections (OHRP) in the U.S. Department of Health and Human Services. All staff members are formally trained annually in the protection of human subjects, as well as other pertinent training such as research misconduct and HIPAA-related privacy and security.

Prior to conducting this research, materials and procedures must be documented for Institutional Review Board (IRB) review and a structured protocol must be created. The materials will include consent forms for focus group and demonstration scenario participants and a detailed protocol for the conduct of the demonstration scenarios. The documents developed will be shared with the COR and refined as needed to protect study personnel from harm. Once the IRB approves the field task procedures and protections to human participants, project staff can begin to organize and conduct the focus groups, and preparations for the test track demonstrations and structured interviews.

1.5.5 Human Factors Research

Human factors monitoring technologies such as in-vehicle cameras, and external cameras will be used to detect the effects of ADS on vehicle occupants and emergency responders to determine the efficacy of each deployed solution. Westat will instrument participating ADS vehicles to capture occupant impressions/behavior and ADS vehicle behavior. Select ADS and emergency responder vehicles that belong to the ADS-HERO project team will be instrumented to collect occupant responses. Westat's instrumentation will be designed to be self-contained and self-powered, with no connection to a vehicle's (CAN) bus, to avoid any unintended interactions with ATC instrumentation or a vehicle's ADS. Westat will work with ATC to coordinate instrumentation plans during several planning visits to Aberdeen.

In order to monitor and record emergency responder and ADS occupant behaviors during the demonstration scenario testing, Westat will instrument ADS and emergency responder vehicles with a suite of cameras capable of capturing audio and video from inside the vehicle as well as GPS to provide common time and location context. Raspberry Pi-based data collection modules will allow a very small computer to be placed in the cars for quick and relatively simple instrumentation purposes. Westat has used systems like these for extended studies in people's new vehicles with multiple cameras (up to 3) for audio and video capture of multiple perspectives, GPS, cellular health monitoring, CAN bus monitoring, accelerometer data, and user inputs. Though the CAN capture will not be part of Westat's instrumentation plan for this effort, the remainder of these capabilities will be in place to allow reliable data capture from the interior of the vehicle. These systems are hardy and have a foundational software and hardware suite that allows customization for data collection, processing, and output review and analysis. Enclosures and mounting interfaces are often custom 3D printed to allow consistent, appropriate, and repeatable aiming of each camera view. Flexible mounts inside the vehicle cab may be reconfigured between scenario operations to ensure ideal context capture for forward or rear approach situations.

Each year, Westat will build and test 3 instrumentation packages in their Rockville laboratory prior to their deployment in vehicles at the ATC. Some software updates to existing instrumentation code may be required each year to accommodate changes in priority for data capture, and 3D printed components will provide the necessary aim and functionality to the discrete instrumentation packs. Though these systems are typically powered by the on-board diagnostics (OBD) port voltage source, Westat will provide battery power for all its data capture needs for this effort.

1.5.6 Vehicle and Infrastructure Instrumentation

Prior to conducting demonstration scenario tests at ATC, a vehicle and infrastructure instrumentation plan will be developed to monitor and record relevant activity. As previously noted, participating ADS developers may restrict access to their vehicle and proprietary data. When permitted, ATC will install a CAN bus to collect vehicle data.

Working in conjunction with the ATC and the rest of the ADS-HERO Team, Westat will instrument ADS vehicles, and where appropriate emergency responders and their vehicles for human factors data collection on the morning of each demonstration scenario test day at the ATC. The work will involve personal accessories such as GoPro and body cameras with audio capabilities, and the loading into vehicles of self-contained instrumentation packages that provides power, cameras, cabling, sensors, and computing hardware that can be deployed and securely mounted in a matter of minutes. The package will fit in one of the seating positions of the vehicle and will allow camera extension to forward, rear, safety driver/occupant, and/or other relevant positions needed to capture key elements of interactions inside and outside the vehicle. We hope to be able to leverage body-cam and in-vehicle cameras that are used be emergency responders as well. That is, we intend to have responders capture what they are doing and saying during the scenarios to capture the best possible video and audio quality at the interface of responders and ADS vehicles. Westat can then download and archive that data for archiving, review, and analysis. GoPros can be used to supplement those cameras to capture more of the observation view of the unfolding scenario activities. These cameras could be attached to the disabled or otherwise unequipped responding vehicle to complement the existing footage.

In addition to the in-vehicle instrumentation, Westat proposes to use aerial videography of the demonstration scenario testing to capture a broad view of the scenario operations and the interactions that occur. The aerial videography may be limited by airfield air traffic control rules as the ATC test course surrounds the Phillips Airfield. Tethered, video-capable drones will be placed at the locations where key demonstration scenario activities will occur. The drones would provide an elevated platform from which emergency responders and ADS vehicles approaching, responding to and departing from an incident scene could be observed and recorded. Cameras include pan and zoom capabilities to frame key interactions in the video. The drone cameras are expected to provide flexibility to enhance ATC's built-in CCTV system coverage, permitting staging of ideal approach angles, framing, and following of maneuvers as they unfold. A 50-100' elevation should provide excellent visibility of scenario progression and

responder activity. The Westat budget includes line items for purchase or rental of video capable drones as well as personnel to operate them during the annual, week long demonstration testing at the ATC.

1.5.7 Risk Identification, Mitigation and Management

The ATC subjects every project to a Hazard Analysis Working Group (HAWG) review. The HAWG is comprised of ATC's safety, environmental, and test item specific subject matter experts (SME). The HAWG identifies project hazards and develops mitigations then prepares a risk assessment report. The ATC Commander reviews the risk assessment report prior to issuing a go/no go directive for the project.

The ATC provides a secure, controlled environment for testing and documenting ADS vehicle and emergency responder interactions and responses. The closed setting of the ATC test course will allow for testing of vehicles that are not yet certified as Federal Motor Vehicle Safety Standard (FMVSS) compliant. To comply with safety procedures, the ADS-HERO Team and specifically the ATC; will work with each ADS developer participant to establish an ATC "kill switch" control on each ADS vehicle that enters the test course.

1.5.8 Field Testing

ADS-HERO partner, MDTA, along with the rest of the ADS-HERO Team,will work with ATC to develop a detailed field condition test plan of the proposed demonstration scenarios including placement of roadway equipment, vehicles, and personnel. MDTA will work with Anne Arundel County Fire and other transportation and emergency response stakeholders to deploy the appropriate roadway and emergency responder equipment and personnel on the morning of the first day of testing at ATC. At the same time, a group of Westat, CATT and ATC personnel will work with emergency responders and the first ADS participant to install instrumentation. It is anticipated that each ADS participant will be on the test course for a half day and that the next participant will be instrumented while the previous participant is testing. An operational briefing will be conducted with each ADS participant prior to beginning each demonstration scenario testing period on the test course.

Video and dynamic data will be collected continuously while the demonstration scenario testing is underway. With ADS developer approval, a responder may be invited to ride in the ADS vehicle during the demonstration scenario testing. These ADS occupants will be asked to use common think-aloud procedures for verbalizing what the ADS appears to be "seeing/doing", what they are experiencing, and their impressions of the ADS functionality as it goes through each demonstration scenario. Over the course of the ADS-HERO project, depending on the success of each ADS to navigate the demonstration scenario test course, the complexity of the vehicle or pedestrian configurations for each scenario could be increased. For example, adding multiple stopped vehicles to an "approach" scenario; adding surrounding traffic to the scenario; creating more extensive or shifting lane blockages; or including pedestrian interactions could be added during later trials. At the end of the demonstration scenario testing periods, the ADS

occupants and emergency responders will be debriefed via structured interviews to ascertain impressions of how the ADS performed and their reactions and concerns.

1.5.9 Structured Interviews

Following the test track observational studies, the Westat team will conduct structured interviews with the participating emergency responders to gather their perceptions of the events in order to understand their apprehensions, and any modifications they may suggest to their standard protocols because of the presence of automated vehicles. Specifically, these interviews will be conducted to gather information on the potential role ADS vehicles may have on emergency responder safety and behaviors. The interviews will be conducted on-site at the ATC immediately following ADS field tests when possible. In the event that emergency responders are not available, follow-up telephone interviews will be conducted. Examples of the types of data that may be obtained from structured interviews include the following:

- Sources of information used by emergency responders to learn about automated vehicles.
- Changes to their impression of ADS based upon the demonstrations scenario testing.
- Review of methods used to identify ADS in the field
- Review of areas where ADS response to emergency response procedure should be modified
- Review of areas were emergency responder standard operating procedures may need to be modified to accommodate ADS
- Concerns about AVs and perceived risks.

Information gathered from structured interviews will be incorporated into a qualitative data analyses to accompany the demonstration scenario reports.

1.5.10 Data Analysis and Reporting

Significant challenges to be addressed as part of proposed ADS-HERO demonstrations include the effective use of ADS equipped vehicles to successfully negotiate roadway incident scenes from responding appropriately to an emergency vehicle approaching from behind to following on-scene emergency responder traffic control directions. The ADS must interact with emergency responders and comply with non-standard roadway conditions without causing adverse responses from occupants and other roadway users. The ADS responses may have unintended and negative consequences on the ADS occupant, emergency responders, and other roadway users. ADS responses especially responses that result in or require the ADS occupant to assume control over an ADS vehicle may result in a dangerous outcome, appreciably delay emergency response activities and/or negatively affect transportation system performance.

Anticipated ADS performance measures for the ADS-HERO project that will be addressed in the analysis may include, but are not limited to:

- Identification of disabled vehicles (or other obstructions) in a lane of travel by approaching ADS equipped vehicles (without active connected vehicle technology)
- Identification of responder vehicles in the lane of travel by approaching ADS equipped vehicles (with and without active connected vehicle technology, V2V/V2X)
- Identification of pedestrians/responders in the lane of travel by ADS equipped vehicles (with and without active connected vehicle technology, V2V/V2X)
- Occupant response to ADS actions
- ADS vehicle responses
    - Followed expected course of action
    - Stopped and waited
    - Stopped and attempted to pull over
      Stopped and attempted to request occupant takeover as driver or contacted operations center for guidance
    - Took an inappropriate action
- ADS response impact on emergency response procedures
- ADS response impact on traffic incident management procedures
- ADS response impact on transportation systems management and operations performance measures

The video and digital data will be aggregated for a given ADS vehicle session and coded in terms of ADS vehicle and emergency responder vehicle(s) and personnel actions in the particular demonstration scenario. The context/aerial camera video will be linked to the vehicle video to provide another aspect of the vehicle interaction for review and analysis. Each session's data and video will be reviewed separately and then considered in conjunction with the other sessions to create an overall review of results and conclusions from the interactions.

A summary report will be prepared within two months after each week of field testing that describes the specific simulated demonstration scenarios and summarizes results and conclusions from a human factors perspective. At the end of the project an aggregated report will describe the trends in the demonstration data from year to year and with respect to ADS responses to particular demonstration scenarios. This will provide pertinent outcomes and lessons learned.

1.5.11 Advancing ADS technology

The ADS-HERO project team will utilize the demonstration scenario reports to facilitate the safe integration of ADS technology unto the nation's roadways through a variety of mechanisms to improve ADS performance, to improve emergency response procedures and to improve transportation system management and operations.

The ADS-HERO project team will conduct outreach with ADS developer participants to discuss areas where the ADS response negatively affected emergency response or transportation system performance and identify potential areas for ADS performance improvements. The ADS-HERO project team will also conduct outreach with transportation and emergency responders to discuss areas where emergency response procedures could be modified to

accommodate ADS integration. The areas where ADS developer participants anticipate ADS performance can be improved or emergency responders anticipate procedures should be modified will be incorporated into the next year's demonstration scenarios.

The ADS-HERO Team will also work independently from the ADS developers to create potential V2V and V2X solutions for the safe integration of ADS unto the nation's roadway. CATT has prior experience working with emergency responders to utilize new technologies. From 2013-2014, CATT, in partnership with the Battelle Corporation, developed prototype solutions as part of the Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) pilot, one element of the U.S. Department of Transportation's Connected Vehicle/Dynamic Mobility Applications (DMA) Program. These prototype solutions were designed to alert emergency responders when vehicles which could pose a threat to their safety, entered a pre-defined "incident zone". In addition, the prototype incorporated new AVL functions into existing/deployed emergency responder software platforms (CapWIN Mobile Client) and used dashboard cameras to establish lane-level views of responders on scene at an incident. The live demonstration was a successful exchange of real-time updates with emergency responders at the scene of an incident. CATT will leverage the technologies developed as part of R.E.S.C.U.M.E. and incorporate them, where appropriate, into the ADS-HERO project.

The CATT will also acquire a Level 2/3 vehicle as part of a separate project. If the ADS grant is awarded, the potential V2V/V2X products will be implemented and the vehicle will be available for inclusion in the next demonstration scenario testing at the ATC. Pilot testing of the V2V/V2X products will occur at the CATT and on the UMD College Park campus. If the V2V/V2X testing at UMD includes operating the ADS on a public roadway, the CATT will apply to the Maryland Department of Transportation, Motor Vehicle Administration for an HAV permit. In addition, any developed V2V/V2X solutions developed under this complimentary project will be shared with USDOT via CARMA or WZDx, as appropriate.

The CATT will be involved in the creation of V2V/V2X solutions using the Maryland State System Development Life Cycle (SDLC) -- a framework intended to reduce the risk of project failure through the application of incremental and iterative solution delivery. This approach focuses on the benefits of Agile development to improve the delivery of IT development projects. The SDLC delivers iterative, rapid development and learning cycles, which ensures the delivery of technical components more frequently, allowing developers to detect small failures early ("fail fast: and treat them as learning opportunities leading to an improved product.

The CATT investigations into ADS technologies will begin by translating previously developed preliminary requirements based on existing specific system requirements for the proposed system design and implementation of ADS-HERO application prototypes. ADS-HERO stakeholder requirements, use cases, operational concept scenarios, and human- machine interactions will be transformed into a set of technical requirements within the context of the conceptual system architecture. Each function will be defined in quantifiable terms that and will enable the system to perform desired functions. Technical and quality performance

parameters will be included in the requirements documents so that operational goals can be easily identified. Iterative meetings with the USDOT, the ADS-HERO Team and stakeholders will be held to refine and solidify the system requirements.

UMD uses the Confluence Jira software solution for Agile requirements identification, software design, development, and documentation. All previously created documents during the ConOps development will be loaded into Jira. This will enable tracking and tracing of each system requirement, architecture element, and design element from prototypes original stakeholder feedback, needs, and input. Jira will enable full end-to-end traceability for the entire lifecycle process.

1.5.11 Project Schedule

ADS-HERO technical development will occur in phases that correlate with each performance year testing cycle, as illustrated in **Figure 3** above. Week long demonstration scenario testing at the ATC is planned for the second thru fourth years. Annual data and result sharing from the demonstration tests are expected to inform the next year's research and demonstration plan. Table 1 presents anticipated project milestones and deliverables.

Phase 1

The ADS-HERO Team will utilize the first year of the project to create a detailed research plan documenting the proposed goals, the proposed demonstration testing and instrumentation plan and the proposed methodology for improving ADS integration into the nation's roadway systems. During Phase 1, the ADS-HERO Team will assemble and secure all required technical and physical assets for the demonstration testing including permits, safety reviews, materials and equipment. The demonstration scenarios and use cases will be documented and invitations to participate in the field testing will be sent to ADS developers. All necessary legal documentation for liability insurance, individual and agency participation and cost reimbursement will be finalized. Phase 1 will include initial prototypes/iterations of ADS-HERO hardware and software with a trial of the proposed demonstration scenario testing and data collection at ATC.

Phase 2

The focus of Phase 2 will be the first week long, demonstration scenario testing cycle at the ATC. The ADS-HERO Team will collect and share data from the first demonstration test cycle with emergency responders and ADS developers. The areas of concern where ADS developer participants anticipate ADS performance can be improved or emergency responders anticipate procedures should be modified will be incorporated into the next year's demonstration scenarios The ADS-HERO Team will also work to implement additional technical components and supplemental scenarios; to the year three demonstration scenario testing, to add complexity and further inform research findings. Potential ADS technology solutions including V2V and V2X prototypes will be developed and lab tested.

Phase 3

Phase 3 will build upon the findings from Phases 1 and 2, and continue technical development for additional field testing at ATC. In addition, initial field testing of potential ADS technology solutions developed as part of the ADS-HERO project may be conducted during the week long demonstration scenario testing at ATC. The ADS-HERO Team will continue to work with all partners and stakeholders to develop enhancements to each technical element. In addition, the ADS-HERO will, where applicable, test additional scenarios that demonstrate more complex technical and human interactions.

Phase 4

Phase 4 will build upon the findings from all previous field testing at ATC and in lieu of continued testing at ATC may include early real world, trial testing of the potential ADS technology solutions developed as part of the ADS-HERO project. As part of the final evaluation report, the ADS-HERO Team will document all findings from the research conducted and prepare detailed reports, presentations, software documentation and sharing, and identify opportunities for ongoing research.

1.5.12 Milestones and Deliverables

Table 1. Schedule of Milestones and Deliverables

TASKS	Approximate Due Date	Milestone/ Deliverable	Section 508 Compliant?
Kick-off Meeting	3 weeks after grant award	M	No
Project Management Plan	2 weeks after kick-off meeting	D	No
Data Management Plan	60 days after grant award and continually updated	D	No
IRB Request and Participant Consent Forms	75 days after grant award	D	No
Project Evaluation Plan	90 days after grant award	D	No
Focus Group Moderator Guide and Question Path	120 days after grant award/ annual updates	D	No
Quarterly Updates with MD CAV Working Group	Quarterly	M	No
Annual Budget Review and Program Plan	60 days prior to award anniversary	D	No
Annual Budget	45 days prior to award	M	No

Review and Program Plan Meeting	anniversary date		
REPORTS			
Quarterly Progress Reports	30 days after the end of the quarter	D	No
Focus Group Reports	30 days following conduct of focus groups/annual	D	No
Demonstration Scenarios Data and Summary Reports	90 days following annual completion of test track scenarios	D	No
Final Evaluation Report	90 days prior to the end of the Period of Performance	D	Yes