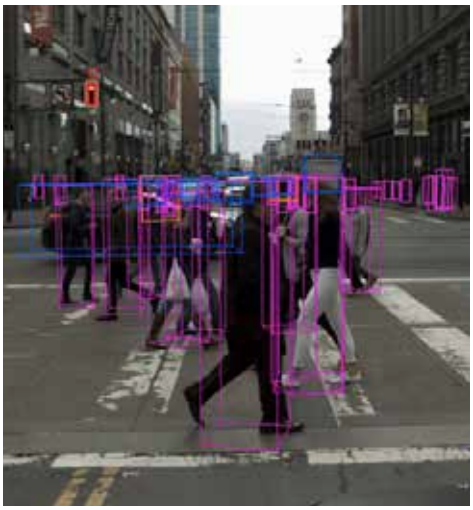
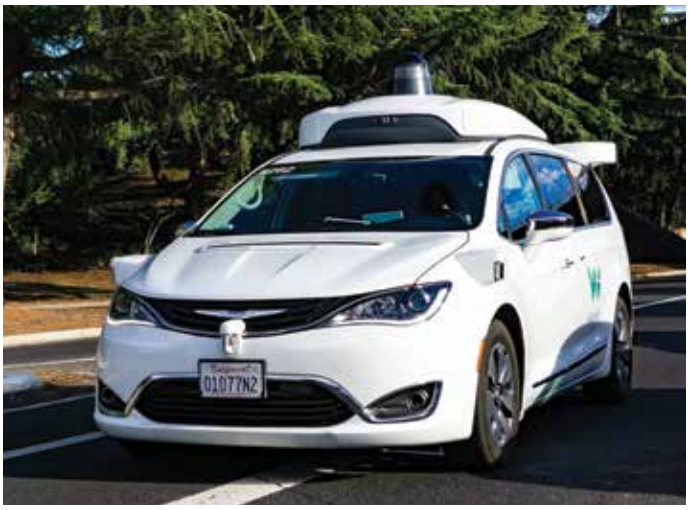


Driving Toward Safety: ADS Learning in Complex Cities



Notice of Funding Opportunity
#693JJ319NF00001

SFMTA

March 21, 2019

The Honorable Elaine L. Chao
Secretary of Transportation
U.S. Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

Subject: San Francisco's Automated Driving System Demonstration Grant Application

Dear Secretary Chao:

On behalf of the City and County of San Francisco, I am pleased to submit this proposal for the U.S. DOT Automated Driving System (ADS) Demonstration Grant.

San Francisco is a hub of transportation innovation. We see ADS passenger vehicles testing on our city streets each day and estimate that at least 500,000 automated driving test miles have occurred on our roadways. San Francisco is an attractive testing ground for these new technologies, partially as a result of our proximity to Silicon Valley, but also because of the complexity of our roadways that provide for an exceptional ADS learning environment.

In 2014, San Francisco adopted Vision Zero to eliminate traffic fatalities on our city streets. Vision Zero is premised on the idea that traffic deaths are preventable and that, through a combination of engineering, education, and enforcement, we can reduce the number and severity of collisions to save lives. Vision Zero is a citywide collaboration, which brings together twelve public agencies with bicycle, pedestrian, and accessibility advocates. While we are making significant progress and have reduced the number and severity of collisions, last year, 23 people lost their lives on our streets. That is 23 too many.

The ADS industry makes a compelling case for the potential of technology to enhance road safety and end the needless injuries and deaths related to human driver. While we embrace this potential, we also have an obligation to protect public safety. This means developing a transparent record of the testing activities occurring on San Francisco's streets and using that information to understand the safety implications of this emerging technology. Given our commitment to Vision Zero, we are particularly interested in

understanding how ADS will impact San Francisco's most vulnerable road users: pedestrians, bicyclists, seniors, children, people with disabilities, and roadway workers.

Our proposal provides a path toward learning from the ongoing ADS testing in San Francisco to ensure that future ADS federal rulemaking efforts reflect the challenges of automated driving in dense, urban environments.

Thank you for your consideration.

Sincerely,

Edward D. Reiskin
Director of Transportation

Summary Table:

City and County of San Francisco USDOT Automated Driving System Demonstration Grant

Project Name	Driving Toward Safety: ADS Learning in Complex Cities:
Eligible Entity	San Francisco Municipal Transportation Agency
Point of Contact	Joel Goldberg, SFMTA Grants Manager, Joel.Goldberg@SFMTA.com 415.646.2520
Proposed Location (State(s) and Municipalities) for the Demonstration Proposed	City and County of San Francisco
Technologies for the Demonstration	ADS Passenger Vehicles, Multiple Vendors
Proposed duration of the Demonstration (period of performance)	Four years
Federal Funding Amount Requested	$5,501,999
Non-Federal Cost Share Amount Proposed	$499,444
Total Project Cost (FederalShare + Non-Federal Cost Share, if applicable)	$6,001,443

Table of Contents

1. EXECUTIVE SUMMARY

Vision

Visionary innovators who have been striving to engineer a reversal in traffic safety trends through automated driving have been testing their engineering prowess on San Francisco streets for several years.

San Francisco's Driving Toward Safety: ADS (Automated Driving System) Learning in Complex Cities (SF DTS) will ensure that industry stakeholders, public policy makers across the country, and the general public learn as much as possible from the ongoing demonstration of the challenges and opportunities for safe integration of ADS vehicles on dense urban roads in San Francisco. Hundreds of thousands of miles of testing have already been logged on San Francisco streets, and we expect testing to escalate in both scale and ambition during the course of the Project.

Numerous factors make close analysis of test driving in San Francisco an ideal way to meet the Safety, Data for Safety Analysis, and Collaboration goals in the Automated Driving System Demonstration Grants NOFO. San Francisco's varied roadway environments, including many that are highly congested with auto, pedestrian, bicycle and transit traffic, our history of interagency collaboration on efforts to achieve zero roadway deaths, and our national leadership in linking and mapping transportation and public health data, set the stage for deep analysis of longitudinal data about the development and safety performance of ADS driving.

San Francisco is a new mobility hub. The future is already here on our streets. Many ADS developers have announced a ride-hailing business model for ADS driving that focuses on customer-rich cities. The Bay Area offices of many ADS developers, combined with hundreds of thousands of test-driving miles that our residents and visitors have directly observed, offer an unparalleled opportunity for industry to come together with local, state and federal government agencies and members of the public (including vulnerable road users and transportation challenged populations) to learn directly from each other. San Francisco's leadership roles and long-standing participation in the National Association of City Transportation Officials, the National League of Cities, the American Public Transit Association, the Institute of Transportation Engineers and other national organizations, along with its partnership with the RAND Corporation, ensure that SF DTS will quickly and effectively disseminate what we learn to other cities.

In short, our vision is to lift the fog of uncertainty and anxiety about the safety of ADS driving and replace it with evidence-based analysis and reliable public information.

Issues and Challenges to be Addressed

Under California law, permittees are conducting a large ongoing demonstration of ADS passenger vehicle driving on San Francisco streets,

ADS developers are learning on our roads every day, but the competitive nature of the industry has limited the dissemination of public information about the safety of their test-driving.

Technology to be Demonstrated

The physical demonstration for SF DTS is the actual demonstration of automated driving systems already occurring on San Francisco streets. We expect this testing to increase dramatically over the project period, according to the stated business plans of developers.

1 PROJECT NARRATIVE AND TECHNICAL APPROACH

Goals

SF DTS will achieve four goals:

1. Through the course of SF DTS, we will gather data and closely examine ADS involved collisions on San Francisco streets (to date and ongoing) to understand the driving and environmental factors that are most associated with ADS safety incidents. We will make the underlying data available to the public by:
   - Expanding San Francisco's pathbreaking public, centralized georeferenced data repository for safety-related transportation data, TransBASEsf.org to include data arising from and relevant to ADS driving safety,
   - Issuing a summary report to help other public entities create a similar database for safety-related transportation data.
2. We will analyze the information currently available through public records and make recommendations about safety metrics, including the use of Operational Design Domains (ODD) in safety evaluation and future rulemakings.[1]
3. We will establish a technical advisory group and a community working group to inform our research and disseminate the results.
4. Finally, we will develop recommendations:
   - for developers and regulators about ADS driving competencies and test scenarios that are important to safe operation on urban roadways,
   - for roadway managers about initiatives that may improve safe ADS integration.
   - for public education that can help reduce risks and maximize benefits from ADS driving.

Key Collaborators

SF DTS will be managed through a collaboration between the San Francisco Municipal Transportation Agency (SFMTA), the San Francisco Department of Public Health (SFDPH), the San Francisco County Transportation Authority and the RAND Corporation (as a subrecipient)

The City joined forces with RAND because of its decade of thought leadership on evaluating ADS safety, which is documented in the Part 2 Capabilities Section. Importantly, the SF DTS is informed by RAND's latest such report, Measuring Automated Vehicle Safety: Forging a Framework.

RAND's participation is key to the Project's ambition to reach beyond publicly available records and work with data provided voluntarily by developers testing ADS on San Francisco streets. RAND will host any data provided to the Project by ADS developers, will aggregate or otherwise de-identify it to protect the proprietary information of developers, and will make it available to the USDOT and to SF DTS for use in the work of the integrated project team.

Geographic Area

SF DTS will focus analysis on ADS passenger vehicles driving on San Francisco streets to provide data to support rulemaking for any and all urban roads.

Performance Period

2019-2023, i.e. four years upon execution of Grant Agreement.

2. ALIGNMENT WITH NOFO GOALS

SF DTS aligns perfectly with the NOFO goals: it makes efficient and effective use of federal resources to advance the public knowledge to be gained from existing testing of SAE level 3 and higher ADS on public roads while relying on developer funds and business plans (past and future) to support the actual operation of ADS test vehicles.

1 PROJECT NARRATIVE AND TECHNICAL APPROACH

Safety

As of March 2019, 62 companies hold permits under California law to test ADS vehicles on public roads with safety drivers present. Reports recently filed with the California Department of Motor Vehicles (CA DMV) by 48 companies document 2.05 million miles of automated driving on public roads in 2018 alone. While these reports do not tell us definitively, we estimate that at least five hundred thousand miles of automated driving have occurred on San Francisco streets. Public records demonstrate that at least four companies have tested ADS software in San Francisco within the last year, but the actual number may be greater. There is every reason to believe that the number of companies testing ADS and the number of vehicles testing on San Francisco streets will grow – perhaps very rapidly -- during the proposed study period. Regulations adopted by the California Public Utilities Commission (CPUC) in 2018 authorize DMV permittees to seek permits to test ADS passenger service. To date, one company has received a passenger service permit and another has publicly announced plans to launch ADS passenger service in San Francisco in 2019.

California permittees are conducting a large test of the safe integration of ADS passenger vehicles into the nation's on-road transportation system right now.

ADS developers are learning on California roads every day, but the highly competitive nature of the industry has resulted in limited information about the safety implications of their progress. State laws and regulations require permittees to report limited information to the public, including all ADS involved collisions, the total miles driven in automated mode and certain "disengagements."[2] However, there has been little analysis of what, if anything, the information collected from this required reporting tells us about a critically important question facing public officials: Can ADS driving fulfill its vision and promise of substantially reducing the number of collisions, injuries and fatalities below levels demonstrated by human drivers? How can we measure the differences in safety performance between human and automated driving?

SF DTS seeks to lay groundwork to help answer these questions about ADS driving in cities because, despite pathbreaking efforts and hundreds of millions of dollars invested in safer streets, we continue to face a crisis of injury and death from traffic collisions.

Data for Safety Analysis and Rulemaking

The level of ADS testing underway on San Francisco streets is impressive because industry sources document that San Francisco streets present an extremely challenging road environment. With the exception of cold weather-related challenges such as snow and ice, San Francisco streets contain most of the challenges ADS vehicles would find on the streets of the nation's cities, often in high concentrations and/or in combination. San Francisco is thus an ideal location in which to evaluate how ADS driving will affect safety in similar urban environments.

Maneuver / Scenario	San Francisco	Phoenix Suburbs	Ratio
Left turn	1462	919	1.6:1
Lane change	772	143	5.4:1
Construction blocking lane	184	10	19.1:1
Pass using opposing lane	422	17	24.3:1
Construction navigation	152	4	39.4:1
Emergency vehicle	270	6	46.6:1

Per 1,000 miles of autonomous driving

Figure 1 General Motors 2018 Self-Driving Safety Report

Documentation of the city's challenging driving environment is found in the General Motors Voluntary Safety Self-Assessment (VSSA) report filed with NHTSA. GM reports that ADS vehicles driving on San Francisco streets identify an average of 32 times as many "possible interactions" – each calling for real time evaluation and planning – as they do on Phoenix streets. Given the density of pedestrians, cyclists, transit riders, scooter users, people with disabilities, and roadway workers on San Francisco streets, we suspect many of the additional "possible interactions" relate to vulnerable road users.

GM reports another dimension of the density and complexity of San Francisco streets. As shown in the GM table in Figure 1,[3] ADS test vehicles must appropriately respond to emergency vehicles 46 times as often in San Francisco as they do in Phoenix per 1000 miles of test driving. They must pass using the opposing lane 24 times as frequently.

According to a 2019 report from Mcity, a University of Michigan advanced mobility research center, the "final factor needed in a comprehensive safety test for highly automated vehicles would be "difficult miles.""[4] An ADS vehicle driving in San Francisco is driving those difficult miles. Safety analysis and future rulemakings must take account of the challenge of test driving on difficult miles. Safety analysis calibrated only to the challenges faced in suburban or lower density settings may fail to identify new risks and fail to set appropriate expectations for safe ADS integration on urban roadways. It may be that vehicles that can safely navigate San Francisco streets can operate almost anywhere.

SF DTS does not seek to measure the safety capacity of any particular developer testing ADS on San Francisco streets or to compare fleets of ADS vehicles to one another.

Rather, SF DTS will synthesize information about our street environment and right-of-way users with data on ADS test driving that is publicly available under California DMV regulations. We will also consider additional data provided to and held securely at RAND by ADS developers to support a comprehensive understanding of the challenges and opportunities for ADS driving in dense urban driving environments. This work will inform local and state officials around the nation and provide a foundation for future federal rulemakings.

As of January 26, 2019, 55% of all ADS involved collisions that have been documented in reports to the California DMV occurred in San Francisco. See Figure 2. We are not aware that any of these collisions has led to serious injuries. Without information about the volume of test miles driven in San Francisco and other parts of the state, we cannot confirm whether this share of California collisions is disproportionate. Assuming it is, this may demonstrate only what we know by intuition and what GM has documented: driving in San Francisco (and other dense urban road environments) is especially challenging. In light of the potential for rapid expansion of test fleets -- and associated collisions --

Reports of Traffic Collision Involving an Autonomous Vehicle (OL 316)

San Francisco, CA (1/1/2014 to 1/26/2019)

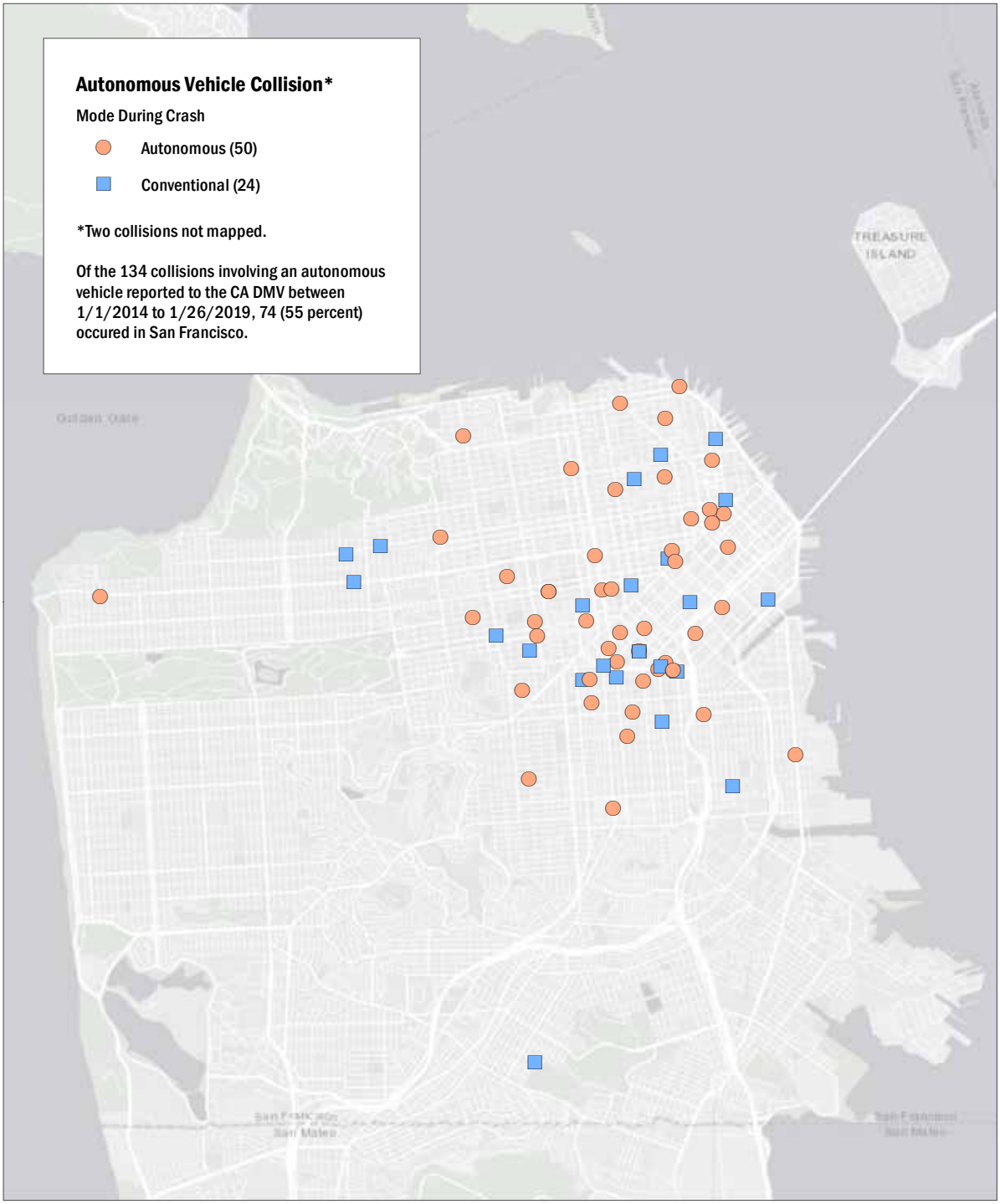


Figure 2. San Francisco Collision Map. (Credit: Paul Douglas Institute, Department of Public Health)

close examination of the collisions that have already occurred in San Francisco may play an important role in identifying patterns that need to be collaboratively addressed between industry and government and that may be relevant to future safety rulemakings.

SF DTS ensures significant data gathering throughout the project period and leverages demonstration data and results in innovative ways by integrating ADS incident data into a robust public geospatial database available to industry, public officials and researchers. It provides data and information to identify risks, opportunities, and insights relevant for USDOT safety and rulemaking priorities by evaluating the role that a common taxonomy of ODD-related terminology can play in future safety analysis and rulemaking and by proposing documentation for an urban ODD that developers or USDOT may use to support unbiased comparison of ADS performance in different road environments. Further, SF DTS explicitly evaluates the safety value of data currently required to be provided by ADS developers and makes recommendations about future data collection.

Collaboration

SF DTS will convene two new collaborative bodies that will work in parallel to provide input on Project work throughout the project period. While these groups will meet in San Francisco and focus closely on San Francisco streets, their work will provide data and analysis to support federal rulemaking, and their reach will be national.

1. The San Francisco ADS Safety Technical Council ("Technical Council") will include invited representatives from industry, government, ADS standards organizations, national safety organizations and academic researchers to inform the project scope and design, to review and discuss issues raised by the ongoing project research and to review and discuss preliminary analyses, findings, and recommendations,
2. The San Francisco ADS Safety Community Working Group ("Community Working Group") will be convened to inform the project work scope, capture concerns from vulnerable communities (seniors, people with disabilities, low income communities, communities of color and non-English speaking residents, transit/ walking dependent residents, walk and bike advocacy organizations) that can be addressed in the analysis and recommendations, and consider public education and engagement around industry opportunities and challenges.

These new SF DTS collaborative environments will harness the collective expertise, ingenuity and knowledge of multiple stakeholders. In regular meetings between industry safety officers, City traffic engineers, public health epidemiologists, ADS standards organizations, and state and local law enforcement, the Technical Council will analyze challenges to ADS roadway safety. We hope that USDOT representatives would join these stakeholder meetings.

In regular meetings between SF DTS project staff and the Community Working Group, local advocates concerned with the safety of vulnerable roadway users and transportation-challenged populations will provide input to the research team and discuss research findings.

3. ALIGNMENT WITH FOCUS AREAS

Significant Public Benefits

The value of SF DTS is its effort to enhance public knowledge and benefit from the private activity that is already taking place within our boundaries. Learning from public road testing in California is currently limited primarily to individual ADS developers. SF DTS seeks to expand that learning to include the general public, state and federal regulators, and all cities with complex and dense road environments.

1 PROJECT NARRATIVE AND TECHNICAL APPROACH

Addressing Market Failure & Compelling Public Needs

Because competing ADS developers are reluctant to share information with each other, and because the City lacks resources to meet separately with every developer to address all of their questions about City streets, the most important market failure SF DTS will address is involves the market for reliable information. SF DTS will increase and improve the flow of information about urban driving challenges for ADS between developers and between developers and government.

Any of the 62 permittees who currently have authority to test ADS on public roads may test their vehicles in San Francisco, but great disparities exist in their knowledge of ADS driving challenges on urban streets. By creating regular opportunities for developer safety officers to interact with San Francisco traffic engineers and public health epidemiologists (as well as other local, state and national stakeholders in traffic safety), and by providing ongoing data and analyses relevant to these challenges to the public and USDOT, SF DTS seeks to build a forum for the exchange of safety learning between the public and private sectors.

An example of the market failure in information that SF DTS can help address relates to the SFMTA's exceptional knowledge about transportation challenges and risks for people with disabilities. SFMTA is a public transit provider and has been providing paratransit service to people with disabilities since well before passage of the Americans with Disabilities Act in 1990. SFMTA paratransit service goes beyond the minimum requirements of the ADA; we operate group van service to locations like Adult Day Health Centers, and we provide same-day service via San Francisco taxi cabs. Taxis, which are regulated by the SFMTA, have historically played a critical role in serving the mobility needs of people with disabilities – especially wheelchair users. We learn about the transportation needs of people with disabilities every day, both by operating these services and by engaging directly with consumers.

The SFMTA's Multimodal Accessibility Advisory Committee and Paratransit Coordinating Council are two bodies of consumers with disabilities (and advocate partners) that inform our work on a daily basis. Because of this broad and deep knowledge base, SFMTA staff are leaders within the of the Autonomous Vehicle Accessibility Working Group recently convened by the California Public Utilities Commission.[5] The City's depth of information about transportation for people with disabilities is illustrated in TransBASEsf.org. We will bring experts to discuss this data with developers in the SF ADS Safety Technical Council. An example of the data we can provide to developers is included here as Figure 3.

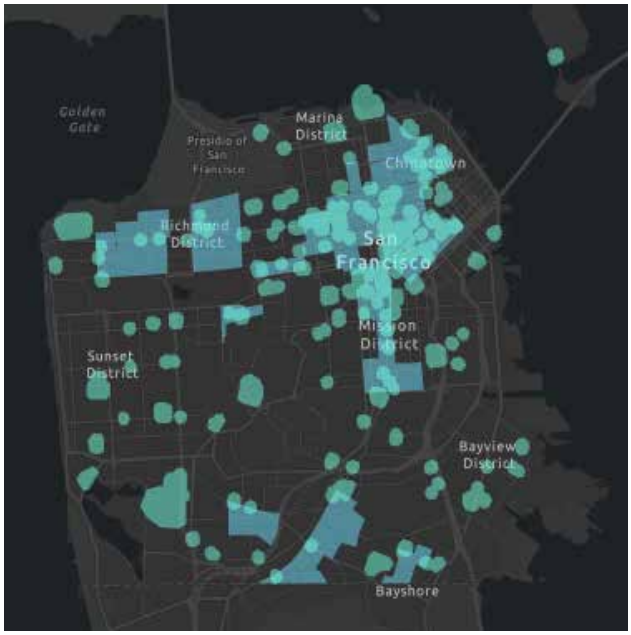


Figure 3 High Concentrations of Attractors for Seniors and People with Disabilities (Source: Http://transbasesf.org/transbase/)

Meetings of the Technical Council will make the knowledge of our experts on transportation for San Francisco residents with disabilities available to all industry developers testing ADS driving in San Francisco.

1 PROJECT NARRATIVE AND TECHNICAL APPROACH

Economic Vitality

SF DTS will support economic vitality at the national and regional level, including advancing domestic industry and promoting domestic development of intellectual property, both because all federal

funds will be used to support analytical work and services performed by public employees and US vendors and because SF DTS will strengthen the regional and national ADS industry by facilitating the safe integration of ADS driving into the regional transportation system.

Complexity of Technology at SAE Level 3 or Greater

SF DTS focuses on "Autonomous Test Vehicles" that may be tested on California public roads under regulations adopted by the Department of Motor Vehicles (DMV Regulations).[6] The DMV Regulations apply to vehicles equipped with technology capable of operating at Levels 3, 4, or 5 of the SAE International *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*.[7] We understand that test driving on San Francisco streets is generally striving to demonstrate Level 3 or greater automation technologies and is thus consistent with this NOFO focus area.

Diversity of Projects

This project focuses on the use of passenger vehicles on urban streets; we do not intend to address ADS service on highways. However, as California regulations may authorize a broader range of vehicles to be tested on public streets, including perhaps larger vehicles and freight vehicles, the scope of the project analysis and recommendations may grow accordingly over the course of the Project performance period. SF DTS intends to capture all publicly available data from all ADS testing on San Francisco roads – regardless of the vehicle type or use case. As state permit options expand and/or local innovators introduce new products, SF DTS analysis will grow to meet the growth in regulatory opportunities and new products.

Transportation-Challenged Populations

The San Francisco Department of Public Health protects and promotes the health of San Franciscans, including the City's most vulnerable residents. This project will leverage the existing, extensive community engagement initiatives SFDPH leads to ensure that the needs of transportation-challenged populations are represented on the ADS Safety Community Working Group. SF DTS will recruit members of the Community Working Group who are seniors, people with disabilities, low income, non-English speaking, communities of color and transit/walking dependent, as well as walk and bike advocacy organizations with diverse memberships to inform the project scope, analysis, and recommendations and consider public education and engagement around industry opportunities and challenges.

Prototypes

While SF DTS focuses on technology that is already being tested on California roads and is thus well beyond the prototype stage, we anticipate that the project analysis will be of value to creators of new technology in earlier stages of development.

4. SATISFACTION OF NOFO REQUIREMENTS

SF DTS meets all NOFO requirements. All SF DTS activities will support the research and development of ADS technology at SAE Level 3 and above. While SF DTS learning is derived from testing on public roads, we expect that SF DTS data analyses, recommendations regarding ODD-related terminology, behavioral competencies and test scenario recommendations will provide information that may feed back into developer work in simulation and on test tracks.

Technology to Be Demonstrated

The San Francisco DTS does not propose to add new ADS vehicles to the hundreds of automated passenger vehicles now testing on San Francisco streets. Rather, the physical demonstration providing the foundation for SF DTS arises from the testing of automated driving systems already occurring on San Francisco streets according to the business plans of multiple developers. We expect a major increase in the volume of ADS vehicles on San Francisco streets over the project period, and we will closely monitor and evaluate safety incidents as they occur in order to mine them for lessons learned.

SF DTS will develop recommendations for safety analysis and future rulemakings, on a developer-and technology-agnostic basis, starting from a foundation of public records filed as required by California law and regulation in connection with ongoing public road testing. With respect to automated driving in San Francisco, these records extend back to at least January 2016. They will continue to accumulate – perhaps at an accelerating rate -- throughout the project period. As additional incidents provide new case studies for qualitative analysis, they will support the breadth of the Project work -- identifying important behavioral competencies critical to urban driving, regulatory initiatives and public education messages.

Since the first reported ADS collision in San Francisco in early 2016, some developers have discontinued their California public road testing; others have started testing or updated their vehicle fleets several times and updated their software even more frequently. These changes reflect the rapid development of the industry. We expect developers participating in the ADS Safety Technical Council, generating public data and/or participating in SF DTS by providing data to RAND to continue to change over the course of the performance period. Because SF DTS is not seeking to evaluate any particular fleet or compare developers to each other, these changes in the technology being physically demonstrated do not interfere with the value of the Project but rather allow it to grow and adapt to the industry as it changes.

Data Provision Commitment:

As further described in the draft Data Management Plan, SF DTS will gather, analyze, and share data with USDOT and the public through regular transmissions, subject to appropriate protection of data that implicates the privacy interests of individuals, as will be determined in connection with each data source. All data posted to TransBASEsf.org will be maintained indefinitely (as resources permit beyond the five year minimum). Published technical reports and final recommendations will be shared directly with USDOT and maintained on SFMTA, SFDPH and RAND Corporation websites. Proprietary data provided voluntarily by industry participants to RAND to support the goals and analyses of SF DTS will be made available in aggregate or otherwise de-identified form to be determined with respect to each source and element of data as mutually agreed between SF DTS, industry participants and RAND. TransBASEsf.org is provided in an accessible form. Additionally, all records will be stored consistent with requirements of the grant award.

The SF DTS goals all involve scaling and sharing the lessons learned from ADS testing on San Francisco roads to cities, developers and public officials across the nation. A taxonomy of common language to

define and classify a dense urban ODD, among perhaps others, would serve to facilitate nationwide communication about ADS capabilities within the industry, between industry and public entities and between industry and the general public. The project team will also work to put together webinars sharing the results of the project and will work with the National League of Cities, the National Association of City Transportation Officers, and other networks such as the Institute of Transportation Engineers, to share our progress and findings with other member cities.

SF DTS will document the expansion of TransBASEsf.org to include specific ADS performance data and to allow for analysis of ADS correlations with other roadway, environmental and public health information through a technical report providing metadata, data schema and recommendations for design and maintenance of a comprehensive data system of linked relevant data streams.

Finally, the composition of the SF ADS Safety Technical Council (including standards organizations, national safety advocates and state and federal officials) will directly support sharing lessons learned with other jurisdictions and the public in furtherance of technical exchange and knowledge transfer.

Performance Period / Preliminary Project Plan:

The ADS test driving that residents and visitors directly observe on San Francisco streets today may increase exponentially or otherwise look profoundly different by the end of the four-year performance period. Among other things, the circumstances and rate of collisions observed to date may change substantially. It is possible that one or more developers may move from testing to deployment during this period. The SF DTS project team will consult with USDOT throughout the project if significant regulatory changes or industry developments call for or compel modifications in the Project approach.

SF DTS anticipates the following schedule of milestones:

Year One

- Launch new layers of geo-spatial data into TransBASEsf.org,
- Launch qualitative analyses of collisions that occurred between 2016 and the kick-off meeting,
- Launch a process to conduct prompt qualitative analysis and site visit for each new ADS collision that occurs after the kick-off meeting,
- Launch the San Francisco ADS Safety Technical Council,
- Launch the ADS Safety Community Working Group.

Year Two

SF DTS will issue an Interim Report that identifies the different characteristics of ADS and human driver collisions in San Francisco and examines the strongest behavioral or environmental correlations with ADS collisions on San Francisco streets. This Interim Report may include discussion of ADS competencies that are especially important in an urban driving environment, as well as potential public education priorities that could minimize the risks and maximize the safety benefits of integrating driving automation on public roads.

Year Three

SF DTS will issue a Second Interim Report that

- Evaluates available data sources in California for ADS safety assessment,
- Makes recommendations about safety metrics, and,
- Makes recommendations about the role of ODD in safety assessment.

The Second Interim report may include additional discussion of ADS competencies that are especially important in an urban driving environment as well as potential public education priorities that could

minimize the risks and maximize the safety benefits of integrating driving automation on public roads.

Year Four

SF DTS will issue a Final Report that makes recommendations to industry, and to regulators and policy makers at all levels of government across the full range of subjects discussed above, as well as about roadway design, maintenance and regulation initiatives.

Publicly sourced data will be updated regularly throughout the project period; developer data provided to RAND will be updated in accordance with the applicable data use agreement between RAND and the developer. Significant or meaningful changes in data trends or observed safety performance may trigger preparation of amended Interim Reports.

5. APPROACH

Technical Approach

SF DTS will approach the four key project goals as follows:

Goal 1: Gather, Post & Analyze Ads Safety Incident Data

SF DTS will identify all available data about safety relevant incidents arising from test driving in San Francisco and the locations, maneuvers, roadway conditions, and other environmental conditions that may correlate with those events (including the density of vulnerable road users at the location). We will make this data publicly available and will analyze similarities and differences between ADS collisions and a subset of matched collisions involving only human drivers.

Publicly Available Transportation Safety Data

San Francisco has been a national leader in linking crash and injury data to information on transportation, infrastructure, land use, and other socio-demographic factors. This leadership is showcased in the development of TransBASEsf.org. TransBASEsf.org is a central data repository for public health-related transportation data; a free and open data resource for the general public to use. It is frequently used to support interagency collaboration, data standards, and data sharing within San Francisco. TransBASEsf.org includes over 200 spatially referenced variables across a range of geographic scales, including infrastructure, transportation, zoning, sociodemographic, and collision data, all linked to an intersection or street segment. The power of TransBASEsf.org is as a tool for safety innovation. For example, in the WalkFirst initiative, it was used to develop knowledge about the specific street segments and intersections where the pedestrian injuries were highest, and the effectiveness and costs of various engineering measures proven to reduce pedestrian collisions. WalkFirst developed a five-year roadmap of pedestrian safety projects and programs and a toolbox of measures to reduce serious pedestrian injuries and fatalities.

TransBASEsf.org currently includes data on motor vehicle collisions reported by the San Francisco Police Department (SFPD), including information about the movement of parties, extent of injuries, weather and road conditions. As of now, TransBASEsf.org does not include data reflecting the collisions that ADS developers report to the California DMV in compliance with DMV regulations. SF DTS will expand TransBasesf.org by adding all publicly available information about collisions reported to the California Department of Motor Vehicles on the DMV form Report of Traffic Collision Involving an Autonomous Vehicle, as well as the subset of collisions that may also be reported on SFPD's recently adopted new version of California Highway Patrol (CHP) 555 Form SFDPH was the first jurisdiction to amend this form to capture the ADS status of a motor vehicle.

We will also develop a process for review and evaluation of each new ADS collision that is reported to DMV by a team that includes traffic engineers and epidemiologists (and, in some cases, law

enforcement.) TransBASEsf.org will also develop a protocol for regular updates of this information to facilitate maximum availability of data to USDOT, the industry, the public, and other researchers.

SF DTS will add additional layers to TransBASEsf.org from the SFMTA data warehouse of data related to street and traffic conditions for purposes of assessing the relevance of these data to ADS collisions or driving challenges. These additions will include data on vulnerable road users, including transit riders, cyclists, and shared mobility users. The Project Team may also work with San Francisco County Transportation Authority (SFCTA) data teams to incorporate third party data sources, including, for example Strava bicycle data or INRIX speed data, if applicable to understanding ADS safety. Compiling these rich data sources in TransBASEsf.org maintains high quality data in a single repository for ease of spatial linkage and data manipulation, and unparalleled transparency to ADS developers and for potential use in safety analysis and rulemakings.

Please see the Data Management Plan for a high-level summary of data fields in TransBASEsf.org.

ADS Developer Data

While working to improve the depth and breadth of publicly available data relevant to ADS safety, we will open dialogue with ADS developers. In addition to the two developers who have already committed to participate in SF DTS, we will invite all companies that hold a public road testing permit to express their interest in participating in SF ADS Safety Technical Council, and we will meet with each interested developer to identify data that may be provided to RAND under a data use agreement to support the SF DTS analyses. Such data may include, for example,

- documentation of the location of disengagements reported to the California DMV that occurred in San Francisco,[8]
- data collected in connection with or at the time of reported disengagements or collisions or information about the maneuver that was underway during a disengagement or collision,
- sensor data documenting the density of vulnerable road users at identified locations in the City.

ADS Safety Data Analyses

The results of industry outreach and data collection through RAND may broaden the research plans and expectations described below and increase the value of SF DTS to the industry, the public and USDOT for future safety analysis and rulemakings.

Having established a clear understanding of available safety data, we will turn to analyzing it. Early work using ADS crash data focused on quantifying crash risk compared to crash data from human driver vehicles. This initial work, primarily undertaken from 2015 to 2017, showed that ADS have a slightly lower likelihood of crashing, although results were not statistically significant.[9] However, analyses were limited in their exploration of crash characteristics. Conclusions are non-generalizable because research primarily reflects the safety record of one developer chiefly operating in suburban areas. Statistical power was also highly limited by the few number of events (crashes) and mileage accumulated by publication time. Additionally, comparing autonomous vehicle (AV) crashes from the California Department of Motor Vehicles *Report of Traffic Collision Involving an Autonomous Vehicle (OL 316)* to police-reported records of human driver vehicle crashes is problematic because the former has a much lower severity threshold for reporting. Initial efforts to assess crash risk have either supplemented human driver vehicle crash data with lower-severity data or limited AV crashes to those severe enough to appear to police records.

SF DTS will perform two initial analyses of ADS-involved collisions, each with different but mutual reinforcing objectives. First, we will assess through statistical analysis whether profile of crashes involving ADS vehicles differs from the crash profile

of human driven vehicles. Results will compare the different characteristics of human driver and ADS collisions in relation to ODD elements.

AV crashes in San Francisco will be sourced from the *Report of Traffic Collision Involving an Autonomous Vehicle (OL 316)* dataset. Each ADS crash will be randomly matched to three human driver crashes occurring in the same approximate area at the same day of the week and time of day. Although matching on exact location and injury severity may not be possible, every effort will be made to find comparison crashes occurring within two blocks of the AV crash and with the same approximate level of reported injury severity. Using descriptive statistics and logistic regression, we will compare crash characteristics to explore different crash profiles. Specifically, we aim to understand if the circumstances under which AV-involved crashes occur differ from human driver vehicle crashes and if the difference relates to the physical infrastructure, vehicle interactions, etc. Such explorations will be augmented by infrastructure, socio-demographic, land use and other data from TransBASEsf.org. If sample size is sufficient, we will examine crash characteristics longitudinally to explore if the way AVs crash has changed over time - potentially due to ADS learning or improvements, or environmental or other factors.

Next, to identify event patterns, we will explore ADS crash narrative data, make crash-site visits and undertake geospatial modeling around proximity to key attractors (e.g. tourist attractions, schools, hospitals, transit stops). This analysis mines qualitative and observational engineering information - using descriptive and pattern coding - to identify trends in event data, and suggests crash factors not traditionally documented in a passive vehicle safety surveillance system designed for human driven vehicles. We will also develop a process for review and evaluation of each new ADS collision that is reported to DMV by a team that includes traffic engineers, epidemiologists and, where appropriate, law enforcement.

Together, the results will be used to identify locations, behavioral factors (maneuvers), and environmental factors (infrastructure; traffic regulations or conditions) that can be correlated with ADS safety events. These analyses may lead to additional expansions of TransBASEsf.org to incorporate digitized and geo-located information related to ADS safety events (crashes, disengagements, citations) or environmental factors which results demonstrate are related to those events (including density of other roadway users if available) as well as other data collection efforts.

At each stage, SF DTS will seek input from the ADS Safety Technical Council and the ADS Safety Community Working Group, will share preliminary findings, and will discuss potential conclusions and recommendations.

Goal 2: Analyze And Make Recommendations About Safety Measures and Taxonomy of ODD Terminology

SF DTS will analyze the strengths and weaknesses of each available data source, collection method and/ or metric for safety analysis purposes (including those based on public data and those enabled by developer data provided to RAND) and make recommendations about what additional or alternate data sources, collection methods and/or metrics may provide greater value for safety analysis and future rulemakings. This will include consideration of the role that a taxonomy of terminology about ODDs could play in safety analysis and rulemaking and a proposed classification for a dense urban ODD that could be used by developers and/or regulators with respect to cities across the country.

After considering what we can learn about trends in ADS collisions in San Francisco and what we can learn about safe integration of ADS into an urban road environment by examining the differences between collisions involving human drivers versus ADS drivers, we will turn to questions about the data itself: are we collecting adequate and appropriate information to inform future safety regulations?

Based on the data collected for Goal 1, SF DTS will additionally review existing and potential safety metrics for ADS that are not ODD-sensitive. We will examine the current state of data based on California DMV requirements as well as other publicly available data sources compiled for SF DTS.[10] Potential safety metrics we will evaluate include crashes, injuries, deaths, disengagements, and other potential ADS data from the industry. Metric exposures we anticipate standardizing by include VMT, driving hours, or potentially other density metrics.

We will additionally propose new safety metrics or exposure definitions based on the findings of Goal 1 that are not currently considered in the ADS safety literature that are informed by the Project's systematic analysis in a dense urban environment. In other words, we will take the theoretical work about safety metrics presented in *Measuring Automated Vehicle Safety: Forging a Framework* and apply it to data available in a driving environment with active ADS test driving on public roads. The Project will then evaluate each metric's validity, feasibility, reliability, gameability, and the burden of collection on both industry and government. Because no one measure is likely to suffice when assessing safety, these factors will be collectively compared and considered with an aim of putting together a portfolio of measures from different data sources to comprehensively understand and assess ADS safety – particularly in a dense urban context. Case studies of the implications of this approach will be further explored as part of the project.

The concept of the Operational Design Domain (ODD) for an automated vehicle is currently described in the *SAE International Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* as a set of parameters identified by each ADS manufacturer:

> *Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.*

There is a compelling argument for considering ODD from the perspective of the developer's design. Each developer should have the most thorough understanding of what a vehicle or feature can and cannot manage, and the developer should be responsible for communicating both to regulators and to the public the circumstances under which an ADS vehicle is and is not competent to operate.

However, for purposes of adopting prospective safety standards that ensure accountability for minimum levels of performance at SAE Level 4, there is also a compelling argument for standardizing the variability of ODD descriptions.[11] A formal taxonomy of Operational Design Domains can in and of itself assist developers by establishing common parameters within which a vehicle is expected to operate competently. For example, if a taxonomy included a series of ODDs numbered one through six, a developer could identify that its vehicle is competent to safely operate in ODDs 1, 2, and 4 but not in 3, 5, or 6. If we assume, for the sake of argument, that dense urban streets with a high density of vulnerable road users are described as ODD 6, vehicles not qualified – by their developer or any other party – to operate in ODD 6 should not enter that jurisdiction.

A common taxonomy of ODDs might also help fairly compare the capacity of one vehicle to another. The safety performance of a vehicle that is qualified to operate only in ODD 5 should not be evaluated outside that ODD – except to the extent of its capacity to bring itself to a minimal risk condition. Similarly, the safety performance of a vehicle qualified to operate in ODD 5 should not be compared to the safety performance of a vehicle qualified to operate only in another ODD.

While these concepts are reasonably intuitive at this very simple level, they are difficult to operationalize in a world that has much greater variation than can be found in the numerical range from one to six. From the perspective of stewards of public roads in dense urban environments that are populated with large numbers of vulnerable road users, the demonstrated capacity of a vehicle to operate safely and successfully in a significantly different road environment may not establish public confidence, while demonstrated capacity to operate safely and successfully in a very similar road environment may support public confidence.

SF DTS will explore the value of a taxonomy of common terms in relation to ODDs based on a close examination of the San Francisco streets and what we can learn from early experience about the challenges to ADS vehicles driving on our roads. Because San Francisco neighborhoods include some with much lower levels of density and complexity, close examination of streets in all areas of the City may provide opportunity to characterize multiple ODDs and to consider how ODD may factor into an overall strategy for safety evaluation.

GOAL 3. CONVENE ADVISORY BODIES

Within nine months of award, SF DTS will convene two new collaborative bodies that will work in parallel to provide input on Project work:

1. The San Francisco ADS Safety Technical Council ("Technical Council") will include invited representatives from industry, government, ADS standards organizations, safety organizations and academic researchers to discuss issues raised by the ongoing project research and to review and discuss preliminary findings, recommendations, and draft analyses. SF RTS anticipates convening the Technical Council on a quarterly basis and inviting the following participants (in addition to collaborators SFMTA, SFDPH, SFCTA and RAND):

    - The chief safety officer for each company actively testing an automated driving system on San Francisco roads (or with a system in deployment on SF streets),

    - The chief safety officer for additional companies planning the near-term launch of ADS testing or deployment in San Francisco (on a space available basis),

    - Representatives from the California Department of Motor Vehicles, California Highway Patrol, Caltrans, and the California Department of Public Health,

    - Representatives from the San Francisco Police Department and the San Francisco County Transportation Authority,

    - Academic researchers with expertise related to the engineering and safety evaluation of ADS,

    - Representatives from national organizations developing standards relevant to the ADS industry,

    - Representatives from national organizations representing traffic safety advocates and vulnerable road users,

    - Representatives of NHTSA, FHWA and/or NTSB.

Consideration by the Technical Council of any data provided to RAND by industry participants will be subject to the RAND Policy on Acquiring and Safeguarding Proprietary Information and subject to a specific data use agreement between RAND and the industry participant.

We are pleased to have received letters of commitment from two developers and look forward to reaching out to additional participants upon award.

2. The ADS Safety Community Working Group will be convened to inform the Project work scope, capture concerns from vulnerable communities (seniors, people with disabilities, low income communities, communities of color and non-English speaking residents, transit/ walking dependent residents, and walk and bike advocacy organizations) that can be addressed in the analysis, and consider public education and engagement around industry opportunities and challenges.

Goal 4: Develop Recommended Behavioral Competencies / Test Scenarios / Roadway Improvements and Education Messages

SF DTS will use the analyses above to develop recommendations for industry, government and the public that improve the potential for ADS driving to increase overall safety in a mixed fleet environment.

ADS developers use a series of test scenarios to evaluate the "behavioral competencies" demonstrated by their automation systems in traffic circumstances that are reasonably foreseeable within the developer's intended ODD. A variety of organizations and researchers have assembled lists of behavioral competencies, along with test scenarios that call for applying the competency in different circumstances. Developers and researchers often refer to "edge cases" or "corner cases" to characterize circumstances in which an automation system may be pushed to (or beyond) the limits of its capabilities by unusual circumstances.[12]

In dense urban driving environments, the unusual is the rule, not the exception, yet we have seen no list of behavior competencies or test scenarios that captures the challenge of circumstances that are common on urban streets. In particular, the current competencies do not apparently consider the capacity of an automated vehicle to make sound decisions in the context of the large number of vulnerable road users we see on San Francisco streets.

SF DTS will consider the analysis of a dense urban road environment through the lens of the analyses described above and, with the assistance of the SF ADS Safety Technical Council and SF ADS Safety Community Working Group, identify recommended behavioral competencies that are essential in an urban ODD. Test methods for these behavioral competencies may call for further innovation in the simulation and test track environment.

In addition, the SF DTS final report will apply what we have learned from all the analyses described above to make recommendations regarding urban roadway management practices (design, maintenance, infrastructure enhancements, traffic regulations) that may minimize risks or maximize safety opportunities for automated driving. Finally, the SF DTS final report will consider recommendations relevant to public education about the many years ahead when cities will likely manage the very different strengths and weaknesses of both human and automated drivers. What we learn from this project would have transferability and scalability benefits to other cities across the country.

Approach to Legal and Regulatory Requirements

Protection of Personal Privacy and Trade Secrets: While we do not see these as obstacles, the SF DTS team is mindful of our responsibilities to protect trade secret information and the data privacy rights of individuals. The RAND Corporation is a critical collaborator both because of their subject matter expertise and their capacity to receive and manipulate industry data in a manner that protects proprietary interests in this highly competitive industry. Most data we expect to rely on for SF DTS does not implicate the privacy rights of individuals; however, as discussed further in the Data Management Plan, we will strive to ensure both the transparency of public functions and the privacy rights of individuals.

Other Legal Compliance: The California Vehicle Code requires vehicles testing on public roads to comply with Federal Motor Vehicle Safety Standards.[13] No additional exemptions are required to undertake SF DTS. In addition, all SF DTS spending will be consistent with NOFO Section F, Paragraph 2.J.

Data Commitment

SF DTS will gather, analyze, and share data with USDOT and the public through regular transmissions, subject to appropriate protection of data that implicates the privacy interests of individuals, as will be determined in connection with each data source. All data posted to TransBASEsf.org **will be maintained indefinitely** (as resources permit beyond the five year minimum). Published technical reports and final recommendations will be shared directly with USDOT and maintained on SFMTA, SFDPH and RAND Corporation websites.

Approach to Risk Identification, Mitigation, and Management

In light of the extraordinary dynamism of the ADS industry, SF DTS must anticipate a variety of risks. SFMTA's AV Policy staff maintain a close watch on local, regional, state and national developments in the ADS industry, and this monitoring will help us anticipate risks as they arise. We foresee the following key potential risks to SF DTS:

1. Unanticipated events: Major safety or technical setbacks or advancements to the industry could slow or accelerate financial investment, public confidence, and/or resulting demonstration activity on San Francisco streets. This could shift the regional and national pattern of investment in public road testing.
2. Industry Consolidation: Many aspects of the industry could be subject to significant consolidation during the performance period, as is known to happen in the broader technology sector, and this could also shift the regional and national pattern of investment in public road testing.
3. Legal / Policy: New laws or regulations at the state and/or federal levels could either accelerate or decelerate the pace of public road testing in San Francisco.
4. Scale of participation: SF DTS will proceed and add value to the understanding of safety analysis for purposes of future rulemakings even if it depends entirely on publicly available information. However, the greater the industry participation – in the form of participation in the SF ADS Technical Council and in the form of the voluntary provision of industry data to the RAND Corporation – the more informative the SF DTS recommendations and reports will be.

We are grateful to have received, in time for this proposal submission, letters of commitment from two developers who will both participate in the Tehnical Council and work with RAND to identify meaningful sources of data gleaned from testing on San Francisco streets that may contribute to the FS DTS project goals. We are confident that after the grant award, as we continue to develop relationships with other companies, additional developers testing on San Francisco streets may show interest in participating. To the extent that participation and data sources are highly constrained, we will maintain close contact with USDOT to advise about any changes that may be warranted in the work program. We assume that participation by USDOT experts in the Technical Council will enhance participation by other stakeholders, and we welcome and invited this participation.

Contribution Of Non-Federal Resources

The SFMTA will contribute approximately $500,000 of staff resources to SF DTS over the four-year performance period in the form of grant administration ($100,000) and data acquisition/ management ($400,000).

CONCLUSION:

For most cities in the United States, ADS vehicles represent an exciting future that is rapidly approaching. Most residents of the United states have never seen an ADS vehicle on public roads. But in San Francisco, ADS vehicles have been roaming the streets for several years. The interim and final reports described above would enable the nation to learn from San Francisco's experience. SF DTS can help the nation's cities copy, adapt, and adopt by delivering the following components of SF DTS interim and final reports.

Expected Overall Project Outcomes

- The expansion of TransBASEsf.org, San Francisco's public, centralized data repository for safety-related transportation data to include data arising from ADS test-driving and data that may be relevant to ADS driving safety,
- A summary report to facilitate replication in other jurisdictions of a comprehensive data system to compile and link data elements that may be relevant to the assessment of ADS safety,
- Analysis of the similarities and differences between ADS- involved collisions and a subset of matched collisions involving only human drivers in a dense urban road environment,
- Analysis of ADS involved collisions and associated factors in a dense urban environment utilizing a quantitative and qualitative case study approach,
- Applied analysis of the role that an ODD taxonomy can play in ADS safety evaluation and a recommended description of the most important elements of a dense urban ODD (as well as for comparator ODDs) for purposes of future safety analysis and rulemaking,
- Recommendations regarding additional or revised data sources and metrics that may effectively support ADS safety analysis and rulemaking,
- Recommended behavioral competencies for ADS driving that reflect the density and complexity of an urban road environment,
- Recommended test scenarios to assess the additional behavioral competencies,
- Recommended approaches to public education and engagement around ADS to improve safe integration into the transportation network.

Citations

Coverpage photo credits: upper left: Aurora Innovation, upper right: Zoox

Page 8 photo credits: upper right: Wikipedia Commons, upper left: Zoox, bottom: Aurora Innovation

1. See Section 3.22 of the *SAE International Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* for the definition of Operational Design Domain as follows: Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.

2. A reportable "disengagement" is "a deactivation of the autonomous mode when a failure of the autonomous technology is detected or when the safe operation of the vehicle requires that the autonomous vehicle test driver disengage the autonomous mode and take immediate manual control of the vehicle, or in the case of driverless vehicles, when the safety of the vehicle, the occupants of the vehicle, or the public requires that the autonomous technology be deactivated. See 13 C.C.R. 227.50. For recently reported disengagements, see CA DMV Disengagement Reports 2018.

3. General Motors 2018 Self-Driving Safety Report. p. 19

4. *Mcity ABC Test: A Concept to Assess the Safety Performance of Highly Automated Vehicles*, January, 2019

5. We recognize that USDOT has transitioned to use of the term ADS, along with others reflected in the June 2018 *SAE Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*. Because this proposal draws on many sources that predated the update, we use the terms AV and ADS interchangeably.

6. See Title 13, California Code of Regulations, Article 3.7: Testing of Autonomous Vehicles and Article 3.8: Deployment of Autonomous Vehicles.

7. *SAE International. Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* J3016_201806

8. California law and regulations require developers who obtain a permit to test their ADS on public roads to file public reports of collisions and safety-related disengagements of an autonomous driving system when ADS vehicles are being tested on public roads. The most recently filed disengagement reports can be found here: CA DMV Disengagement Reports 2018. As of now, the value of disengagement reports for safety analysis is limited by the fact that location information is not provided for each disengagement. Based on agreements between collaborating ADS developers and RAND after award, SF DTS may use disengagement reports to help document the urban ODD by analyzing the extent to which disengagements can be correlated with other data elements in TransBASEsf.org.

9. Virginia Tech Transportation Institute, "Automated Vehicle Crash Rate Comparison Using Naturalistic Data," January 8, 2016. As of September 6, 2017: http://www.vtti.vt.edu/featured/?p=422; Teoh, Eric R., and David G. Kidd, "Rage Against the Machine? Google's Self Driving Cars Versus Human Drivers (in Draft), Journal of Safety Research Volume 63, December 2017, Pages 57-60; Schoettle, Brandon, and Michael Sivak, "A Preliminary Analysis of Real-World Crashes Involving Self-Driving Vehicles," University of Michigan Transportation Research Institute, 2015. As of September 6, 2017: http://umich.edu/~umtriswt/PDF/UMTRI-2015-34.pdf

10. During the project period, it is likely that one or more developers may begin providing data to the public according to requirements of the California Public Utilities Commission. SF DTS will examine this data for safety analysis purposes.

11. See discussion of Operational Design Domain in Fraade-Blanar, Laura, Marjory S. Blumenthal, James M. Anderson, and Nidhi Kalra, *Measuring Automated Vehicle Safety: Forging a Framework*. Santa Monica, CA: RAND Corporation, 2018. pp 43-44.

12. *Mcity ABC Test: A Concept to Assess the Safety Performance of Highly Automated Vehicles*, January, 2019

13. Cal. Veh. Code Section 38750(c) and (g) and 13 C.C.R. 227.38(b)(3)