C2SMARTER
CONNECTED COMMUNITIES WITH SMART MOBILITY TO EQUITABLY REDUCE CONGESTION

SEMI-ANNUAL PROGRESS REPORT

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Signature: *Kaan Ozbay*

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I. Accomplishments

A. Goals and Objectives

Reducing Congestion is the main research area of the Connected Communities for Smart Mobility towards Accessible and Resilient Transportation for Equitably Reducing Congestion (C2SMARTER) Center. C2SMARTER's goal will be to solve two key problems related to urban congestion: (1) untangling the broad system-of-systems interdependencies facing congested urban systems that not only include multiple modes, but many interrelated sectors, and (2) understanding the system-wide impacts of congestion, in particular those that exacerbate inequities on different population segments. We propose to develop new technologies, operational policies, and strategies towards ensuring system-level congestion reduction for all users. C2SMARTER will focus on all three topic areas under reducing congestion framing our three research thrusts on demand management technologies, system-operational control, and data-driven analyses. Throughout our planned activities, we seek to follow the principles of the US DOT strategic goal of transformation – heavily relying on experimentation, with the goal of using evidence-based decision making to turn research into transformative and equitable solutions that take advantage of emerging technologies such as artificial intelligence (AI)/machine learning (ML) and connected and automated vehicles.

This integrative approach is also present in the proposed education, training, workforce development, and technology transfer initiatives. Curricula will be revised to be increasingly systems-oriented and hands-on, with real data from these testbeds. New capstones and student exchanges will foster increased collaboration between students from different universities and partners. Increased funding for students from minority-serving institutions (MSIs) will also increase diversity and representation in transportation research. Faculty will learn from the experiences of consortium-wide members to build locally-contextual programs designed to help their partners and communities deploy highly transformative solutions that may already be working at another site. Deploying community-oriented technology transfer will further ensure that issues of equity are not studied from a behind-the-glass perspective, and that tools and technologies developed under this grant reach those who need them the most.

B. Accomplishments of Goals and Objectives

1. Center Administration

Grant award paperwork was received and fully executed by New York University (NYU) as the lead member of the consortium in July 2023. Since then, Center administration has been working with each of the consortium partner members to establish programs and execute subcontracts from NYU.

On May 17, 2023, the Center Director Kaan Ozbay, Managing Director Shri Iyer, and Associate Directors Hani Nassif, Semiha Ergan, and Jeff Ban, traveled to US DOT headquarters in Washington, DC for the Center's kickoff meeting, joined virtually by faculty and staff from each of the partner institutions. C2SMARTER leads presented about the Center's plans and each institution's strengths for the consortium. Associate Director Hani Nassif attended the Council of University Transportation Centers (CUTC) summer meeting in Miami, FL in June 2023, and Center Director Kaan Ozbay attended virtually.

The C2SMARTER Center website has been as established at c2smarter.engineering.nyu.edu. The website includes content from the predecessor C2SMART Center established under the FAST act, to provide a seamless transition between the two synergistic centers. The Center mission and key personnel have been added, including the Center's Data Management Plan (DMP), which was created and approved by US DOT with input from the National Transportation Library in September 2023. The DMP is available at under the Publications section of the Center website.

2. Research

In preparation for the first year of research activities, the Center released a Request for Proposals (RFP) to its university consortium partners' faculty in July 2023. The RFP called for projects/initiatives within the Center's overarching theme of Reducing Congestion, addressing the Center's and US DOT's strategic goals and focus of implementable research, technology transfer, and educating/retraining the transportation industry workforce. Proposed efforts were asked to identify and address US DOT research strategic goals and performance metrics, as identified in the US DOT RD&T Strategic Plan.

Proposals were called for in five established tracks of the Center:

Track 1: Deployment of Efficient and Reliable Multi-Modal Technologies - Innovative yet practical deployments of technology for communities that most need them. Collaborative, interdisciplinary, initiatives which enable readily transferrable multimodal technologies and solutions.

Track 2: Research on Enhancing Operations through System Control and Design - Projects that will take advantage of infrastructure, testbeds, or large and novel datasets that will break new ground in the understanding of congestion reduction systems. Novel approaches using artificial-intelligence/machine-learning (AI/ML)-based methods in combination with complex simulation and modeling approaches.

Track 3: Evidence-based Policy-Making for Reducing Congestion - Leverage models and real-world data into the development and deployment of data-driven tools, centered around fairness and equity in long-term decision-making where they are deployed. Further implementations of responsible AI, smart cities and infrastructure, and adaptable infrastructure under the threat of major external disruptions such as COVID-19.

Track 4: Education or Development Program Filling a Gap in Transportation Workforce Development - Programs that teach transformative technologies/methods that will reduce congestion to one or more diverse student groups, from primary-level students through working professionals. (1) equip students with the foundational knowledge they need to begin their careers, as well as instilling soft skills like adaptability and willingness to learn and experiment; or (2) help current industry and agency professionals upskill to master new technologies and keep up with rapid technological change.

Track 5: Signature Technology Transfer Activities to Address Congestion Reduction and Transportation System Equity - Outreach focused on equitable outcomes, for targeted and effective technology transfer across partnerships, communities, and diverse student groups. Leverage diverse institutional relationships with city and state agencies, and with the local communities who rely on them, enable technology transfer efforts to address even the most complex issues, including land use policy, multimodal deployment, and high transportation costs.

For research projects (Tracks 1-3), the RFP and project selection process employed a three-step review process as follows:

1) Prospective principal investigators (PIs) were invited to submit project abstracts detailing proposed research goals and methods, as well as any partners or targets of dissemination/outreach. The Center's executive team reviewed for research merit, alignment with the RFP and Center themes, and feasibility of implementation, funding, timeline, and cost-share requirements. Following the review, PIs and teams were invited to submit full proposals. In some cases, the Center encouraged PIs working on closely aligned topics to team up in order to produce stronger proposals and avoid duplication.
2) Full proposals composed of a research narrative, technology transfer plan, data management plan, and budget, were solicited and submitted to anonymous reviewers from a group of academic and industry experts. A minimum of 2 reviewers were assigned to each proposal from a

panel of reviewers, who received an honorarium for their contributions. Reviewers were asked to rate each proposal based on a set of 10 review questions, provide comments for proposal improvement, and provide their assessment of whether the proposal should be funded.

3) Finally, these and Center comments were transmitted to submitters for revised proposals – with each proposal undergoing 2-5 iterations to address all comments. This included feedback from the Center's review team to ensure meaningful technology transfer activities and data management plans in compliance with US DOT requirements. Proposals received under Tracks 4-5 also employed this step.

As a result of the RFP process, the following projects were selected for funding for the 2023-2024 period:

Research Projects (Tracks 1-3):

An AI-reinforced Traffic Digital Twin for Testing Emergency Vehicle Interventions (EMV) - This project will build a traffic digital twin (TDT) to be developed in collaboration with the New York City Fire Department (FDNY) as a virtual test bed to evaluate interventions and support decision-making and planning in a safe simulation environment. Key challenges are incorporating AI to learn non-EMV driver responses to EMV signals (sirens, V2X technologies) and to train the TDT to different traffic states using historical traffic data and dispatch data from FDNY. Proposed outputs of the project include:

- An EMV Intervention Playbook which summarizes results of those interventions on a set of historical dispatches to quantify their simulated performances, which we can expand further in a future phase of research.
- A prototype TDT based on simulation and real time data sources of a district in Harlem that the FDNY can use, and which can be further expanded in a future phase, powered by a new open-source AI software that links the simulation to emergency dispatch data, dubbed EMVAID.
- Open-source software for the AI model portion of the TDT to append to other simulations.

The impact of this work will be measured through average simulated response times. The status quo will be used as a baseline, such that the impact on Transformation is clear through the use of digital twin to identify alternative strategies. In addition, the target area of the simulation is a lower-income neighborhood with majority residents of color in New York City. Synthetic population data developed by the researchers for New York City in prior research will be used to quantify the impact of the response time improvements on different population segments in the target area. These findings will contribute to better understanding and improving equity disparities in emergency response time. Finally, as a replicable outcome of this work, guidelines for other emergency agencies around the country to adopt such a TDT and/or interventions, particularly those in congested urban areas

- *PI: Joseph Chow; Lead: New York University*

Sensor-enabled Calibration of VR-Integrated Co-Simulation Platforms for Enhanced Accuracy in Multi-modal Mobility Models - This research endeavors to meticulously calibrate a virtual ecosystem comprising diverse agents, including cars, pedestrians, workers, and agents with disabilities. By integrating data from multiple sensing sources like camera streams, drone data, connected vehicle information, and worker behaviors captured in virtual reality, the research seeks to tackle the intricacies of multi-simulation calibration. The project intends to create a vocabulary of calibration metrics for simulators, devise methods to expand data sources, and identify challenges on the way to establish a flexible framework for integrated calibration. Additionally, an existing testbed (e.g., Flatbush Avenue testbed) will be expanded to cover a disadvantaged community defined by US DOT Climate and Economic Justice Screening Tool in order to identify the challenges on the way to the proposed calibration platform and defining ways to measure its efficiency, accuracy, and robustness. This research strives to contribute

significantly to the field of multi-modal mobility solutions, ultimately enhancing congestion reduction strategies and advancing the capabilities of simulation-driven planning.

This initiative aims to provide accurately calibrated simulation models of interactive agents in real road networks where a multitude of decision processes (e.g., implementation of congestion reduction strategies, infrastructure design improvements, implementation of new mobility modes, traffic control, etc.) rely on the accuracy of the models. Calibrated models improve service quality, efficiency, cost-benefit analysis for improved quality of life of citizens, used to make investment decisions and assess the efficacy of congestion reduction project and strategies. In addition to the value of the calibration metrics being produced, this work will identify challenges that should be addressed for developing co-simulation platforms, and provide an assessment of the accuracy of the calibrated model.

- *PI: Semiha Ergan; Lead: New York University*

Multi-Horizon Urban EV Charging Infrastructure Planning: Integrating Activity Patterns, Grid Dynamics, and Uncertainty - This project aims to develop a multi-horizon planning model that can assist policymakers in determining the timing and location of EV charging stations in an urban environment. The model incorporates several dimensions of decision-making, operation, and planning relevant to EV charging. The model and insights will prove valuable to several stakeholders: policymakers; federal, state, and city transportation and planning agencies; and power grid operators and regulators.

The tool will allow planners at different levels—electric grid, city and state leadership, US DOT—to better strategize and understand the impact of EV charging stations. While decision makers have devoted much needed attention to the need for modernization and decarbonization of the transportation system, there has been a lack of focus on a proper weighting of the costs and benefits of different schemes. Thus, it is in the best interest of the public and of the US to make use of sound tools and methodologies that can guide the use of resources allocated by the Infrastructure Investment and Jobs Act. The policy effects that this project will seek to evaluate as a result of different policies and scenarios include:

- charger accessibility and surplus across locations and demographic groups;
- financial resource allocation across locations and demographic groups;
- robustness of the strategy with respect to uncertainty in technology;
- grid operation reliability given the energy mix;
- emission reduction potential
- *PI: Daniel Vignon; Leads: New York University & University of Washington*

Building Intersection Digital Twins via GPU-Accelerated Human Regularized Reinforcement Learning -. This project aims to use new techniques in artificial intelligence and simulator design to enable the design of realistic driver models. The team will construct an open-source platform that potential state and federal partners can use to evaluate congestion mitigation schemes in realistic settings. Users will be able to provide different road layouts, speed limits, traffic control settings, etc., and be able to quickly evaluate the performance with diverse agents capable of non-idealized behaviors such as red light running, inching into intersections, performing cut-offs of agents in nearby lanes and other complex, realistic behaviors. As an additional benefit, this proposal will sharply reduce the cost needed to apply reinforcement learning for congestion reduction.

This research is intended to accelerate and improve the study of safety and congestion of highly interactive, multi-modal transportation systems by improving the realism and speed of the simulators used to study these systems. It is expected that this will have the following outcomes with respect to practice:

1. The integration of the agent models into existing simulators that are widely used in practice such as SUMO or AIMSUN. This will make existing pipelines more realistic.
2. It is expected that the simulator and agent models will be used to rigorously evaluate the safety and congestion benefits of proposed interventions as it will be possible to rapidly identify rare edge cases as well as potential adaptive responses of traffic participants to infrastructure changes.
3. A 5-100x cost reduction in the infrastructure costs needed to perform reinforcement-learning-based congestion reduction.

- *PI: Eugene Vinitsky; Lead: New York University*

Control of Connected and Autonomous Vehicles for Congestion Reduction in Mixed Traffic: A Learning-Based Approach - This project aims at taking a significant step forward to develop innovative learning-based, real-time control algorithms for connected and autonomous vehicles to reduce traffic congestion. This project aims at achieving four major objectives: 1) developing a traffic light prediction method by utilizing advanced deep learning techniques; 2) developing a trajectory optimization framework for a stream of vehicles to efficiently reduce the traffic congestion, attenuate the stop-and-go waves, and increase the throughput of the traffic; 3) integrating reinforcement learning techniques with (control) barrier functions to address the safety-oriented learning-based trajectory tracking control of autonomous vehicles; 4) validating the proposed congestion-reducing scheme with real-world vehicle trajectory data and SUMO testing under different environments in the presence of different vehicle mixes and driver uncertainties.

Based on the traffic light prediction and trajectory optimization techniques for a stream of connected and autonomous vehicles, the proposed congestion-reducing scheme can increase the throughput of the transportation network by attenuating the deceleration and acceleration of vehicles before the signalized intersections, accompanied by decreased fuel consumption and emissions. By integrating the state-of-art reinforcement learning and control-theoretic methodologies, the motion of the autonomous vehicles can be well guided such that fewer numbers of lane changes are possible and the reference trajectory from the trajectory planning module can be accurately tracked with stability guarantee and collision avoidance with surrounding vehicles and pedestrians.

The proposed congestion-reducing control scheme for connected and autonomous vehicles (CAVs) can significantly improve safety, strengthen economics, ameliorate climate, and promote mobility equity. Impact will be measured by a number of performance measures, including:

1) Safety: miles driven without disengagement, collision rate per mile, adherence to traffic laws
2) Economics and Congestion: traffic flow improvement, travel time reduction, average vehicle speed in areas with CAVs compared to areas without CAVs

- *PI: Zhong-Ping Jiang; Lead: New York University*

Development of a Vision-Based Landside Traffic Management System for Congestion and Safety Monitoring at Airports – This project proposes developing an operationalized computer vision-based analytics tool in collaboration with Port Authority of NY & NJ (PANYNJ) that will leverage JFK airport's existing cameras and provide real-time traffic data extraction, assisting the Transportation Management Center (PA-TMC) in its decision-making process. Key features include real-time traffic alerts, evaluations of the mobility and safety impacts from frontage modifications, and AI-driven assessments of construction zones. By using JFK as a demonstration, this initiative seeks to enhance the efficiency of airport traffic monitoring, ultimately benefiting the regional economy and improving passenger satisfaction. Outputs of this project include:

- A prototype of the landside traffic monitoring analytic tool for selected high-priority locations determined by the research/PANYNJ team.
- An auto pipeline to generate new mobility and safety data from the cameras for daily airport operations and constructions.
- Proof of concept of a construction zone performance reporting tool.
- Guidelines for other airports worldwide, especially those grappling with congestion challenges similar to JFK, to adopt such a vision-based approach for landside traffic monitoring and management.

Improved traffic monitoring and operations, enabled by the proposed approach, will ultimately help reduce congestion and promote more equitable access to and from JFK. This is particularly significant for workers living in low-income communities or areas with high traffic burdens who commute to JFK regularly.

- *PI: Jingqin Gao; Lead: New York University*

Multimodal Multi-scale Urban Traffic Control in Connected and Automated Cities - The proposed research will expand on prior work to consider multimodal traffic (especially non-motorized road users such as pedestrians and bicyclists) and explore the opportunities to test/validate the models using real-world connected and automated vehicle (CAV) testbeds. The research outputs include multimodal multiscale urban traffic control models and algorithms, simulation and testbed testing/validation results and findings, and general guidance and recommendations on how the models may be tested and deployed in real-world settings. The proposed research adds new models/knowledge to the growing CAV control and management literature.

The investigation and testing of the proposed methods are also expected to positively impact the deployment of the methods and provide useful insights for congestion reduction and safety improvements using emerging technologies and systems more broadly in the US. Performance will be measured by metrics including travel time, delay, speed, travel time reliability (mobility), energy consumption (sustainability), conflicts with other vehicles and peds/bikes, frequency and severity of crashes (safety), and comparison of other measures (mobility, sustainability, safety) among different user groups (equity).

- *PI: Jeff Ban; Lead: University of Washington*

Operational Analysis of the Flipped Left Diamond Interchange Design - This research is to investigate the operational performance of an innovative interchange design, Flipped Left Diamond Interchange (FLDI). In this study, signal timing strategies for this innovative interchange design will be developed. The operational benefits of using FLDI at the interchanges with different traffic conditions will be estimated and a procedure for selecting appropriate locations for implementing this new design will also be developed. The outcomes of this work will help promote this innovative interchange design and its successful implementation in the future. Specifically, it will provide a set of performance metrics for this new interchange design, including the percentage of reduction in traffic delay, average queue length, and the average number of stops per vehicle. It will reduce the traffic congestion at diamond interchanges and improve the traffic operation of the overall roadway network.

- *PI: Yi Qi; Lead: Texas Southern University*

Enhancing Transit Access and Safety Through Equitable Micromobility Solution - This project will investigate two major issues associated with the use of micromobility as a solution to improve the accessibility to transit in underserved communities. The first issue is related to the identification of micromobility stations in areas that are underserved by the fixed-route transit system. The second issue is

the safety impacts of implementing micromobility in the abovementioned neighborhoods, and the related infrastructure improvements. A Concept of Operations (ConOps) of micromobility will be proposed to address the needs of the first and last-mile travel in consideration of traffic safety and infrastructure needs. This project will create the awareness that promoting micromobility has an impact on traffic safety, and the need of infrastructure improvements. This project will also advance the knowledge on transportation equity with regards to accessibility to transit. Specific measures that will be produced include:

1. Cost components of implementation of a mobility system.
2. Travel time saving due to the introduction of a micromobility system.
3. Safety benefits in infrastructure improvement to facilitate micromobility.

- *PI: Kelvin Cheu; Lead: University of Texas - El Paso*

Impact of WIM-based Direct Enforcement on the Service Life of Bridges – This project will study the impact of the reduction in overweight (OW) trucks resulting from direct OW enforcement on extending the service life of the Brooklyn-Queens Expressway (BQE) in New York City. The team will conduct a life-cycle cost analysis (LCCA) of the network of bridges in NYC based on the established correlation. The output of this project will be a new framework to evaluate the effect of reduced OW percentage on the service life prediction. This framework will help introduce new legislation(s) for direct OW enforcement to mitigate the number of OW trucks and their OW tonnages; thus, improving bridge service life and preserving highway infrastructure. Based on prior studies conducted by the team, New York State introduced new legislation to issue notices of liability (NOL) to the OW violators using the Weigh-in-Motion (WIM) system without statically weighments using static scales for OW direct enforcement. This project will create the framework to help other states introduce similar legislation, as well as further incorporating this important work into industry standards.

- *PI: Hani Nassif; Lead: Rutgers University*

Equitable Flood Impact Analysis Integrating GeoAI and Digital Twin Modeling - This research aims to explore the interdependencies between water and transportation infrastructures in urban areas. The flood risks and their impacts on infrastructure and livelihoods such as transportation mobility and accessibility will be assessed with a focus on social equity; for example, low-income households are more likely to live in high-risk zones, face higher damages, and are less able to recover.

As its impact, the calibrated models and GIS story maps will be developed for use by the agencies in the case studies. Additionally, the project will result in publications in data-driven digital twin modeling and GeoAI tools for assessment of flooding impacts and modeling interdependencies between water and transportation infrastructure. The impact and outcomes of this research will extend beyond the project's immediate scope of equitable communities and climate change resiliency. The project will estimate changes in transportation accessibility for vulnerable communities, measured using flood risk assessments with corresponding risk scoring, the number of disrupted trips by trip purpose, and estimates of costs incurred by individuals due to flooding. Using the feedback from the agencies, the developed models will be useful for disaster mitigation, and facilitating better preparedness and response strategies. Furthermore, the project aligns with Goal #4 "Climate and Sustainability" of the US DOT RD&T Strategic Plan, emphasizing its significance in tackling climate-related challenges.

- *PI: Venktesh Pandey; Lead: North Carolina A&T*

Multi-Modal Tripchain Planner for Disadvantaged Travelers to Incentivize Transit Usage - This project aims to enhance accessibility and mobility for disadvantaged travelers by developing an AI-powered multimodal tripchain planner. The proposed planner optimizes for multiple trips in a day, considering various modes and group-based travel preferences. The key outputs include (1) an open-source

multimodal tripchain planner that can be appended to NREL OpenPATH, (2) estimated tripchain behavioral models for City of Arlington (CoA) users considering joint choices of multiple trips, (3) survey data demonstrating the tripchain planner's data collection capabilities with users of the autonomous vehicle fleet, and (4) an evaluation of revenue management strategies in partnership with CoA and select participants.

By considering the limitations, needs, and budgets of individual users, this planner will enhance transit travel for disadvantaged individuals, providing them with equitable access to opportunities and essential services. Through collaboration with various stakeholders (industry, academia, DOTs, and City/State governments) and through AI-driven data analytics, the project will yield a comprehensive and user-centric solution, aligned with the US DOT's vision. The project's impacts will be measured through metrics such as timely trip completion, user satisfaction, increased usage among disadvantaged groups, and reduction in private car usage and carbon footprint.

- *PI: Venktesh Pandey; Leads: North Carolina A&T & New York University*

<u>Education & Workforce Development (Track 4):</u>

K-12 STEAM Club Drone Tech for Hazards Resilience and Transportation Workforce Development in Rural, Isolated, Tribal and Indigenous Communities - This project builds on a relationship and program established at the Ocosta Junior High School After School Program and the City of Westport in South Beach, WA, under a series of Center for Safety Equity in Transportation (CSET) projects in Rural, Isolated, Tribal and Indigenous Communities since 2018. Students participating in the program will learn to apply drone video and video editing skills to citizen science initiatives in a community that is existentially threatened by a Cascadia Subduction Earthquake and Tsunami as well as climate change-driven sea level rise and worsening coastal floods, landslides, and erosion.

The project will generate curricular and extracurricular materials for the training of junior and senior high school students, and the staff who supervise them, in drone applications for rural transportation, infrastructure and emergency management and environmental hazards monitoring. The materials will also inform partnership efforts between local school districts and institutions of higher learning. Materials generated by the project will help to bridge gaps in service and workforce development between rural and lower-income communities and underrepresented populations and urban centers with highly specialized technical knowledge and more abundant resources. The former will gain expertise appropriate to their communities' situation and needs; the latter will gain opportunities to research the diversity of conditions that test regional systems performance and possible solutions to improve performance. The project will also contribute to local self-reliance in managing regional transportation systems that are fragile given multiple coastal hazards facing the community. Local youth will train and gain licenses to pilot drones, enhancing their employability in local agencies.

- *PI: Dan Abramson; Lead: University of Washington*

Emerging Leaders in Transportation - This program engages early-career transportation professionals to develop and promote innovations within their organizations to improve mobility practices. Participants develop plans to incorporate innovative tools or practices within their organizations, such as new workflows, data analysis tools, networking activities and access to educational programs. The program has successfully completed seven Emerging Leaders programs, with nearly 150 participants since 2014. Participants report high satisfaction rates with their knowledge exchange and leadership development. They also appreciate time with executives, industry leaders, as well as one another, and maintain these contacts throughout the years. Transportation agencies and companies enjoy new efficiencies and programs, as well as employees who are more ready to take on leadership roles.

- *PI: Sarah Kaufman; Lead: New York University*

Tech Transfer with Undergraduate Research & Workforce Development - The major output of this effort will be to fund a cohort of faculty and students engaged specifically in tech transfer activities to the broader scientific, transportation, and local communities. The Undergraduate Research program at City Tech is open to all disciplines; for this grant, a cohort of faculty and students will be dedicated to the field of transportation engineering. The proposed output will have a positive impact because, as this cohort (of predominantly underrepresented minorities) enters the workforce, our graduates will continue to enhance the local economy in these communities as they and/or their families will live and work within the target communities.

- *PI: Gerarda Shields; Lead: NYC College of Technology*

Technology Transfer Initiatives (Track 5):

Charting Equitable Outcomes for Highway Communities/Smart Technology and Smart Development - Researchers in a range of fields will come together to discuss successes and create best practices for the coming wave of urban highway rethinking. Panel discussions and breakout sessions will include: Best practices for regulatory approval, successful P3 structures, smart infrastructure finance, value capture and leveraging adjacencies as well as the role of technology in reducing dedicated car space while also reducing congestion. This proposal would include research assistants used for information gathering and coordination among the partners, followed by a summer convening bringing together national and international experts in the fields of equitable development, environmental justice, smart technology, urban design, economic development and finance. The outcome of the convening would be follow up discussions and the production of a whitepaper to serve as best practices and a roadmaps for jurisdictions reimagining urban highways and redressing the historic harms caused by the dismantling of communities for highway infrastructure.

- *PI: Marc Norman; Lead: New York University*

Transit Accessibility Showcase - The Transit Accessibility Showcase will demonstrate new and emerging technologies to assist people with disabilities in using public transportation. A panel discussion and technology showcase will generate new innovations and connections among policymakers, advocates, and riders to make public transportation more usable by all. The showcase will help policymakers to better understand new technologies and accommodates in transit, and the potential roles of local advocates and startups. This work will assist planners in evaluating and implementing new technologies.

- *PI: Sarah Kaufman; Lead: New York University*

A Knowledge Capture and Deployment Tracking Platform for UTC Research – The effort will develop a knowledge base to track the deployment of ITS projects and summarize their equity outcomes, performance measures, tools, benefits, costs, and best practices in contributing to US DOT strategic goals. A web portal will be created to connect academic research and the state of the practice. Findings from this project will help researchers, decision makers, and partitioners understand best practices in ITS project evaluation processes and establish outcome-based performance measures for all major programs, a key US DOT goal.

- *PI: Jingqin Gao; Lead: New York University*

Projects are scheduled to begin on October 1, 2023. Their details have been added to the C2SMARTER website and entered into the Research in Progress (RiP) federal database.

3. Education

At New York University, changes to the MS and PhD programs in transportation were approved by NYU and New York State.

- The PhD in Transportation Planning & Engineering will be changed in title to PhD in *Transportation Systems*. This reflects a shift in focus of faculty research to more systems-oriented work.
- The MS in Transportation Planning & Engineering and MS in Transportation Management will be consolidated into a new MS in *Transportation Systems*, with concentrations in Mobility Engineering and Transportation Systems Management. Students in the current programs can opt to stay within their existing curriculum or to switch over to one of the tracks in the new curriculum.

New faculty also joined the NYU transportation engineering department.

- Prof. Eugene Vinitsky joins NYU as an Assistant Professor in the area of reinforcement learning and autonomous vehicles.
- Prof. Linda Ng Boyle joins NYU as Tandon's Vice Dean of Research, bringing research and experience in driving behavior and crash and safety analysis.
- In addition, Prof. Zhibin Chen from NYU-Shanghai will be based at Tandon for the fall semester, and Prof. Lavanya Marla from University of Illinois Urbana Champaign will be visiting for the academic year. Both faculty will collaborate with the Cente on transportation research.

C. Training and Professional Development

- The C2SMART Student Learning Hub (SLH), originally created under the C2SMART Tier 1 UTC, has been extended and relaunched as part of the C2SMARTER Center. The Student Learning Hub is open to all students attending C2SMARTER Consortium Universities as well as a network of community colleges. It has offered free courses on applicable skills for students since its launch in September 2020. The classes are taught by doctoral students in transportation programs at Consortium schools, providing teaching and curriculum development experience. The SLH will offer new courses in the coming academic year open to all consortium partners.
- C2SMARTER Center supports consortium institution student chapters of professional associations. In mid-August, the Traffic Bowl Grand Championship was held during the Joint ITE International and Western District Annual Meeting in Portland, OR. The winning team from NYU featuring students, Luke Buttenwieser, Nick Hudanich, and Nate Sutton, had their names added to the Voigt/Davis Cup, the championship trophy.

D. Dissemination and Outreach

1. Conferences, Symposia, and Workshops

- C2SMARTER co-hosted and presented at the "Transit Techies" event in July 2023: NYU students Hai Yang and Farnoosh Namdarpour gave presentations; Hai's presentation focused on an API that connects NYU's MATSim testbed with the ride-pooling simulator while Farnoosh's was on simulating mobility services, including a local simulator designed to simulate a ride-pooling service and the open-source multi-agent simulation model for New York City using MATSim, based on the outcomes of the One-to-many simulator and prior C2SMART MATSim projects.
- In June 2023, researchers from C2SMARTER attended and presented at the five-day American Institute of Mathematical Sciences (AIMS) conference in Wilmington, North Carolina. Both NYU

researchers presented in the section Special Session 57: Mathematical Models for Traffic Monitoring and Control.

- On June 14-16, 2023, student researchers from NYU traveled to Saratoga Springs for the 30th annual ITS-NY meeting. The four researchers attended the conference and also presented their projects as part of the technology exhibition, the theme of which was "A Connected World." The four students competed for the annual Best Poster awards, with three projects receiving recognition:
    - 1st prize: Analysis of Urban Freight Flow in NYC by means of Synthetic Populations
    - 2nd Prize: Exploring Cost-effective Computer Vision Solution for Real-time Urban Work Zone
    - Honorable mention: Leveraging Connected and Automated Vehicle Data for Ramp Metering Strategies to Improve Highway Operations
    - Advanced Traffic Event Analysis and Management Platform for Transportation Data-Driven Problem Solving

C2SMARTER hosted the following seminars/webinars during this period:

- Applications of data analytics in Smart Cities: Spatio-temporal crime prediction; and Epidemic forecasting based on mobility patterns by Dr. Eugenio Cesario
- Reducing US Transit Costs: An Empirical Review and Comparative Case Study of Portland, Manchester Rail Systems by NYU MS student Chetan Sharma and Dr. Joseph Chow

2. Industry and Public Agency Outreach

- Professor Hani Nassif and the Rutgers team presented their work on the standards for Weigh-in-Motion based automated enforcement of overweight trucks at the following events:
    - NCWM in Norfolk, VA (7/31/23)
    - CWMA in Dubuque, IA (9/12/23)
    - WWMA in Sparks, NV (9/18/23)
    - FRC-2023 International Workshop in Tempe, AZ (9/18/23)
- Professor Nassif also helped organize the NYC Bridge Conference - Session 5A in August 2023

3. Media Coverage and Public Understanding

- Center Director Prof. Kaan Ozbay participated as a panelist in The Oliver Wyman Forum, whose focus is on developing solutions to social issues, climate change, and sustainability, in September of 2023.
- In August of 2023, C2SMARTER partner Sarah Kaufman hosted a conversation with Jamie Torres-Springer, President, MTA Construction & Development. The conversation directly followed a presentation on the reconstruction of Penn Station.
- In September of 2023, Sarah Kaufman was a panelist at the NYU Rudin Center's seminar Reconnecting Communities: Creating More Equitable Outcomes in Transportation Projects.

E. Plans for Next Reporting Period

C2SMARTER will embark on it ambitious slate of research, education, and technology transfer activities selected for funding in the 2023-2024 annual cycle. The Center will continue to host webinars/seminars by leading scholars and researchers to promote technology transfer.

II. Participants and Collaborating Organizations

A. Partner Organizations

As part of the development of proposals for C2SMARTER's RFP, several partner organizations were involved in project development, and will serve as partners in the projects:

An AI-reinforced Traffic Digital Twin for Testing Emergency Vehicle Interventions

- **New York City Fire Department (FDNY)** will be a partner, and will commit to $45,000 in in-kind cost share. This will cover the staff time to help provide data and work with our team to understand the interventions of interest.
- **AirSage** will also collaborate with data and commit $11,000 in-kind as cost share.

Multi-Horizon Urban EV Charging Infrastructure Planning: Integrating Activity Patterns, Grid Dynamics, and Uncertainty

- **National Renewable Energy Laboratory (NREL)** will participate as an advisory role. Dr. Fei Ding, a distinguished member of research staff and senior research engineer at NREL, has extensive expertise in EV, renewable energy grid integration, distributed energy resources aggregation and controls, and grid resilience and security. She will provide support to the project team by offering insights on model development and feedback on model outputs, and engage actively with the project team and other stakeholders throughout the project lifecycle.

Control of Connected and Autonomous Vehicles for Congestion Reduction in Mixed Traffic: A Learning-Based Approach

- This project will collaborate closely with practicing engineers/researchers at **ClearMotion** who aim at advancing modern driving platforms for comfort and safe driving experience.

Development of a Vision-Based Landside Traffic Management System for Congestion and Safety Monitoring at Airports

- **Port Authority of NY & NJ (PANYNJ)** has agreed be a partner and will commit to $20,000 cost share. PANYNJ will provide either online or offline video data from their existing cameras and work with the team to understand the performance measures of interest.

Multimodal Multi-scale Urban Traffic Control in Connected and Automated Cities

- **City of Madison** (Dr. Yang Tao) and TOPS Lab of UW-Madison (Drs. Steven Parker and Yang Cheng) will provide CAV data support, testing/validation using Madison CAV testbed, advice on research directions and method, research collaboration on multiscale traffic control.
- **City of Seattle** (Mr. Jeffrey Conor) will provide traffic data and traffic control systems/methods in the City of Seattle; facilitating the building of the CAV testbed; coordinating testing/validation of the research methods in the City of Seattle.

Operational Analysis of the Flipped Left Diamond Interchange Design

- Mr. Ali Mozdbar with **LJA Engineering** will serve in an advisory capacity.

Enhancing Transit Access and Safety Through Equitable Micromobility Solution

- **El Paso MPO** will provide planning documents, organizes public meetings, and feedback.
- **TxDOT** will provide crash data.
- **City of El Paso (Sun Metro transit)** will provide transit service data and feedback.

- **City of El Paso (Street & Maintenance Department)** will advise on infrastructure improvements and traffic safety analysis in underserved communities.
- **GLIDE Scooter** will provide advice on shared e-scooter operations for the development of the proposed ConOps.

Impact of WIM-based Direct Enforcement on the Service Life of Bridges

- **New York City Department of Transportation (NYCDOT)** will provide logistical and technical support to operate the direct overweight enforcement testbed, including in-kind cost-sharing.
- **Kistler Instrument Corp. (KIC)** will provide technical support to maintain the direct overweight enforcement testbed.

Equitable Flood Impact Analysis Integrating GeoAI and Digital Twin Modeling

- **North Carolina Department of Transportation (NCDOT)**, Integrated Mobility Division and **City of Greensboro** will serve in an advisory capacity.

Multi-Modal Tripchain Planner for Disadvantaged Travelers to Incentivize Transit Usage

- **City of Arlington (CoA)** will provide testbed and data for the microtransit services offered in the city and will help with outreach for the focus group surveys.
- Data from **Replica** will be shared to obtain a baseline synthetic population of the city to develop models.
- **NCDOT** will contribute as an advisory stakeholder. The planner's effectiveness and usability will be tested on the North Carolina Department of Transportation network to ensure its reliability and robustness in real-world scenarios.

K-12 STEAM Club Drone Tech for Hazards Resilience and Transportation Workforce Development in Rural, Isolated, Tribal and Indigenous Communities

- This project builds on a relationship and program established at the **Ocosta Junior High School After School Program** and the **City of Westport** in South Beach, WA.

Transit Accessibility Showcase

- This project involves contribution from the **Metropolitan Transportation Authority (MTA)** and, local transportation agencies, organizations and companies will be invited as both participants and speakers.

In addition, C2SMARTER is renewing its long-term consortium agreement with the **New York State Department of Transportation (NYSDOT)** to provide on-call research services. Currently, under the NYSDOT agreement with C2SMART, the following funded projects are taking place:

- SR-20-03 Capital Program Resource Model
- SR-20-04 Statewide Open-Source Advanced Traffic Management System (ATMS) Pilot
- SR-20-05 AASHTO and NBI Element Deterioration Rates for Bridge Management System
- SR-21-02 Design Finite Element Analyses and Crash Testing
- SR-21-03 Finite Element Analyses and Crash Testing of NYSDOT Bridge Railing and Barrier
- SR-23-03 Large Culvert Resilience Metric

The NYU and Rutgers teams continue to work directly with the **NYC Department of Transportation** via **NYC Town+Gown** to study and implement Weigh-In-Motion sensors throughout New York City, as well as on C2SMARTER's Smart Urban Roadway Testbed on the Brooklyn Queens Expressway. Professor Ozbay's team at NYU also continues to work with **Noblis** on US DOT's Benefits/Cost Lessons Learned project.

Professor Nassif of Rutgers is working with **NJDOT** on the Bridge Resource Program, as well as REEFENSE - A Mosaic Oyster Habitat (MOH) for coastal defense **(DARPA).**

B. Other Collaborators or Contacts

1. Collaborations within the Consortium

Several of the efforts selected for funding in the 2023 RFP feature collaborations between researchers across the consortium.

- **Multi-Horizon Urban EV Charging Infrastructure Planning: Integrating Activity Patterns, Grid Dynamics, and Uncertainty** is a collaboration between faculty at New York University & University of Washington
- **Multi-Modal Tripchain Planner for Disadvantaged Travelers to Incentivize Transit Usage** is a collaboration between faculty at North Carolina A&T & New York University
- **Tech Transfer with Undergraduate Research & Workforce Development** will include faculty mentoring by faculty at NYC College of Technology & New York University

2. Collaborations outside the Consortium

- Buffalo Mayor Myron Brown commissioned NYU researchers, including Dr. Kaan Ozbay, to conduct an analysis of the impacts of the city's fatal snowstorm in the winter of 2022 and to identify actionable solutions for the future. The team released a report in June 2023, Lessons Learned from the Buffalo Blizzard, focused on and investigated four primary areas of impact: roads, utilities, communications, and equity.

3. International Collaborations

- In August 2023, NYU Tandon School of Engineering welcomed distinguished faculty members from the Indian Institute of Technology-Kanpur to Tandon for a workshop which explored collaboration and joint research opportunities.

III. Outputs

A. Publications, Conference Papers, and Presentations

- In September 2023, members of the C2SMARTER team traveled to Bilbao, Spain, to attend and present at IEEE ITSC 2023. Seven papers were accepted for oral presentation at the conference, which welcomes articles and presentations in the field of Intelligent Transportation Systems:
    - Learning When to See for Long-term Traffic Data Collection on Power-constrained Devices
    - Investigating Safety of Evasion Maneuver Choices by Human-Driven Vehicles in Response to High-Density Truck Platoons Near Freeway Diverging Areas
    - Urban Work Zone Detection and Sizing: A Data-Centric Training and Topology-Based Inference Approach
    - Robust Queue Length Estimation for Ramp Metering in a Connected Vehicle Environment
    - Naturalistic Driving Data Analytics: Safety Evaluation with Multi-state Survival Models
    - Choice-based Service Region Assortment Problem: Equitable Design with Statewide Synthetic Data
    - Estimation of Road Horizontal Alignment Using Public Bus GPS Data
    - Automated Lane Changing through Learning-Based Control: An Experimental Study

IV. Outcomes

- Nothing to report, as the Center's research and activity are just getting underway.

V. Impacts

- Nothing to report, as the Center's research and activity are just getting underway.

VI. Changes/Problems

- Nothing to report