

## SEMI-ANNUAL PROGRESS REPORT

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Submitted to the Office of the Assistant Secretary for Research and Technology

<b>Federal Grant Number</b>	69A3551747124
<b>Project Title</b>	C2SMART Tier I University Transportation Center
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<b>Submitting Official</b>	Center Director
<b>Submission Date</b>	October 30, 2019
<b>DUNS</b>	04-196-8306
<b>EIN</b>	13-5562308
<b>Project/Grant Period</b>	Start Date: November 1, 2016 End Date: November 1, 2022
<b>Reporting Period End Date</b>	September 30, 2019
<b>Report Term or Frequency</b>	Semi-Annual

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## I. Accomplishments

### A. Goals and Objectives

C2SMART is the first Tier 1 University Transportation Center (UTC) in New York City, led by the New York University (NYU) Tandon School of Engineering. The mission of C2SMART is to build a solution-oriented research center that uses resources from consortium members' cities as a decentralized but comprehensive living laboratory. The Center brings together a unique combination of strengths and resources in urban informatics, connected technologies, behavioral informatics, and city partners. Its research approach is based on a system-of-systems (SoS) perspective that integrates roads, transport services, energy grids, financial information, and other urban networks.

**Research** — C2SMART will study challenging transportation problems and field test novel solutions in close collaboration with end-users, city agencies, policy makers, private companies, and entrepreneurs. We are focused on developing innovative solutions based on emerging disruptive technologies and their impacts on transportation systems. Our three main research areas are: Urban Mobility and Connected Citizens; Urban Analytics for Smart Cities; and Resilient, Secure, and Smart Transportation Infrastructure.

**Education** — As an academic institution, C2SMART is focused on training the workforce of tomorrow to deal with new mobility problems in ways that are not covered in existing transportation curricula.

**Dissemination and Outreach** — C2SMART aims to overcome institutional barriers to innovation and hear and meet the needs of city and state stakeholders, including government agencies, policy makers, the private sector, non-profit organizations, and entrepreneurs. The Center is also working to make it possible to safely share data to equip transportation decision-makers with the best information available.

### B. Accomplishments Under These Goals

#### 1. Center Administration

##### **Facilities & Staffing**

Renovations of new permanent center space at NYU Tandon School of Engineering in Brooklyn, NY continue to progress with an anticipated move-in date of Spring 2020. C2SMART is also continuing to grow its full-time research staff, including the hiring of two additional postdoctoral research associates based at NYU, as well as several new full-time funded students across the consortium universities.

##### **Data Management**

C2SMART researchers have worked to become compliant with the Center and USDOT's data management requirements, including uploading datasets, code and other outputs to the center's Zenodo Data Repository and submitting all products from completed projects to the National Transportation Library repository.

##### **Advisory Board**

C2SMART held an annual meeting of its advisory board in July 2019 where the advisory board members provided input on center activity and ideas for further collaboration with government and industry partners and experts. The advisory board will participate in the Request for Proposals process set to occur during the next reporting period, which will determine C2SMART's next set of funded research projects.

## 2. Research

**Table 1: Projects completed during the reporting period**

<p><b>Integrated Analytics and Visualization for Multi-modality Transportation Data</b> NYU</p>	<p>This project leveraged recent advances in computer vision to develop a method for processing a large collection of complex images, resulting in a model for pedestrian density estimation and an interactive visual analysis tool.</p>
<p><b>Using High Resolution Mobility Data to Understand Human Behavior and Population Dynamics in Cities</b> NYU</p>	<p>This research explored the usefulness of information from Wi-Fi networks and other large-scale mobility data to quantify and understand urban dynamics with new granularity. Using high spatial and temporal anonymized information from mobile devices, new approaches for estimating urban populations in real-time were established, quantifying human activities that have historically been difficult to understand.</p>
<p><b>Dual Rebalancing Strategies for Electric Vehicle Carsharing Operations</b> NYU</p>	<p>A new mathematical model for rebalancing carsharing vehicles over time was developed and a large test-case simulation experiment based on data obtained from car-sharing operations in Brooklyn, New York was developed.</p>
<p><b>Development of a Mobile Navigation Smartphone Application for Seniors in Urban Areas</b> UTEP</p>	<p>Through surveys and community engagement with seniors in El Paso, the research team has developed a smartphone application that caters to the specific needs and preferences of seniors in navigating their urban areas.</p>
<p><b>Automated Truck Lanes in Urban Areas for Through and Cross Border Traffic</b> UTEP</p>	<p>This project evaluated the existing design of interstate freeways in Texas for automated trucks. Using the I-10 Freeway in the El Paso as the testbed, the research team assessed the existing structural, geometric and traffic designs in handling fully automated trucks, performed microscopic traffic simulations to develop recommendations on the access point locations and weave length, and conducted a preliminary cost estimation on such infrastructure improvements.</p>
<p><b>An AI Platform for Network-Wide Congestion Detection and Prediction</b> UW</p>	<p>This project developed a prototypical artificial intelligence platform capable of providing standardized datasets and novel deep learning-based models for specific problems. The developed platform is capable of evaluating the traffic prediction performance of various implemented models by comparing and visualizing the prediction results tested on multiple real-world network-wide traffic state data sets.</p>
<p><b>Integrative Vehicle-Traffic Control in Connected/Automated Cities</b> UW</p>	<p>This project proposed a reinforcement learning-based traffic control method focused on cases with limited connected/autonomous vehicle penetration, more realistic traffic control scenarios (e.g., movements, control design methods, etc.), and the application of a deep learning method.</p>
<p><b>Development of A-WIM System for Effective Enforcement of Overweight Trucks to Reduce their Socioeconomic Impact on Major Highways</b> Rutgers</p>	<p>This project aims to monitor the impact of overweight trucks on the bridges and pavement infrastructure under the jurisdiction of NYC Department of Transportation (NYCDOT). The preliminary economic impact of overweight vehicles on bridges was quantified as dollar per overweight-ton per deck area per trip for three case studies, finding higher than previously studied impacts as compared to neighboring structures. This indicates that the impact of overweight trucks on structures is a concern in New York City.</p>

**Table 2: Updates on ongoing center-funded research projects**

Urban Mobility and Connected Citizens	<b>Integrative Vehicle Infrastructure Traffic System (iVITS) Control in Connected Cities</b> CCNY, NYU	Data collection for calibration has been obtained, with counts, travel times and estimations for a few intersections. Counts from video data are being processed. With this calibration, the model of the connected vehicle testbed will be completed.
	<b>Impact of Ride-Sharing in New York City</b> NYU	Researchers have collected available data and the route characteristics of major transportation modes between pairs of taxi zone across NYC. The team has started framing three different approaches for assessing the impact of ridesharing.
	<b>Increasing Work Zone Safety: Worker Behavior Analysis with Integration of Wearable Sensors and Virtual Reality</b> NYU	Researchers have developed an Apple Watch application to receive notifications from the Virtual Reality (VR) environment and forewarn user for incoming vehicles. VR environment was created using the laser scanner captured real-world intersections and work zone. The researchers have completed literature review for several topics like driving factors and started working on an IRB proposal.
	<b>Simulation and Analytical Evaluation of Bus Redesign Alternatives in Transit Deserts with Ride-Hail Presence</b> NYU	Progress has been made on model development and existing total cost computation. The second baseline approach estimating the mode-shift for the regular home-work commute as well as the general discrete choice model together with the Monte-Carlo Bayesian inference framework for it has been implemented.
	<b>Development of a Mobile Navigation Smartphone Application for Seniors in Urban Areas</b> UTEP, NYU	The research team has developed a beta version of the mobile application and is in the process of customizing the beta version based on the information collected in El Paso in Year 2 (the third survey), to release Version 1.0. This continued project will have a beta test in New York City and explore a data analysis framework that will characterize an application user's mobility patterns without knowing the person's identification.
	<b>Research and Field Testing of Vehicle-Traffic Control with Limited-Capacity Connected/Automated Vehicles</b> UW	Researchers have started the review of traffic-vehicle control under limited CAVs (i.e., limited penetration and/or lower automation level of AVs) and are in the process of developing research methods of traffic-vehicle control with LCAVs Coordinate with EcoCar3 team on field implementation and testing.
	<b>Valuing Vehicle Rebalancing in Free-Float Carsharing Systems</b> UW	This project is building on prior work to develop a tool for calculating the expected profit impacts of relocating vehicles in a free-float carsharing system. The research team has begun reevaluating and improving on dwell time and destination models.
Urban Analytics for Smart Cities	<b>Development and Tech Transfer of Multi-Agent Virtual Simulation Test Bed Ecosystem</b> NYU	Research team has improved the mode choice model to be more realistic considered the wait times for taxi and For-Hire-Vehicle (FHV) and mode choice in subtour level. The MATSim network has been updated as well with dedicated links for public transit to avoid unrealistic traffic congestion.
	<b>Connected Vehicles for Municipal Vehicular Fleets</b> CCNY	Researchers have obtained a database on unsafe events such as hard acceleration, hard braking, etc., at different times on day and location. The team performed analysis of unsafe events and clustered them to identify hotspots. These hotspots will be mapped with NYC crash data along the CV pilot corridors.
	<b>Sparkman: A Smart Parking Management Tool for University Campuses</b> UTEP	This project will conduct a survey to understand the factors that influence students' parking choice, patterns, and preferences in using Intelligent Transportation Systems (ITS) applications and levels of tolerance for parking search time. The researchers are in

		the process of developing the level of service (LOS) criteria for parking search time and a student parking lot zoning and zone permit pricing (Z2P2) model. A software tool for smart parking management will also be developed as part of this project.
Resilient, Secure, and Smart Transportation Infrastructure	<b>Design of Resilient Smart Highway Systems with Data Driven Monitoring from Networked Cameras</b> NYU	Researchers has developed algorithm for sensing fault detection and correction based on multiple machine learning techniques. The team has completed modeling sensing faults on linear highways and developed Python codes that count vehicles from camera data.
	<b>Developing Secure Strategies for Vehicular Ad Hoc Networks in Connected and Autonomous Vehicles</b> NYU	A framework for the hypothetical frequency of use of connections by trip purpose and readiness for CAV deployment has been developed. A literature review was conducted from a diverse set of journals and reports that specifically targets user behavior toward CAVs and the relationship to multi-modal connectivity.
	<b>Development of Autonomous Enforcement Approach Using Advanced Weigh-in-Motion (A-WIM) System to Minimize Impact of Overweight Trucks</b> Rutgers	Researchers have discussed with local transportation agencies including NYCDOT and NJDOT for the A-WIM implementation, and selected two WIM sites along the Brooklyn Queens Expressway (BQE) with NYCDOT and one WIM site with NJDOT. The team instrumented the high accuracy sensors and system at site #2 on BQE on 9/27/19-9/30/19.

The following projects are funded by public agencies and are used as matching funds for C2SMART or have complementary research aims to C2SMART-funded projects. These projects have a state/local agency client and directly complement the research being conducted using center funding. Combined with C2SMART-funded research, these projects enable the center to build larger, more impactful efforts that have direct end-user benefits for state and local agencies as well as other users.

**Table 3: Matching or complementary funded projects to C2SMART-funded projects**

Urban Mobility and Connected Citizens	<b>NYC Connected Vehicle Deployment &amp; Mobile Accessible Pedestrian Signal System Application</b>	NYCDOT/JHK Engineering
	<b>CIDNY – Develop a Multi-Agency/Multimodal Construction Management Tool to Enhance Coordination Projects City-Wide During Planning and Operation Phases to Improve Highway Mobility and Drivers Experience</b>	NYCDOT/NYS DOT
Urban Analytics for Smart Cities	<b>Calibration/Development of Safety Performance Function for New Jersey</b>	NJDOT
	<b>Needs Assessment for the Development of Data-Driven Predictive Non-Recurrent Delay Models for TRANSCOM</b>	TRANSCOM/Infosenseglobal Solutions
	<b>Development of Reconfigurable Environmental Intelligence Platform</b>	NSF
Resilient, Secure, and Smart Transportation Infrastructure	<b>Research on Concrete Applications for Sustainable Transportation: Life Cycle Cost Analysis</b>	USDOT/UTC program
	<b>Ongoing Research and Development of Situational Awareness Platform for the Port Authority of New York &amp; New Jersey</b>	Port Authority of NY & NJ
	<b>Bridge Resource Program</b>	NJDOT
	<b>Technical Support Services for the Maintenance Department</b>	NJ Turnpike Authority

### 3. Education

C2SMART undertakes several educational efforts to transfer new research and technology to today's transportation workforce and professionals in training across cities, companies, and agencies.

C2SMART mentored four students from **Applied Research Innovations in Science and Engineering (ARISE)** through the K-12 STEM program at NYU. ARISE is full-time, seven week program for academically strong, current 10th and 11th grade New York City students with a demonstrated interest in STEM. The program includes college level workshops and seminars, a high-level research experience in participating NYU faculty labs, and mentoring in that placement by a graduate or postdoctoral student.

This summer, 44 New York City-area high school students also participated in a three-week **CS4CS (Computer Science for Cybersecurity) program**, learning programming, virtuous hacking and digital forensics. The group came from a variety of backgrounds, and 80 percent were young women.

C2SMART has connected with the **Undergraduate Summer Research Program at NYU Tandon** to offer eight undergraduate students the opportunity to work on research projects. Abstracts include:

- Resilience of Dynamic Routing over Parallel-Link Networks against Recurrent and Random Sensing Faults
- Development of data-driven models for highway traffic flow: A case study on Interstate 210
- Two-Sided Market Operational Policy for Real Time Public Transit Route Deviation
- Brooklyn Queens Connector Evaluation Through a Multi-agent Virtual Simulation
- Recommender system development and deployment for elderly mobility in NYC
- Deep Learning for Traffic Video Analysis

**Vertically Integrated Projects (VIP)** - This program provides a multi-year, multidisciplinary approach to learning that emphasizes project-based, innovative, research-active education. The C2SMART affiliated VIP team is working on a database of infrastructure safety for autonomous vehicle planning. This is a project that we hope to adapt through University of Washington's VIP Program to analyze the needs of different cities using Seattle and New York City as a testbed. C2SMART is planning on connecting with NYCDOT, NYC Department of Design and Construction, and NYC Citywide Services on projects related to electric vehicles and work zone safety.

**Institute of Transportation Engineers (ITE) and Intelligent Transportation Society (ITS) student chapters** – C2SMART-funded graduate students continue to serve in leadership roles in these student-run organizations. The center provides space and support for their networking and educational activities. During this period, NYU's ITE chapter, in collaboration with the ITE Northeastern District, ITE MET Section and C2SMART Center hosted this year's ITE Northeast District Collegiate Traffic Bowl, a quiz-style transportation competition. Teams from NYU, Cooper Union, University of Connecticut, University of Massachusetts Amherst and NJIT competed, with NYU finishing in second place. The full-day event also included a mentorship lunch, during which attendees from all of the participating schools had an opportunity to network with professionals in transportation, and a poster session featuring student research.

The NYU ITE student chapter was awarded the **Student Chapter Achievement Award** by the ITE Northeastern District at its 2019 annual meeting in New Haven, given in recognition of providing outstanding services to its members. It also received the Organization of the Year award and the Outstanding Organization Growth award in the annual NYU Tandon Student Leader Awards.

C2SMART also supported student participation in the **Micro-Transit Hack-a-thon 2019**, organized by TTA and IATR, which was won by a team of students at NYU. The students will present their work at the Mobilize 2019 conference in Las Vegas, NV in October.



To maintain digital presence and outreach for all of these educational initiatives C2SMART hosts a web portal for student activities and social media. C2SMART utilizes social media platforms including LinkedIn, Twitter, Facebook, and Instagram for posting up to date information about events and student opportunities organized by C2SMART.

### C. Dissemination and Outreach

C2SMART disseminates research findings through a variety of outlets. Center updates, including news, events, and research developments, are disseminated through the C2SMART website. Research outputs, including final reports and peer-reviewed publications resulting from center-funded research, are submitted to the National Transportation Library’s ROSA-P repository, Research Hub, and TRB’s TRID database. Research results are also disseminated through papers, presentations, and meetings between center researchers and agency or industry partners and stakeholders. C2SMART also engages non-technical audiences to enhance public understanding of developments in transportation through media outreach.

#### 1. Training and Tech Transfer Events



C2SMART planned and co-hosted the **Connected and Autonomous Vehicles in New York City REDUX** event with NYC Town+Gown on April 18, 2019. This knowledge transfer event was based on the symposium held by C2SMART on October 23-24, 2018, at NYU Tandon in conjunction with City University of New York, University at Buffalo, Rensselaer Polytechnic Institute, and Rutgers University. The symposium brought together engineers, land-use planners, policymakers, industry representatives, agency

staff, academic researchers, and others to address the challenges involved in real-world deployment of connected and autonomous vehicle technology in the city.

C2SMART Director Kaan Ozbay and Professor Alain Kornhauser, Princeton University, presented a summary of the symposium, followed by an update on the USDOT/NYCDOT Connected Vehicle Pilot Project by Mohamad Talas, Director of ITS Management & CV Pilot Program Manager, NYCDOT. Experts and stakeholders from academia and government agencies offered further insights on the need for a CAV testbed in New York City, policy directions for CAVs, EVs, and shared vehicles, and accessibility concerns related to CAVs. Other participants included NYC Taxi & Limousine Commission, NYC Mayor’s Office for People with Disabilities, and NY State Energy Research and Development Authority. The event concluded with a panel discussion on future collaborative efforts in CAVs. Topics covered included:

- Summary of the NYC CAV Symposium in October 2018
- Update on the NYC Connected Vehicle Pilot Project
- CAVs in Smart Cities, and the Need for a CAV Testbed in New York City
- CAV, EV, and Shared Vehicles Policy/Strategy
- CAVs, Accessibility, and Inclusive Design for People with Disabilities
- Future Collaborative Efforts in CAVs

**Improving Representation in Transportation** is a Center-funded series of workshops and events on transportation policy and how to foster representation of diverse groups. The discussion workshops will generate policy briefs, including recommendations for policymakers to improve mobility for underserved groups and areas. The findings will be disseminated on the Center’s website and conveyed to transportation leaders. The workshops will help policymakers to understand gender disparity in urban travel behaviors and the potential role of local groups and startups. This work will assist planners, such as tapping into for-hire



vehicles for accessible trips and underrepresented in New York City. C2SMART and partners at the NYU Rudin Center are working with local community groups not traditionally involved in transportation planning.

A **For-Hire Vehicles and Passengers with Disabilities** panel discussion was held as part of this series on September 17, 2019. The event featured a discussion with policymakers, experts and advocates who work to improve access to wheelchair-accessible vehicles. Jelena Kovačević, Dean of NYU’s Tandon School of Engineering, gave opening remarks for the event. As a part of this effort, the **Women Leaders in Transportation** series, led by C2SMART PI Sarah Kaufman. Two breakfasts featuring lectures and discussions with female leaders in local transportation, **Women Leaders in Transportation Panel** and **a conversation with Lysa Scully, the General Manager of LaGuardia Airport**, took place during this reporting period. These events were open to the public and well-attended with over 100 attendees.

C2SMART hosted the **Second Freight Forum** on June 18<sup>th</sup>, 2019 on Busch Campus, Rutgers University. Over 50 engineers and stakeholders from public and private sectors (FHWA, NY, NJ, RI, VT and IL) attended to convene transportation stakeholders to address the effect of oversize and overweight trucks on the transportation infrastructure. They discussed the overweight and oversize strategies to comply with the MAP-21 Act per the USDOT final report entitled Comprehensive Truck Size and Weight Limit Study. The attendees discussed the 5 topics in pavement, bridge, freight, safety and enforcement. This forum attracted participants from Federal and Local Government (FHWA headquarter, FHWA NJ Division, NJDOT, NJTPA, NYCDOT, Port Authority NY/NJ, and Virginia DMV), academia (Rutgers, NYU, NYU-INTERCEP, Rensselaer Polytechnic Institute (RPI), New Jersey Institute of Technology, Stevens Institute of Technology and University of Illinois, Urbana-Champaign), Trucking Association (American Trucking Association, New York Motor Truck Association, NJ Motor Truck Association, Rhode Island Trucking Association and Specialized Carriers & Rigging Association), and other firms (Carbon Express, Arora and Associates, P.C., Ferrara Concrete, Keller Engineers of New Jersey and LifeSpan Technologies).



During this reporting period, the center undertook additional dissemination and outreach efforts:

**Conference Presentations and Research Showcases**

- Director Kaan Ozbay’s work was presented at the 2019 Smart Conference hosted by the University of Central Florida. Professor Ozbay also served as Session Chair (Innovation and Industrial Logistics) at the 5th International Conference on Innovation and Industrial Logistics, in France.
- Rae Zimmerman presented her research related to connected and autonomous vehicles, mainstreaming resiliency, and infrastructure service risks at the following events:
  - Environmental Design Research Association (EDRA): EDRA50 Sustainable Urban Environments: Research, Design and Planning for the Next 50 Years, May 23, 2019.
  - Sustainable Urban Subsurface Systems Workshop, NYU, CUSP, June 24, 2019.
- Rae Zimmerman served as the organizer, co-presenter, moderator, and speaker at Transportation Research Board session (co-developed for TRB2020 annual meeting): Mainstreaming Resiliency: Physical Security Faces New Challenges.
- Yueshuai He, a Ph.D candidate under the supervision of deputy director Joseph Chow presented his research on evaluating emerging technologies and policies with a Network of Living Labs: Case of New York City at ETH Zurich, Switzerland, July 22, 2019.
- Don Mackenzie of UW presented his research work at the following events:
  - Stanford Energy Global Council. August 22, 2019.
  - NBER Economics of Energy Use in Transportation Conference. May 3, 2019.
  - Center for Climate and Energy Decision Making. April 15, 2019.

- Jeff Ban of UW presented research findings at the following events:
  - Nanjing University of Science and Technology, Invited Talk, July 2019.
  - Southeast University, Invited Talk, July 2019.
  - Hong Kong University Smart Mobility Workshop, May 2019.
  - 23rd International Symposium on Transportation and Traffic Theory, Lausanne, Switzerland.
  - 19th CICTP Annual Conference, Nanjing, China.
  - 2nd Forum on Frontiers of Science and Engineering, Tsinghua University, Beijing, China.
  - Canadian Transportation Research Forum, Vancouver, BC, Canada.
- PI Joseph Chow and PI Kaan Ozbay, and their Ph.D. students at the center continue to present their research results on the evaluation of city-scale built environment policies in New York City using an emerging mobility-accessible synthetic population at numerous city-wide events in New York City.
- C2SMART graduate students at NYU Tandon shared their research with fellow academics, journalists and visitors from the Brooklyn community at the annual Tandon Research Expo on May 3, 2019.
- Sarah Kaufman presented previous research on online shopping as part of the C2SMART study on consumption practices at:
  - The Ford City of Tomorrow conference on May 23, 2019, in Los Angeles.
  - The Conference on World Affairs in Boulder, Colorado on April 9-11,
- Sarah Kaufman presented on the C2SMART Pink Tax research at:
  - Smart Cities New York on May 15, 2019
  - US Department of Transportation Volpe Center in Cambridge, MA on September 19, 2019.
  - ITS America Executive Summit on September 17, 2019, in New York City.
- UTEP work on C2SMART-funded projects was presented at the Joint ITE International and Texas District Annual Meeting and Exhibit, Austin, TX, July 23, 2019.

### Workshops

- C2SMART co-sponsored the SunCity Hack, hosted at UTEP on April 26-28, 2019. C2SMART PI Kelvin Cheu and affiliated faculty Natalia Villanueva Rosales and Jeffrey Weidner were involved with the event, which attracted teams of students from engineering and computer science majors at UTEP.
- PI Joseph Chow gave an expert lecture on May 15, 2019 on the need to bridge the gap between urban transportation sciences and data-driven transportation professionals in emerging mobility technologies and lay out examples shared in his book. The event was hosted by C2SMART and The Greater New York City chapter of Young Professionals in Transportation (YPT NYC).
- The Future of Micromobility in NYC event was held with representatives from the NYC Council, NYC Department of Transportation, Bird, Transportation Alternatives and Lyft, on June 10, 2019.
- The Sustainable Urban Subsurface Systems Workshop was held at NYU CUSP on June 24-25, 2019. Rae Zimmerman was an invited member of the organizing committee.
- C2SMART and German Center for Research and Innovation (DWIH NY) co-hosted a Smart Cities Never Sleep Workshop at NYU's Center for Urban Science and Progress in September 2019 that brought international stakeholders to discuss how cities should be thinking about nighttime planning and how data, innovative approaches and digital solutions can support the social, cultural and economic activities.

### 2. Industry and Public Agency Outreach:

- C2SMART's team at NYU hosted several visiting delegations from transportation industry companies and their representatives during the current reporting period for the purposes of knowledge sharing, transfer, and developing new opportunities for collaboration. These included domestic companies as well as industry from around the world.

### 3. Seminars and Webinars

C2SMART’s ongoing Distinguished Speaker Series presented talks on advances in transportation. In addition, the center also hosted seminars and webinars presented by center faculty and students and other visiting researchers. All seminars are broadcast live and archived for viewing on the Center’s [Youtube channel](#).

#### Seminars

- Dr. Francesco Corman, Chair of Transport Systems, ETH Zurich, Disruption Management in Railway Networks.
- Michael Pack, Director of the CATT Laboratory, University of Maryland, Visual Analytics Tools for Enhanced Travel Behavior Pattern Analysis.
- Mladen Čičić, Ph.D. Candidate, KTH Royal Institute of Technology, Macroscopic Traffic Control Using Connected Autonomous Vehicles.
- Dr. Paul Fuchs and Dr. Glenn Washer, ThermalStare, LLC, IR-UTD Infrared Inspection of Bridges & New Updates on Manual of Bridge Element Inspection.
- Dr. Tulio N. Bittencourt, Professor, University of Sao Paulo, Monitoring of Structural Integrity of Mixed Concrete-Steel Railway Bridges.
- Dr. Eui-Seung Hwang, Professor, Kyung Hee University, Evaluation Methods of Vibration Serviceability for Long Span Cable Bridges.

#### Project Webinars

- Dr. Hani Nassif, Professor, Rutgers, the State University of New Jersey, Monitoring and Control of Overweight Trucks for Smart Mobility and Safety of Freight Operations.

### 4. Media Coverage and Public Outreach

- C2SMART has continued to grow its mailing list, which is used to advertise center events and disseminate news and research findings via regular newsletters. The center’s email communications achieve consistently high open and click rates, averaging 43% and 3.4% respectively. These results are well above the 17.1% open rate and 2% click-through rate averages for other mailing lists in education and training reported by MailChimp, the email marketing service used by the center.
- C2SMART also works to reach a wider public audience through its [Youtube channel](#). All of the center’s seminars are streamed live, and video recordings from other events and webinars are posted as well. During this reporting period, the center’s Youtube channel accumulated 1,048 views.
- UTEP’s Sparkman project [appeared in Prospector, the UTEP campus newspaper](#), on March 15, 2019.
- Director Kaan Ozbay, Associate Director Hani Nassif, and Affiliate Faculty Mitchell Moss, continue to serve on the New York City Mayor’s expert panel on reconstruction of the Brooklyn-Queens Expressway. The panel continues to receive wide media coverage in New York media outlets.
- Director Kaan Ozbay was featured in interviews by media outlets CBS and Cheddar on Connected Vehicle Infrastructure and the NYC Connected Vehicle Pilot project.
- The Tandon-VectolQ Tech Talks at the New York International Auto Show, featuring C2SMART Director Kaan Ozbay and Deputy Director Joseph Chow, were held in April 2019. Co-sponsored by C2SMART, the event featured two panels which looked at the expansion of mobility beyond privately owned cars and trucks, as well as related technologies that are changing how people commute and travel.
  - The first panel, moderated by Prof. Joseph Chow, looked at disruptive technologies in the urban mobility space. The lineup included Lyft’s Motivate, DollarRide, and Cruise, touching on the companies’ missions and the advances happening in emerging mobility modes.



- The second panel focused on how technology, big data, and artificial intelligence can impact urban mobility, alleviate congestion, and aid better city planning. C2SMART Director Ozbay, spoke about the center’s mission to work with and analyze transportation big data.
- PI Don Mackenzie was featured in 8 different articles and media coverage on topics covering self-driving cars, ridehailing and transit, bikesharing, and climate impacts.

## D. Plans for Next Reporting Period

C2SMART will continue to support the Improving Representation in Transportation Series with outreach events targeted at underrepresented groups in transportation. Planned events will take place including a Technology Showcase towards improving mobility for people with disabilities, as well as a continuation of the Women Leaders in Transportation series. C2SMART will also host TransportationCamp New York at NYU in October 2019, as well as a nationwide Workshop for Parking and Mobility in Cities expected to be attended by public agency delegates from across the country.

Several C2SMART PIs will be presenting at the Informs conference in October 2019 in Seattle, WA, and several other conference presentations are also planned. C2SMART will once again also have a strong presence at the Transportation Research Board meeting in January 2020.

## II. Participants and Collaborating Organizations

### A. Partner Organizations

C2SMART has established partnerships with a range of agencies and private companies, outlined in Table 4Table :

**Table 4: C2SMART partner organizations**

Organization Name	Location	Contribution		
		Financial Support	In-kind Support	Collaborative Research
6-t Bureau de Recherche	Paris, France			X
Abu Dhabi DOT	Abu Dhabi, UAE		X	
Alliance for Downtown New York	New York City, NY		X	
Arcadis	New York, NY		X	
Bestmile	San Francisco, CA		X	
BMW ReachNow	Seattle, WA		X	
Carmera	Brooklyn, NY		X	
Castrol	Various		X	
Central Japan Railways	Tokyo, Japan	X		
City of El Paso	El Paso, TX		X	
Conway Marine Construction, Inc.	Long Island, NY		X	
Cuebiq	New York, NY			X
Daidone Electric, Inc.	Newark, NJ		X	
Drive Engineering	Blue Bell, PA			X
Federal Transit Administration	Washington, DC	X		
Foundation for the Future	Brooklyn, NY			X
Ikos Lab	Europe (various)			X
Intelligent Transportation Society of NY	New York, NY		X	
International Parking & Mobility Institute	Alexandria, VA	X		
King County Metro	Seattle, WA			X
Kistler Instrument Corp.	Buffalo, NY		X	

<b>Nexar</b>	New York City, NY			<b>X</b>
<b>NEXT</b>	Silicon Valley, CA			<b>X</b>
<b>NJ Turnpike Authority</b>	Woodbridge, NJ	<b>X</b>		
<b>NJDOT</b>	Newark, NJ	<b>X</b>		
<b>NYC Mayor's Office</b>	New York City, NY			<b>X</b>
<b>NYCDOT</b>	New York City, NY	<b>X</b>		
<b>NYS DOT</b>	Albany, NY	<b>X</b>		
<b>Parkofon</b>	Alexandria, VA		<b>X</b>	
<b>Port Authority of NYNJ</b>	New York City, NY	<b>X</b>		
<b>Puget Sound Regional Council</b>	Seattle, WA		<b>X</b>	
<b>Red Hook Initiative</b>	Brooklyn, NY		<b>X</b>	
<b>SHARE NOW</b>	Seattle, WA			<b>X</b>
<b>Sound Transit</b>	Seattle, WA			<b>X</b>
<b>Texas Department of Transportation</b>	Austin, TX		<b>X</b>	
<b>Toyota</b>	Various			<b>X</b>
<b>TrafficCast International</b>	Middleton, WI		<b>X</b>	
<b>Transpod</b>	Toronto, Canada			<b>X</b>
<b>Trust for Governor's Island</b>	New York City, NY		<b>X</b>	
<b>US-China Clean Energy Research Center</b>	Various			<b>X</b>
<b>Via</b>	New York City, NY		<b>X</b>	
<b>Washington State DOT</b>	Olympia, WA		<b>X</b>	<b>X</b>
<b>Zendrive</b>	San Francisco, CA			<b>X</b>

## B. Other Collaborators or Contacts

### 1. Collaborations with other departments and research centers

- C2SMART collaborated with NYU's Center for Urban Science & Progress as well as the German Center for Research and Innovation (DWIH NY) to hold the Smart Cities Never Sleep Workshop to discuss how cities should be thinking about nighttime planning better in the Smart Cities era.
- C2SMART has continued its collaboration with INTERCEP, a research center based at NYU Tandon that is focused on organizational resilience. The center is working closely with the Rutgers team on a project focused on developing effective policies to reduce the impact costs of overweight vehicles on roads and bridges.
- C2SMART entered into an agreement with the International Parking & Mobility Institute (IPMI) to co-host a workshop in the following reporting period on mobility and street-level issues in Smart Cities. It will be held at C2SMART's home at NYU in November 2019.
- Director Kaan Ozbay & Prof. Zhong-Ping Jiang in the Electrical and Computer Engineering department at NYU Tandon continue to co-advise and mentor graduate students on transportation-related research.

### 2. Inter-University collaboration

- The Connected and Autonomous Vehicles Redux event featured work by consortium member universities as well as other universities including Princeton, the State University of New York and Rensselaer Polytechnic Institute.
- INTERCEP at NYU and the Rutgers team collaborated to host the second forum on overweight trucks in June 2018. This event brought engineers from several state DOTs together with researchers to advance the state of practice in dealing with overweight trucks.

- C2SMART PIs at NYU and Rutgers continue to collaborate extensively on the Brooklyn Queens Expressway (BQE) project and analysis of overweight trucks. This has led to the creation of a new testbed in New York City.
- UTEP and NYU researchers are collaborating to bring the work on UTEP’s Urban Connector smartphone application to help seniors and their mobility in El Paso, TX, to New York City.
- C2SMART hosts several researchers from other institutions as Visiting Scholars on a regular basis

### 3. Other collaborations

- A new testbed has been created by C2SMART and the New York City Department of Transportation on the Brooklyn-Queens Expressway with sensors installed for data collection and analysis by C2SMART. Led by Rutgers University and New York University, this testbed will generate volumes of data on the structure and traffic of a section of the BQE in Brooklyn, NY slated for reconstruction to better inform the new project and decision-making process.
- Meetings were organized during this reporting period with NYCDOT and USDOT to brief them on the project Impact of Ridesharing in New York City project, and US DOT expressed interest to follow the progress and readiness to share available data such as survey-based travel statistics. Data sharing procedure is being explored.
  - Uber was briefed about the project scope and objectives and expressed interest to follow further developments.
  - A meeting was organized with Arcadis to brief them into the project. Arcadis shared aggregated city-wide mobility patterns based on mobile device data.
  - Via was briefed about the project scope and objectives and expressed interest to follow further developments.
- The UW team is currently working with SHARE NOW, the carsharing unit of the Daimler-BMW joint venture, to evaluate whether the previously agreed upon work is relevant to SHARE NOW’s business needs. If it is, the team expects to continue with the proposed work plan. If it is not, the team hopes to develop a revised work plan that fits within the C2SMART priority areas and is relevant to SHARE NOW or another industry partner
- UTEP researchers have had several collaborative meetings with TxDOT engineers, City of El Paso engineers, and El Paso MPO planners in to obtain projected traffic volume data, signal timing data, and to share the results of simulations

## III. Outputs

C2SMART is exceeding its targeted performance metrics in each of the areas identified in its Technology Transfer Plan, identified in Table 5.

### A. Publications, Conference Papers and Presentations

#### 1. List of Journal Publications

- Bartin, B., Ozbay, K., Xu, C., (2019) Extracting Horizontal Curvature Data from GIS Maps: Clustering Method. Transportation Research Record: Journal of Transportation Research Board, National Academies, Washington, D.C., Sage Publications.

**Table 5: Output Performance Measures**

Performance Measures	Annual Goal	Achieved (current period)
Peer-reviewed papers	20	27
Conference presentations	10	25
Joint proposals/projects with industry/agency partners	10	11
Website analytics	5,000 unique pageviews	14,069 unique pageviews



- Yang, D., Xie, K., Ozbay, K. Yang, H., Budnick, N. (2019) Modeling of time-dependent safety performance using anonymized and aggregated smartphone-based dangerous driving event data. *Accident Analysis and Prevention*, Volume 132.
- Xie, K., Ozbay, K., Yang, D. (2019) A multivariate spatial approach to model crash counts by injury severity, *Accident Analysis & Prevention*.
- Ozbay, K. et al., (2019) Review and assessment of New Jersey rail freight assistance program, *Journal of Research In Economics*, Elsevier.
- Mudigonda, S., Ozbay, K. and Bartin, B. (2019) Evaluating the resilience and recovery of public transit system using big data: Case study from New Jersey, *Journal of Transportation Safety & Security*, 11:5, 491-519.
- Kalan, O., Kurkcu, K., Ozbay, K. (2019) Is Additive Utility Function Always A Sufficient Method in the Project Prioritization Process? A Bridge Management Perspective. 98th Transportation Research Board (Committee AHD35: Bridge Management), *Transportation Research Record: Journal of Transportation Research Board*, National Academies, Washington, D.C., Sage Publications.
- Gao, J., Ozbay, K., Nassif, H., Kalan, O. (2019) Stochastic Multi-Objective Optimization-Based Life Cycle Cost Analysis for New Construction Materials and Technologies (Committee AHD35: Bridge Management). *Transportation Research Record: Journal of Transportation Research Board*, National Academies, Washington, D.C., Sage Publications.
- Bian, Z., Ozbay, K. (2019) Identifying Uncertainty of Work Zone Capacity Using Neural Network Models. (Committee AHB55: Work Zone Traffic Control). *Transportation Research Record: Journal of Transportation Research Board*, Volume: 2673, Issue: 2, page(s): 49-59, National Academies, Washington, D.C., Sage Publications.
- Xie, K., Ozbay, K., Yang, D. (2019) A multivariate spatial approach to model crash counts by injury severity, *Accident Analysis & Prevention*, Volume 122, Pages 189-198.
- Gao, W. Gao, J. Ozbay, K., Jiang, Z. (2019) Reinforcement-Learning-Based Cooperative Adaptive Cruise Control of Buses in the Lincoln Tunnel Corridor With Time-Varying Topology. *IEEE Transactions of Intelligent Transportation Systems.*, Volume: 20, Issue: 10, Oct. 2019.
- Xie, K., Yang, D., Ozbay, K., Yang, H. (2019) Use of real-world connected vehicle data in identifying high-risk locations based on a new surrogate safety measure. *Accident Analysis & Prevention*, Vol. 125, pp. 311-319.
- Zimmerman and C.E. Restrepo, *Physical Security: External Applications*. In: *Encyclopedia of Security and Emergency Management*, edited by L. R. Shapiro and M.-H. Maras. 2019 forthcoming. Springer Nature.
- Zimmerman and C.E. Restrepo, *Physical Security: External Applications*, In: *Encyclopedia of Security and Emergency Management*, edited by L. R. Shapiro and M.-H. Maras, forthcoming, 2020. Springer Nature.
- Zimmerman, *Historical and Anticipated Changes in Interconnected and Concentrated Infrastructure and Social Networks in Weather, Climate and Human-Initiated Disruptions*, in *Urban Infrastructure: Interdisciplinary Perspectives from History and the Social Sciences*, edited by J. Soffer, J. Heathcott, and R. Zimmerman. Pittsburgh, PA: University of Pittsburgh Press, forthcoming.
- S. Zhou, J. Pang, and Q. Zhu, *MUSIC: A High-Capacity Low-Waiting Time Intersection Management System for Connected Autonomous Vehicles*, in preparation for submission to journal.
- *Monitoring & Evaluation for Performing Project- and Network-Level Life Cycle Cost Analysis*. Transportation Research Board's 99th Annual Meeting, Washington, DC, USA, January 12-16, 2020 (submitted for presentation and publication).
- Peters, L. & MacKenzie, D. *The Death and Rebirth of Bikesharing in Seattle: Implications for Policy and System Design*. *Transportation Research Part A: Policy and Practice*. (accepted)
- Ge, Y., Ranjbari, A., Lewis, E.O., Barber, E., & MacKenzie, D. *Defining Psychometric Variables Related to Use of Autonomous Vehicles*. *Transportation Research Record: Journal of the Transportation Research Board*.
- Gao, J., Ranjbari, A., & MacKenzie, D. *Would Being Driven by Others Affect the Value of Travel Time? Ride-hailing as an Analogy for Automated Vehicles*. *Transportation*.
- Ban, X., Dessouky, M., Pang, J.S., Fan, R, 2019. A general equilibrium model for transportation systems with e-hailing services and flow congestion. *Transportation Research Part B* 129, 273-304.
- Di, X., Ban, X., 2019. A mixed link-node and path formulation for equilibrium of new mobility systems. *Transportation Research Part B* 129, 50-78.
- Li, W., Ban, X., 2019. Connected vehicle based traffic signal coordination. *Engineering*.

- Wang, F., Wang, J., Cao, J., Chen, C., Ban, X., 2019. Extracting trips from multi-sourced data for mobility pattern analysis: An app-based data example. *Transportation Research Part C* 105, 183-202.
- Wang, J.P., Huang, H.J., Ban, X., 2019. Optimal capacity allocation for high occupancy vehicle (HOV) lane in morning commute. *Physica A* 524, 354-361.
- Guo, Q., Li, L., Ban, X., 2019. Urban traffic signal control with connected and automated vehicles: A survey. *Transportation Research Part C* 101, 313-334.
- Wang, J.P., Ban, X., Huang, H.J., 2019. Dynamic ridesharing with variable-ratio charging-compensation scheme for morning commute. *Transportation Research Part B* 122, 390-415.
- Li, W., Cui, Z., Li, Y., Ban, X., 2019. Characterization of ridesplitting based on observed data: A case study of Chendu, China. *Transportation Research Part C* 100, 330-353.

## 2. Books or other non-periodical, one-time publications

Nothing to report during this reporting period.

## 3. Other Publications, Conference Papers and Presentations

- Kurkcu, A. and Ozbay, K. (2019) Analysis and Modeling of Transit Passenger Arrivals to a Bus Terminal using a Doubly Stochastic Model, 8th Symposium of the European Association for Research in Transportation (hEART 2019), September, 4-6, Budapest, Hungary.
- Gao, J. and Ozbay, K. (2019) Applying Machine Learning Techniques on Spatial and Temporal Analysis to Explore Double Parking Behavior of Commercial Vehicles, 5th International Conference on Innovation and Industrial Logistics, Paris, France, August 21-23, 2019.
- Gao, J., Ozbay, K., Nassif, H., Khayat, K.H., Demiroglu, S. (2019). ASSISTME-LCCA: Advanced Software for State-Wide Integrated Sustainable Transportation (submitted for presentation).
- Nassif, H. presented the recent research topic related to resilience and safety of bridge structures. AASHTO Committee on Maintenance meeting, Grand Rapids, MI, July 13-18, 2019.
- Nassif, H. The advanced concrete materials for resilience of bridge structures. NJACI dinner meeting, Rutgers University, NJ, September, 2019.
- J.Y.J., Chow and Goldwyn E. Simulation and analytical evaluation of bus redesign alternatives in transit deserts with ride-hail presence, 2019.
- He, Y. Evaluating emerging technologies and policies with a Network of Living Labs: Case of New York City. ETH Zurich, Switzerland, July 22, 2019.
- He, Y., Zhou, J., Ma, Z., Chow, J.Y. J., Ozbay, K. Evaluation of city-scale built environment policies in New York City using an emerging mobility-accessible synthetic population, 2019.
- Zimmerman, R. Human Behavioral Factors that Shape Urban Physical Infrastructure Services. Paper presentation at the Environmental Design Research Association (EDRA): EDRA50 Sustainable Urban Environments: Research, Design and Planning for the Next 50 Years, May 23, 2019.
- Zimmerman, R. closing remarks for Sustainable Urban Subsurface Systems Workshop, NYU, CUSP, June 24, 2019.
- Zimmerman, R. The Challenge of Physical Security Adaptation for Multi-Hazards for Resilient Transportation. Transportation Research Board session Co-developed for TRB2020 annual meeting (January 2020), 2019.
- Zimmerman, R. A data-driven framework for user, provider, and community behavior toward infrastructure services risks, SRA 2019 annual meeting, Arlington, VA.
- Kaufman, S. presented previous research on online shopping at the Ford City of Tomorrow conference, Los Angeles, May 23, 2019.
- Kaufman, S. presented generally about transportation research at the Conference on World Affairs, Boulder, Colorado, April 9-11, 2019.
- Kaufman, S. Pink Tax on Transportation. Smart Cities New York, May 15, 2019.
- Mackenzie, D. Stanford Energy Global Council. Energy Implications of Automation & Mobility Services. Stanford University. Palo Alto, CA. August 22, 2019.
- Mackenzie, D. NBER Economics of Energy Use in Transportation Conference. Discussant: Effect of on-demand ridesourcing on vehicle ownership, travel, energy, and environmental outcomes in the United States. Washington, DC. May 3, 2019.

- Mackenzie, D. Center for Climate and Energy Decision Making. How might automated vehicles affect energy use and emissions? Carnegie Mellon University. Pittsburgh, PA. April 15, 2019.
- Ban, X. Nanjing University of Science and Technology, Transportation big data: promises, issues, implications, and potential solutions, July 2019.
- Ban, X. Southeast University, Modeling dynamic transportation networks using differential variational inequalities, July 2019.
- Ban, X. Hong Kong University of Science and Technology, Equilibrium modeling of e-hailing services on a transportation network (one of the invited speeches at the Smart Mobility Workshop), May 2019.
- Siddique, N., Ban, X., 2019. Self-adaptive online trajectory sampling (SAOTS) using spectral domain properties. Presented at the 23rd International Symposium on Transportation and Traffic Theory, Lausanne, Switzerland.
- Li, W., Ban, X., 2019. Real-time movement-based traffic volume prediction for signalized intersections. Presented at the 19th CICTP Annual Conference, Nanjing, China.
- Ban, X., 2019. Smart urban mobility with mobile sensing. Presented at the 2nd Forum on Frontiers of Science and Engineering, Tsinghua University, Beijing, China.
- Guo, Q., Parks, S., Ban, X., 2019. Macroscopic fundamental diagram based perimeter control considering dynamic user equilibrium. Presented at the Canadian Transportation Research Forum, Vancouver, BC, Canada.

## B. Websites

The **C2SMART website** ([c2smart.engineering.nyu.edu](http://c2smart.engineering.nyu.edu)) continues to be used for disseminating information about the Center’s activities and research. The site is frequently updated with news about events and achievements involving C2SMART faculty and students, and final project reports and additional research progress updates are added regularly. C2SMART’s website had 14,069 unique pageviews during this reporting period, exceeding its annual goal of 5,000 pageviews.

In addition, the [Sustainable Transportation Lab](#) website is used to disseminate information about research at the University of Washington, including C2SMART-funded work on shared electric vehicle systems. The [Rudin Center](#) website shares information about research and workforce development by PI Sarah Kaufman, including the Emerging Leaders in Transportation program. The [Rutgers Infrastructure Monitoring and Evaluation Group \(RIME\)](#) website provides regular updates on the group’s activities. INTERCEP is developing a Resource Hub to consolidate research related to the impacts of overweight trucks on infrastructure. When completed, this resource will be disseminated to stakeholders.

## C. Technologies or Techniques

C2SMART’s research projects have produced several technologies and techniques during this reporting period. As part of the Work zone safety project, PI Semiha Ergan’s team developed a Python web application with Tornado framework to support the communication between the VR environment and Apple Watches. An Apple Watch application was developed as well to receive notifications from the VR environment and alert user of the incoming vehicles.

Two RIME researchers, Chaekuk Na and Peng Lou, were trained to install the high accuracy WIM sensor (Kistler Quartz sensor) by the Kistler Instrument Corp. representative and received the certifications to instrument additional high accuracy WIM sensor in the future. The RIME team is able to instrument the high accuracy WIM sensors in any location for additional A-WIM implementation.

## D. Joint Proposals/Partnerships with Industry/Agency Partners

NYU is entering into a formal partnership with the New York State Department of Transportation to assist in research and collaborative workforce development and tech transfer. Formalization of the agreement is expected during the next reporting period. C2SMART researchers jointly applied for and were selected by the Port Authority of New York & New Jersey in response to a Request for Proposals

for Academic Institutions to advise on discrete engineering projects on a call-in basis in 2019. Formalization of the agreement is expected to occur in the next reporting period.

The Rutgers and NYU teams had several meetings with NYCDOT and NJDOT engineers for future field implementation projects. For NYCDOT, the team reviewed numbers of locations in the City to implement the A-WIM system. The team visited the field on 6/24/19 to evaluate the roadway condition and found two feasible locations for installation. Accordingly, the team prepared the scope of work, specifications, layout, drawings, and other supporting documents and submitted to NYCDOT. The team is currently working with NYCDOT to expedite the installation process.

The Rutgers team received possible locations on NJ highway system for A-WIM system installation. After discussion with NJDOT, the team concluded one location near a static weighing station which can confirm the accuracy of A-WIM system. The team is currently developing the scope of work, specifications, layout, drawing and other supporting documents.

Table 3 provides a list of active funded grant projects being conducted by C2SMART PIs, while Table 5 lists all current active or renewed collaborations with agency and industry partners. C2SMART is actively pursuing new funding opportunities to complement or continue center-funded research to expand upon the initial research into implementation projects. Some of these include:

- National Science Foundation, Learning to control non-linear cyber-physical systems
- New York State Center for Advanced Technology
- NYC CV Pilot program – Pedestrian Task (FHWA BAA - Solicitation No. DTFH6115R00003)
- NSF Engineering Research Center for Smart Engineering Systems for Resilient Coastlines (SERC)
- National Cooperative Highway Research Program: Algorithms to Convert Safety Measures into Traffic Measures
- National Science Foundation: Smart and Connected Communities (3)
- New Jersey Turnpike Authority Technical Support Services (3)

## E. Other Products

The researchers have produced various datasets, models, mobile applications and summaries during this reporting period. The bus network design project has produced demand matrix, Bus GTFS data, bus network file, and route summary to be shared with the MTA and the larger transportation research community. The Impact of Ridesharing in NYC project has created models and multiple datasets such as aggregated monthly FHV and shared FHV ridership and residential population per wage group counts per NYC taxi zone. PI Li Jin’s team has developed code for crawling videos and traffic volume from online sources and collected 300G video camera data for a section of US Route 101.

A summary report of a forum on overweight vehicles in June 2019 has been produced and shared.

## IV. Outcomes

### A. Increased Understanding and Awareness of Transportation Issues

C2SMART’s outreach, dissemination and education efforts have reached a wide audience.

The **Future of Mobility workshop series** and the **Improving Representation in Transportation** series

have helped policymakers to understand gender disparity and issues for people with disabilities in urban

**Table 6: Outcomes Performance Measures**

Performance Measures	Annual Goal	Achieved (current period)
Media interviews, mentions, coverage	10	61
Workshops, webinars, and seminars	10	17

travel behaviors and the potential role of local groups and startups. This work will assist planners, such as tapping into for-hire vehicles for accessible trips and underrepresented in New York City.

The **Smart Cities Never Sleep Workshop** brought several city, national, and international stakeholders together to discuss how cities should be thinking about nighttime planning and how data, innovative approaches and digital solutions can support the social, cultural and economic activities.

The **Second Freight Forum** at Rutgers University brought over 50 engineers and stakeholders from public and private sectors (FHWA, NY, NJ, RI, VT and IL) to address the effect of oversize and overweight trucks on the transportation infrastructure. They discussed the overweight and oversize strategies to comply with the MAP-21 Act per the USDOT final report entitled Comprehensive Truck Size and Weight Limit Study. The attendees discussed the 5 topics in pavement, bridge, freight, safety and enforcement.

The team at UTEP has made significant inroads into partnering with seniors and improving their mobility through the **Development of a Mobile Navigation Smartphone Application for Seniors** project. They have accomplished a significant level of education and training for seniors on how to make better use of smartphones to improve their ability to move around their cities easily. It has provided new and valuable insights for researchers and policymakers into the needs and preferences of seniors, a group that faces specific challenges when it comes to urban transportation. This work will now be extended to seniors in New York City as part of a joint UTEP-NYU initiative.

The usage data will enable city transportation agencies to understand mobility patterns of older adults with privacy of their data in mind. The city and service providers for seniors can use the data to improve infrastructure including wheelchair accessibility and ramps, as well as public services for the seniors.

## B. Increases in the Body of Knowledge

C2SMART researchers have taken a multi-pronged effort to address how best to manage and control connected and autonomous vehicles in urban environments and to improve the integration of these technologies into cities as real-world implementation begins. The NYU and CCNY teams are working in various capacities with NYCDOT on USDOT's **NYC Connected Vehicle Project**, including the development of an application for visually impaired pedestrians that uses connected infrastructure to aid them in navigating urban streets. NYU researchers have made significant impact in understanding human behavioral foundations for use of CAVs for last-mile connectivity. They have also looked into Physical Security Challenges for Multi-Hazards and Multimodal Networks Interconnecting Transportation Technologies for CAVs and other Mode Innovations. Meanwhile, the UW team is developing models for traffic signal control that integrate data from connected vehicles to optimize system performance.

## C. Improvement and Adoption of Processes, Technologies, Techniques and Skills in Addressing Transportation Issues

Contacts have been made for potential partners from other venues that include an academic connection to the NYC Fire Department to deploy CAVs and to the NYC Office of Emergency Management.

PI Hani Nassif presented the A-WIM implementation plan, bridge design using site-specific load, etc. to help NYCDOT design a new BQE bridge. The Rutgers team implemented the A-WIM at BQE bridge to determine the accuracy using calibration truck and to monitor the truck weights of typical traffic in NYC.

The City of El Paso has also expressed interest in expanding the features in Urban Connector to also serve non-seniors but people with disabilities. UTEP researchers met with City's ADA Coordinator Mr. Julio Perez in April 2019. This expansion will be included in the Urban Connector project.



## V. Impact

### A. Effectiveness of the Transportation System

Through C2SMART’s funded and matching research projects, it has collaborative relationships with all of the major state and local transportation agencies in its collaborating institutions’ areas. These connections provide an opportunity to introduce planners, engineers, and decision-makers to center research and topics, and transfer findings into tangible improvements to the transportation systems of these regions.

Most significantly, C2SMART has worked with NYCDOT to develop a new testbed on the Brooklyn-Queens Expressway. This testbed will provide significant opportunities for further collaborative research with New York City agencies, with results transferrable to critical infrastructure across the country.

### B. New Practices or Companies

Nothing to report in this reporting period

### C. Body of Scientific Knowledge

Though most of C2SMART’s work is in applied research, it continues to push the edges of basic and advanced research through its projects. Its work in connected vehicles and cities continues to generate significant scientific knowledge in this area prior to full-scale deployment.

### D. Transportation Workforce Development

C2SMART has made an impact on transportation workforce development through classes taught by Center faculty, support of students involved in transportation research projects, funding for masters and Ph.D. students, and opportunities for undergraduate students. Our efforts in this area also include:

- Supporting the Emerging Leaders in Transportation program. This workshop directly supports the development of the current transportation workforce by teaching early-career professionals leadership skills, how to build influence in their organizations, and strategies for effecting change. The application period for Emerging Leaders in Transportation. The 82 applications are currently being evaluated to select approximately 25 participants. Applicants will be notified of their selection status in mid-October
- An Advanced Traffic Fundamentals Workshop 2-day course will be held for NYCDOT employees in the next reporting period at NYU.
- The Second Forum on Overweight trucks was attended by DOT engineers to learn pressing issues in this area. The Rutgers team has also hosted seminars at NJDOT to improve enhanced learning and exposure to advanced researchers for NJDOT staff.

**Table 7: Impacts Performance Measures**

Performance Measures	Annual Goal	Achieved (current period)
<b>Instances of software, tools, research results, or guidelines adopted by transportation agencies leading to operational improvements</b>	5	6
<b>Partnerships/collaborative relationships with companies or transportation agencies established or renewed</b>	10	50

## VI. Changes/Problems

Nothing to report during this reporting period.