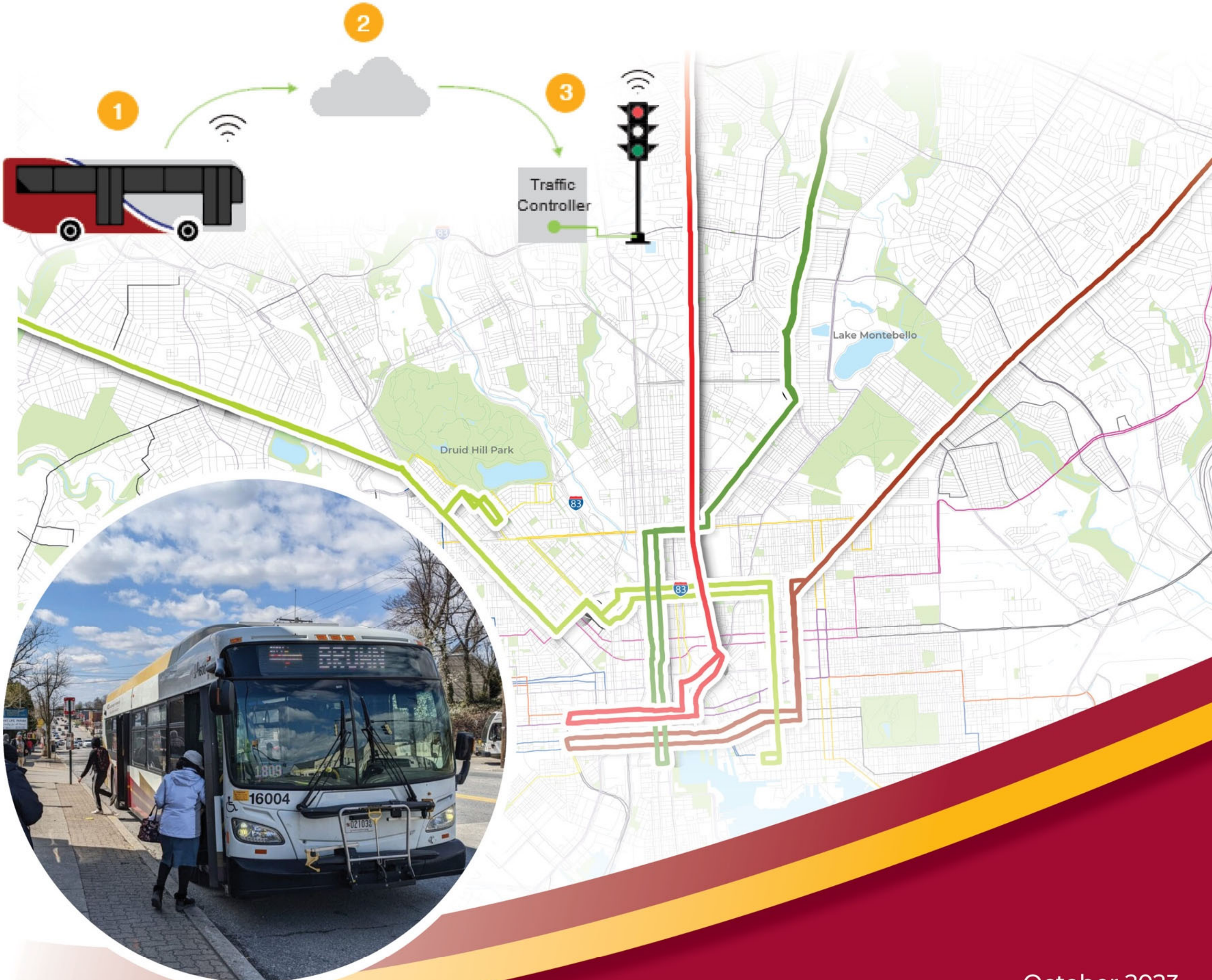


October 2023

MTA Cloud-Based Transit Signal Priority

Maryland Department of Transportation Maryland Transit Administration
FY 2023 Strengthening Mobility & Revolutionizing Transportation (SMART) Program Application

Submitted by:

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION

Submitted to:

U.S. Department of Transportation

1. Overview/Project Description

The Maryland Transit Administration (MTA) is requesting funding from the United States Department of Transportation (USDOT) Strengthening Mobility and Revolutionizing Transportation (SMART) program to prototype and develop a plan for the deployment of cloud-based transit signal priority (TSP) technologies (the Project) along bus route corridors within northwest Baltimore that can communicate with buses in shorter time intervals and with reduced installation and maintenance costs compared to current TSP systems, leading to a service that overall is cheaper, more efficient, and more reliable.

MTA provides a range of transit services in the City of Baltimore, including fixed-route local and express bus service, Baltimore Light RailLink (light rail transit), Metro SubwayLink (heavy rail rapid transit), and MobilityLink (paratransit). The CityLink RED, GREEN, BROWN, and LIME routes presently use TSP systems and are among bus options available to connect passengers from across neighborhoods between the northern and central areas of the city.

Aboard buses, on pole mounts, and within intersection controller cabinets, GPS-based TSP equipment is present at 90 intersections along the CityLink RED, GREEN, BROWN, and LIME routes. These CityLink routes represent MTA's 1st, 8th, 12th, and 14th highest bus ridership volumes, respectively, as of May 2023. As MTA considers additional TSP treatments in Baltimore, the specialized TSP equipment, such as pole upgrades at intersections, incur substantial installation and maintenance costs. Currently these upfront cost and maintenance obligations on specialized equipment have been a limiting factor for expanding the technology's use. Further, whereas the existing TSP system has improved travel times for buses, the traffic signals and buses require quick communication updates with each other to ensure high efficiency of TSP. During special events, there is increased pressure on all transportation modes to compensate for additional travel demand on the City's roadways. These types of acute changes to the transportation system warrant TSP's having more agile response times to buffer impacts of such events.

Cloud-based TSP presents a potential solution to the relatively high costs and operational limitations of the GPS-based TSP used in Baltimore and should increase reliability of MTA's bus transit system for everyday travel and during special cases. The cloud-based TSP would obviate the need for vehicle detection hardware, by utilizing existing Automatic Vehicle Location (AVL) equipment that tracks bus positions using GPS that can communicate with a cloud platform at nearly real-time intervals. Intersection traffic signal controller cabinets would utilize existing wireless cellular modems to receive real-time bus position data and respond by modifying a signalized intersection's phase timings, such as to activate or extend green time for an approaching bus. Some cloud-based TSP's are capable of machine learning, which aggregates bus position data to continuously generate updated algorithms that can assist traffic signals in predicting bus arrivals on diurnal and seasonal bases. The algorithm would remain capable of detecting and responding to unexpected bus arrival times, such as ensuring that signalized intersections can react to actual bus arrival times in real-time without inadvertently compromising a side street phase during a signal cycle. In special cases that increase travel demand within the City, such as festivals or other large events, additional buses may be deployed along these bus routes. Utilizing existing AVL systems becomes a relatively low-cost option that can be adapted to bus routes with intersections equipped with modems, thereby enabling the cloud-based TSP to detect an influx of buses and adjust traffic signal timings in favor of the arriving buses. This ensures that Baltimore's overall transit system capacity and reliability can be maintained during abrupt shifts.

MTA is considering potential technology vendors to prototype this cloud-based TSP technology during the Stage 1 of the SMART program. The prototype would be implemented for a total of 90 intersections on corridors that presently have TSP equipment, including the CityLink RED, GREEN, BROWN, and LIME routes. The Stage 1 project will include an on-site technology demonstration and development of an Implementation Plan for a larger deployment of the cloud-based TSP technology in a subsequent Stage 2 SMART grant-funded project. The Stage 2 deployment will provide the opportunity to widely demonstrate the technology both internally to bus maintenance and operations staff, as well as externally in revenue service for the general public and stakeholders to experience, while the agency explores the potential to adopt this technology citywide across multiple bus route corridors and light rail transit. The Implementation Plan in Stage 1 will include a Performance Management Plan, a Before and After analysis, and identification of necessary software and hardware updates to successfully deploy cloud-based TSP technology in the larger Stage 2 demonstration.

Overall, the Project will prototype, measure, and communicate how cloud-based TSP technology may provide the following major benefits:

- Higher frequency of communication between buses and traffic signals to maximize efficiency of green time priority to buses, improving travel time savings and on-time performance
- Higher reliability of the overall transit system during everyday traffic and special events
- Reduced costs for equipment installation and maintenance by utilizing AVL systems and wireless cellular modems
- Coordination with MTA partners on how the technology could be used for additional road users (e.g. emergency vehicles)

2. Project Location

The Project is within the City of Baltimore (part of the Baltimore, Maryland urban area) and focuses on 28 signalized intersections along York Road and Greenmount Avenue on the RED route, 19 signalized intersections along Loch Raven Boulevard on the GREEN route, 26 signalized intersections along Belair Road on the BROWN route, and 17 signalized intersections along Liberty Heights Avenue on the LIME route. The Project is bounded to the north, east, and west by the Baltimore City limits. The pertinent intersections encompass or directly abut 54 Census tracts in Baltimore that have a combined residential population of 178,500, as of the 2020 United States Census. Twenty-eight of these Census tracts are classified as disadvantaged, based on the Climate and Economic Justice Screening Tool (CEJST). The table below indicates the Census tracts that are classified as disadvantaged and if transportation is an associated socioeconomic burden.

Table 1 Project Area Census Tracts

Census Tract Number	Transportation Burdens
24510080102	90th percentile for traffic proximity and volume
24510080200	None
24510080400	None
24510080600	None
24510080700	None
24510080800	None
24510090100	None
24510090400	None
24510090500	None
24510090600	93rd percentile for traffic proximity and volume
24510090700	None
24510090800	None
24510090900	None
24510100100	94th percentile for traffic proximity and volume
24510100200	93rd percentile for traffic proximity and volume
24510120400	None
24510150500	94th percentile for traffic proximity and volume
24510150701	None
24510150800	None
24510151000	None
24510151100	None
24510260201	None
24510260202	None
24510260301	None
24510270802	None
24510271001	None
24510271002	None
24510280102	None
24510080102	90th percentile for traffic proximity and volume

3. Community Impact

A principal purpose of deploying cloud-based TSP technologies to the Project area is to improve the reliability and performance of the transit system for the City of Baltimore. The Project area includes 54 Census tracts, of which 28 are classified as disadvantaged. According to the 5-year estimates ending in 2021 from the American Community Survey, a range of 9.0% to 65.7% of residents within these disadvantaged tracts take public transportation as a means of transportation to work. Especially for residents of disadvantaged communities who are more likely to depend on public transportation, maintaining and expanding accessibility of the transit system, minimizing travel time delays and improving on-time performance for buses, and upholding bus service as a reliable alternative to private automobiles that contribute to air quality impacts are key benefits that cloud-based TSP technologies may demonstrably support. Transitioning the GPS-based TSP to a cloud-based approach that utilizes existing AVL systems and wireless cellular modems will translate to cost savings for MTA—in terms of implementation, operations, and maintenance—such that surpluses can be reinvested in other transportation improvements.

4. Technical Merit

4.1 Identification and Understanding of the Problem to Be Solved

MTA is increasing its option of transit signal priority treatments for bus corridors within the City of Baltimore, which can improve on-time performance and reliability of the bus system. Along the CityLink RED, GREEN, BROWN, and LIME routes, GPS-based TSP systems are used at 90 signalized intersections associated with these routes, but these systems have limitations for further improving the performance of the existing roadway corridor and in terms of potential expansion into other bus corridors. Time intervals between bus location updates and traffic signal detections must be closer to real-time for maximal efficiency of the TSP systems. In acute situations, such as special events that could require temporary increases in buses along the CityLink routes, the current TSP infrastructure is inadequately equipped to nimbly shift green time priority to maintain the transit system's reliability. To address these specific challenges, the Project will be implemented to demonstrate costs savings and travel time savings of the cloud-based TSP's as advantages over current the GPS-based TSP.

Relative to cloud-based TSP technologies, current GPS-based TSP technologies require a plethora of physical equipment both on the buses and at the intersections. Vehicle detection hardware includes equipment such as emitters on buses, detectors on traffic signal heads, and phase selectors in controller cabinets. Installation of pole mounts and antennae at signalized intersections can cost approximately $20,000 per intersection and can thereby prohibit the pace of TSP expansion. The specialized TSP equipment also adds additional maintenance burdens by requiring regular manual inspection of the equipment, thereby incurring additional labor costs.

A reliable transit system occurs in the context of other transportation modes that interact with and depend on the transit service. Since bus traffic on the CityLink routes mix with other vehicular traffic, TSP's can mitigate the impact of this integration by shifting green time towards buses. For the current GPS-based TSP's, traffic signals are not able to anticipate arrival times for buses several blocks upstream. This scope of communication limits the potential for TSP to operate highly efficiently. Further, during large special events that increase travel demand, the current TSP systems are limited in their ability to efficiently process additional buses used to temporarily increase the transit system's capacity.

4.2 Appropriateness of Proposed Solution

Cloud-based TSP technologies can provide a solution for current and future TSP applications on bus corridors in Baltimore, because of their ability to analyze bus locations and communicate with traffic signals in near real-time, and because they require substantially less hardware than the GPS-based counterpart.

Cloud-based TSP technologies obviate a need for costly intersection installations and inspections. Currently MTA equips all buses with AVL systems to geolocate bus positions and will continue to do so in future bus procurements. Future intersection TSP-capable traffic signal controller equipment and wireless cellular modems will be the primary components used to communicate with a cloud platform. These systems can be integrated with existing traffic signals and buses, minimizing the number of pole mount installations at intersections or additional hardware for buses and controller cabinets.

Buses equipped with AVL systems can communicate with satellites to provide information of bus positions to cloud platforms from farther distances than current GPS-based systems. Additionally, the feedback between buses and the cloud platforms receiving satellite data is continuous and nearly instantaneous. This results in a system that has advantages over current TSP technologies both in terms of geographic range, temporal response, and ability to adapt. Anticipated cost savings and improved transit system reliability may have a compounding effect, with potential to scale up TSP treatments throughout Baltimore.

If MTA is awarded Stage 1 SMART grant funding to prototype cloud-based TSP's in Baltimore, MTA will conduct a procurement process that ensures the highest quality equipment provider that is compatible with project goals. For its own education, MTA has initiated preliminary engagements with potential providers and other transit agencies to gather consensus of available services and user experiences. A key consideration for equipment procurement is the prospect of machine learning and artificial intelligence applications in cloud-based TSP equipment, which can dynamically and intelligently predict bus arrivals when adjusting signal timings. The expanding presence of these features in a wider array of providers will open MTA to multiple options when selecting a technology vendor that is suitable for this project.

4.3 Expected Benefits

Cloud-based TSP technologies have the potential to generate benefits for MTA and its fixed-route bus service passengers and operators in terms of overall transit service and reliability. With the application of machine learning and nearly real-time communication between buses, cloud platforms, and intersection controllers, traffic signals would be able to respond to bus arrivals more dynamically and intelligently. The effect of this capability would be enhanced green time priority for buses along the CityLink RED, GREEN, BROWN, and LIME routes, such as by gapping out the side street phases to activate green time for phases with approaching buses or by extending green time for approaching buses to continue through an intersection. The product of this enhanced green time priority is an overall reduction in intersection and arterial delays, or travel times more generally. Because of reduced delays for buses, buses would be more likely to improve their on-time performance. Improved on-time performance and reduced travel time delays will support the reliability of the transit system, both during everyday travel and during abrupt changes to the transportation system because of special events.

The benefits of adopting cloud-based TSP technologies for transit system performance become even more palatable when considering financial cost savings. Currently-used, GPS-based TSP equipment costs approximately $5,000 per bus and $20,000 per intersection, on average to install. It is anticipated that equipment for cloud-based TSP equipment would cost $1,000 per bus and $4,000 per intersection, on average to install. By replacing GPS-based TSP's with cloud-based TSP's as applicable, compounding the expected relative cost savings and improved transit system reliability would translate to potentially wider applications for additional bus corridors in the City of Baltimore. Adopting this cloud-based TSP opens potential applications for additional road users, such as emergency response vehicles that must minimize their delays for public health and safety.

Lastly, with the potential to scale up TSP treatments more quickly, MTA will be able to provide a transit service that is overall more accessible, efficient, and reliable.

5. Project Readiness

5.1 Feasibility of Workplan

This project is anticipated to occur over a fifteen-month period. MTA is currently exploring ways to deploy cloud-based TSP's at several of the intersections along the CityLink LIME route using other funding appropriations. This early deployment on a portion of the CityLink LIME route ahead of the Stage 1 technology demonstration will allow MTA an opportunity to test the new technology's functionality and minimize potential challenges with initial deployment for remaining intersections on the CityLink LIME and other CityLink routes. Additionally, permitting and regulatory requirements for Stage 1 will not be applicable since the cloud-based TSP technology upgrades would pertain to intersections with MTA-owned legacy TSP equipment, thereby minimizing scheduling risks for this project. The Stage 1 project will be budgeted for a total of $1,276,000 and specific breakdowns of the cost inputs are provided in the table below.

Vendor installation of cloud-based TSP	$ 585,000
Traffic engineering support for implementation, testing, and evaluation	$ 300,000
Traffic management center network configuration support	$ 30,000
Reconfigure 25 buses for testing (pilot fleet)	$ 55,000
Systems engineering support	$ 90,000
Implementation Plan	$ 100,000
10% Contingency	$ 116,000
Total Stage 1 Project	**$ 1,276,000**

In addition to demonstration of cloud-based TSP's, MTA will prepare an Implementation Plan at the conclusion of Stage 1 to confirm the feasibility of scaling up this technology demonstration and proceed with an Implementation Plan. The Implementation Plan will include a Performance Management Plan, a Before and After analysis, and identification of necessary software and hardware updates to successfully deploy a scaled-up cloud-based TSP demonstration. The table below depicts an outline of the project schedule for development of the Implementation Plan.

Activity	**Month**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Project Kick-Off	*														
Coordination Meetings	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Data and Performance Reporting	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Quarterly Progress Reports and Federal Financial Reports			*			*			*			*			*
Draft Implementation Plan	*	*	*												

Technology Demonstration				*	*	*	*	*	*	*	*	*	*	*	*

5.2 Community Engagement and Partnerships

MTA will apply public education and marketing tools to engage and inform the general public of the Stage 1 technology demonstration, such as project information displays at bus stops along each of the four bus routes (CityLink RED, GREEN, BROWN, and LIME) within the project area.

MTA has an extensive history of working with the Baltimore City Department of Transportation (BCDOT) to implement and improve transit projects within the City and is prepared to explore its BCDOT channels to install cloud-based TSP's as well. An example of this shared vision between MTA and BCDOT to expand TSP's in the City includes the RAISE Baltimore project, a partnership between MTA and BCDOT to install TSP equipment for over 60 signalized intersections along the CityLink BLUE and ORANGE routes. The Stage 1 technology demonstration will provide MTA an opportunity to demonstrate the utility and feasibility of deploying cloud-based TSP's specifically, establishing a foundation for progressing to scaled-up deployment as part of a Stage 2 SMART grant application.

5.3 Leadership and Qualifications

MTA is the 13th-largest transit operator in the country and has extensive experience executing and successfully completing USDOT grants and projects in compliance with Federal grant requirements. As the lead agency and grant recipient, MTA will coordinate with the partners to ensure that all federal grant regulatory standards are being met. Overall, MTA has the legal, financial, and technical capacity to carry out the Project.

As a state agency providing technical assistance to locally operated transit services across Maryland, MTA is uniquely positioned to spread the information gained from the Project in order to garner maximum value from the technology demonstration. Additionally, MTA's Statewide Transit Innovation Grant provides an opportunity to provide grant funding to local transit systems that demonstrate a strong opportunity to successfully apply similar cloud-based TSP technologies.

APPENDIX I: Resumes

Nanette M. Schieke

Motor Vehicle Administration

Office of Policy & Innovation CAV Program Manager

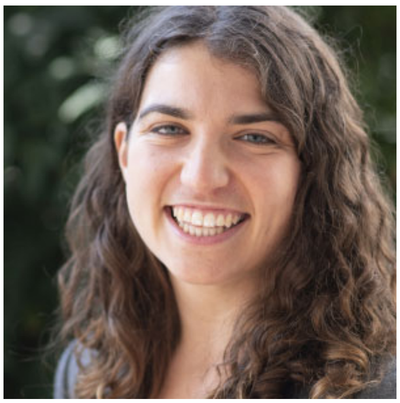
Nanette M. Schieke holds an undergraduate degree in pre-law and a Masters' Degree in Public Administration and has served in management roles in state and local government over 28 years. Ms. Schieke's main role at Motor Vehicle Administration (MVA) the last fifteen years, has been as Chief in Driver Safety with a focus on building and sustaining partnerships of local, regional, and national professionals in the driver safety arena. Over the last seven years, Nanette has been instrumental in the development of the Connected and Automated Vehicle (CAV) program at MDOT and serves now as *CAV Program Manager* at MVA which is the designated lead agency for CAV in the State. Projects have included creating a vision and a Statewide framework outlining CAV issues intended to encourage and empower stakeholders with integration of CAV in planning and policies.

One of Nanette's principal responsibilities is Coordinator for the *Maryland CAV Working Group* – a group of over 550 local stakeholders interested in research, testing, and implementation of CAV and includes four subgroups on technology, policy, freight, and emergency response that provide venues to discuss value and potential Maryland application of the latest research and promising practices. In this capacity, Nanette works directly for Ms. Chrissy Nizer, Administrator of MVA and the Co-Chair of the *Maryland CAV Working Group*. Nanette's charges include ascertaining priority issues from the myriad of CAV aspects, identifying opportunities for the State to be responsive to this emerging technology, and to bring those issues with potential practical applications to the top for consideration. Ms. Schieke also serves as Chair of the *Automated Vehicle Subcommittee* for the American Association of Motor Vehicle Administrators (AAMVA) and on the *Standing Committee on Vehicle User Education, Training, and Licensing* with the Transportation Research Board.

Ms. Schieke plays a primary role in managing the inclusive collaboration with external and internal partners, including coordination of CAV issues amongst all business units under MDOT and between other key State agencies, representing Maryland on regional and national organizations, and in working point on contact with private companies interested in CAV. Nanette's role includes directing the processes of a one-stop shop for companies expressing interest in CAV for Maryland and administration of several processes that provide a forum for facilitating dialogue on CAV with industry, including permitting of on-road testing with highly automated vehicles, operations of personal delivery devices, and platooning operations with electronically synced trucks. Her background and experience in governmental relations and public administration work well in this regard.

Ms. Schieke is especially passionate on education of ADAS – lower-level vehicle technology. She participated on a national team project to develop ADAS education materials for driver education instructors and brought this training to Maryland driving instructors as well as providing the adapted version to Maryland law enforcement liaisons. Nanette led the effort for Maryland to be the first state to include substantial information on ADAS in the Driver's Manual for novice drivers. Currently, Nanette is involved with both a regional project of East Coast states to develop an ADAS training module and a national research effort on *Determining the State of Knowledge, Opportunities for Outreach, and Data-driven Tools for Consumer Education of ADAS*.

In another core area that provides interesting synergies, Ms. Schieke also serves as a subject matter expert on aging driver safety – working through many groups, including as Co-founder of the *Aging Road User Program Interstate Collaboration.* In the driver safety arena, Nanette has been successful in spearheading many major projects and educational outreach to provide practical solutions to Maryland drivers, law enforcement, social workers, and the healthcare community. Nanette has presented this work at professional conferences and committees both locally and nationally.



Clea Baumhofer, P.E.

Complete Streets Manager at Baltimore
City Department of Transportation

PROFESSIONAL SUMMARY

Clea is a certified civil engineer with over 9 years of experience in the field. Educated at The Johns Hopkins University in Baltimore, Clea has excelled in both the private and public sector. She currently manages the Complete Streets Program at the Baltimore City Department of Transportation (BCDOT).

PROFESSIONAL EXPERIENCE

Baltimore City Department of Transportation, Baltimore, MD (2021 - Present) – Complete Streets Manager

Toole Design Group, Silver Spring, MD (2017-2021) – Engineer

RK&K, Baltimore, MD (2014-2017) – Field Engineer

EDUCATION

The Johns Hopkins University, BS, Civil Engineering (2010-2014)

Gregory A. Pedersen

PROFESSIONAL SUMMARY

Electrical engineer with experience in Intelligent Transportation Systems, wireless communications, computer networking, chemical agent detection, radar, and military electronics (including the state-of-the-art US Navy AEGIS system), with emphasis on teamwork, collaborative projects, and development of novel technologies & applications.

PROFESSIONAL EXPERIENCE

GL Communications Inc, Gaithersburg, MD (2017 - Present)
Project Manager/Senior Systems Engineer

Currently engaged in on-site project management and engineering services for the Systems Engineering department of the Maryland Transit Administration (MTA). These services encompass a range of projects, including Transit Signal Priority (TSP), CCTV, wireless communications, and various other systems to align with MTA's strategic goals. Extensive expertise through collaboration with the Baltimore City Department of Transportation (BCDOT), particularly in the deployment and integration of TSP with their intersection signal control system.

Rockwell Collins, Annapolis, MD (2001-2017) Project Manager/Systems Engineer

Supported the MTA Systems Engineering division as project manager for the BaltimoreLink TSP and Light Rail train approach warning systems. Previous projects include Metro chemical detection, fiber optic design/deployment for MARC, and managing multiple systems' components during the relocation of the Light Rail Lexington Market station. Project manager for the integration of GPS based TSP for Light Rail – one of the first uses of this technology in the country.

Provided engineering support for the Washington Metro Area Transit Authority (WMATA) Comprehensive Radio Communication System (CRCS) project. Duties included system testing and rail vehicle communications integration. Also involved with development of circuitry to correct electrical mismatch between Motorola radios and existing WMATA rail communications equipment.

Provided engineering services to MART (Montachusett Area Regional Transit) in the implementation of a CAD/AVL system for their para-transit fleet. Phase 1 consisted of 15 vehicles that successfully underwent operational acceptance testing. Duties included program management, system testing oversight, and AVL systems integration.

Fannie Mae, Washington, DC (2000-2001) Network Engineer

Member of Network Operation Center team which assisted Fannie Mae customers in troubleshooting network problems. This required knowledge of telecommunication protocols, routers, switches, network management, fiber optic systems, and both Local Area Network (LAN) / Wide Area Network (WAN) applications and infrastructure.

EDUCATION

Bachelor of Science in Electrical Engineering
Old Dominion University, Norfolk, VA, 1995
United States Naval Communication Encryption School, Mare Island, CA, 1988 United States Naval Advanced Electronics School, San Diego, CA, 1986 United States Naval Electronics School, Great Lakes, IL, 1984

APPENDIX II: Budget Narrative

The project budget is summarized in the SF-424A and totals $1,276,000. These include various equipment, contractual, and other costs associated with contracted consultant and vendor tasks to assist MTA with delivering the project. The project implementation will consist of six main tasks, which are listed below:

- Initial installation by vendor and subscription service for cloud-based TSP
- Traffic engineering support during implementation, testing, and evaluation
- Traffic management center network configuration support
- Reconfiguration of buses for prototype testing
- Systems engineering support
- Implementation Plan (including a Performance Management Plan, a Before and After analysis, and identification of software and hardware needs for Stage 2 demonstration)

The costs, relevant assumptions, and categories (including equipment, contractual, and other costs) associated with these tasks are described in the table below. A vendor will support the initial installation and reconfiguration of buses for the prototype testing. Traffic engineering support, traffic management center network configuration support, systems engineering support, and development of the Implementation Plan are to be performed by contracted consulting staff. Costs for work performed by MTA staff would be outside of this project budget.

Task	Performed by	Description of Activity	Category	Quantity	Unit Cost	Total
Initial installation and subscription	Vendor	System configuration, deployment, reporting, and ongoing optimization per intersection	Equipment	90 (intersections)	$4,000	$360,000
Initial installation and subscription	Vendor	12-month TSP license per intersection	Equipment	90 (intersections)	$2,500	$225,000
Traffic engineering support during implementation, testing, and evaluation	MTA-Contractual	Labor hours for 2 traffic engineers - signal controller configuration, testing, and evaluation	Contractual	1,500 (labor-hours)	$200	$300,000

Task	Performed by	Description of Activity	Category	Quantity	Unit Cost	Total
Traffic management center network configuration support	MTA-Contractual	Upgraded network firewall	Equipment	1	$12,000	$12,000
Traffic management center network configuration support	MTA-Contractual	Labor hours (installation, configuration, testing, meetings with MTA and Baltimore City IT)	Contractual	120 (labor-hours)	$150	$18,000
Reconfiguration of buses for prototype testing	Vendor	Cabling	Equipment	25	$200	$5,000
Reconfiguration of buses for prototype testing	Vendor	Contractor labor hours for 2 technical workers from vendor for cabling installation, vendor reconfiguration, and cellular router configuration	Contractual	300 (labor-hours)	$150	$45,000
Reconfiguration of buses for prototype testing	Vendor	Travel and lodging for 2 technical workers from vendor	Contractual		Lump sum	$5,000
Systems engineering support	MTA-Contractual	Labor hours for project management and systems testing	Contractual	400 (labor-hours)	$225	$90,000

Task	Performed by	Description of Activity	Category	Quantity	Unit Cost	Total
Implementation Plan	MTA-Contractual	Includes a Performance Management Plan, Before and After analysis, and identification of software and hardware needs for Stage 2 demonstration.	Contractual	560 (labor-hours) assuming one report for each of the four bus routes (based on 140 labor-hours for each report)	$178.57	$100,000
All tasks	Either MTA-Contractual or Vendor	Contingency	Other		10% of total of other tasks	$116,000
Total						**$1,276,000**

The aggregate budget costs by each category are summarized in the table below. Fringe benefits, personnel, travel costs, personal property costs, construction costs, and other indirect costs are not assumed to apply for this project.

Budget Category	Total Cost
Equipment	$602,000
Contractual	$558,000
Other	$116,000

APPENDIX III: Letters of Commitment

- Maryland Connected and Autonomous Vehicle (CAV) Working Group
- Baltimore City Department of Transportation (BCDOT)

MARYLAND DEPARTMENT OF TRANSPORTATION
MOTOR VEHICLE ADMINISTRATION

Wes Moore
Governor
Aruna Miller
Lieutenant Governor
Paul J. Wiedefeld
Secretary
Christine Nizer
Administrator

October 5, 2023

The Honorable Pete Buttigieg
Secretary
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington DC 20590

Dear Secretary Buttigieg:

I am writing on behalf of the Maryland Connected and Automated Vehicle Working Group (CAV WG), which brings together members from both the public and private sectors to advance cooperation on CAV technologies, including TSP and smart signalization. We commit to working with the Maryland Transit Administration (MTA) on the Cloud-Based Transit Signal Priority project, which seeks to demonstrate the use of cloud-based transit signal priority (TSP) technology in support of high-ridership transit corridors in Baltimore and aligns with the goals and expertise of the Maryland CAV WG.

To support the project and its partners, the Maryland CAV WG commits to using its extensive network to convene a diverse project review team to provide a comprehensive review of each major project milestone to ensure a stronger project. Among other areas, the Maryland CAV WG's expertise will support the implementation of the TSP technology, consideration of impacts on regional freight logistics, and reinforcing efficiency in emergency services.

As chair of the Maryland CAV WG, I am committed to working with the MTA to support this project and successfully implement it. With more than 650 stakeholders statewide, this group has been a central point of coordination for emerging CAV technologies for eight years, working to deliver collaborative and leading-edge CAV solutions. More specifically, the Maryland CAV WG includes participation from the Maryland Transportation Authority (MDTA) and State Highway Administration (SHA) and has supported both TSP and smart signalization efforts across the state. The relevant expertise and public involvement of the Maryland CAV WG will provide a high impact on the outcomes of the project and improve the potential for potential wider application across the state.

6601 Ritchie Highway NE, Glen Burnie, Maryland 21062 | 410.768.7000 | 800.950.1MVA | Maryland Relay TTY 800.492.4575 | mva.maryland.gov

We appreciate the USDOT's continued commitment to funding innovative projects that will bring the public sector and industry leaders together to improve transportation systems. If you have any additional questions or concerns, please do not hesitate to contact me at 410-768-7274 or cnizer@mdot.maryland.gov. I will be happy to assist you.

Sincerely,

Christine Nizer
Administrator, MDOT MVA
Chair, Maryland CAV Working Group

cc: Ms. Holly Arnold, Administrator, MTA

CITY OF BALTIMORE

BRANDON M. SCOTT, Mayor

DEPARTMENT OF TRANSPORTATION
Corren Johnson, Director
417 E. Fayette Street
Baltimore, Maryland 21202

October 10, 2023

The Honorable Pete Buttigieg
Secretary of Transportation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

Dear Secretary Buttigieg,

I am writing on behalf of the Baltimore City Department of Transportation (BCDOT) to express our commitment towards the Maryland Transit Administration's (MTA) application for a Stage 1 grant from the Strengthening Mobility and Revolutionizing Transportation (SMART) program. They seek funding to prototype and develop a plan for the deployment of cloud-based transit signal priority (TSP) technologies along targeted bus route corridors within Baltimore. The new cloud-based technology communicates with buses in shorter time intervals and has reduced installation and maintenance costs compared to current, GPS-based TSP systems, leading to a service that overall is more efficient and reliable.

The BCDOT commits to providing technical assistance when evaluating technology options, sharing roadway data collected by the City, and providing guidance on outreach opportunities to the communities adjacent to the project. MTA's CityLink RED, GREEN, BROWN, and LIME routes provide high-frequency bus service to connect passengers across neighborhoods between the northern and central areas of Baltimore. The corridors serving these CityLink routes presently have GPS-based TSP equipment on intersection pole mounts, within intersection controller cabinets, and aboard buses. MTA's current TSP system therefore requires specialized equipment on its buses as well as at the signals, which adds additional maintenance time and equipment costs. In coordination with BCDOT, MTA is proposing to deploy cloud-based TSP technology along these priority corridors to ensure the long-term success of TSP within the City.

Concurrent with MTA's application for a Stage 1 grant, BCDOT has prepared a separate application for a Stage 1 grant of the SMART program that seeks USDOT support for installing Light Detection and Ranging (LiDAR) and rectangular rapid flash beacons (RRFB). This is proposed at intersections along Eastern Avenue in southeast Baltimore and Belair Road through Herring Run in northeast Baltimore, with the latter corridor overlapping portions of MTA's CityLink BROWN route. The use of LiDAR and RRFB's as intersection treatments will allow BCDOT to better analyze traffic flow, pedestrian and vehicular interactions, and safety metrics on these roadways. We expect MTA's cloud-based TSP proposal will be complementary to BCDOT's proposal, with the potential to improve transit system reliability for bus passengers and improve pedestrian safety. The City considers this a strong collaborative opportunity to coordinate with MTA and provide improvements in the safe and efficient travel for all users of Baltimore's roadways. BCDOT is committed to guide MTA in its public outreach of the project to ensure that the cloud-based TSP project is properly communicated with Baltimore residents.

In conclusion, Baltimore City's commitment to this project will greatly improve transit service reliability, improve access for nearby communities, and limit greenhouse gas emissions.

Sincerely,

Corren Johnson

Corren Johnson
Director, Baltimore City Department of Transportation

APPENDIX IV:

Please see Valid Eval submission.