C2SMART
CONNECTED CITIES WITH SMART TRANSPORTATION
A USDOT University Transportation Center

New York University
Rutgers University
University of Washington
University of Texas at El Paso
The City College of New York

PROGRAM PROGRESS PERFORMANCE REPORT

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

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Center Director	Kaan Ozbay, Ph.D., Professor of Civil and Urban Engineering, New York University Tandon School of Engineering, kaan.ozbay@nyu.edu, (646) 997-3691
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Submitting Official Name: Kaan Ozbay

Signature: *Kaan Ozbay*

C2SMART
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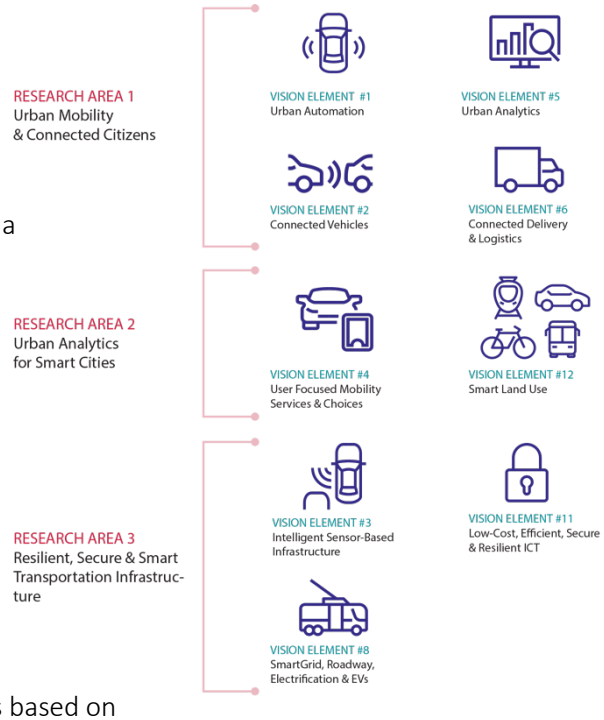
Table of Contents

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.

During the previous reporting period, C2SMART was in the process of getting started, including launching its first set of research projects and building its administrative setup. We are now able to report initial achievements in pursuit of our goals and mission.

B. Accomplishments Under These Goals

1. Center Administration

1.1 Facilities

C2SMART's offices at NYU moved to a dedicated space in 15 MetroTech Center at the NYU Tandon downtown Brooklyn campus. The space includes a new lab, conference room and workspace for all C2SMART faculty, staff, and students. The new home also includes space for center collaborators to come and work with the center researchers and take part in center activities. Work is also in progress for renovations of another building at NYU Tandon, which will include facilities designed for C2SMART's future needs to grow the scope and impact of its research. Those renovations are currently due to be completed in 2019. All renovations and move costs are funded directly by NYU.

1.2 Staffing

Over the past reporting period, the Center has hired full-time staff to accomplish its goals and objectives and has reached its full minimum staffing level under the proposal.

Senior Associate Director. The Senior Associate Director was hired to coordinate all Center operations as well as serve as a liaison with agencies, industry partners, and all external collaborators of the center to develop partnerships and disseminate accomplished research. The Senior Associate Director's salary is funded through matching contribution by New York University, and is not paid for with grant funding.

Assistant Director for Education and Workforce Development. The Center expanded its team by bringing on Professor Jack Bringardner of the NYU Tandon School of Engineering to lead educational and workforce development initiatives. Prof. Bringardner is already building C2SMART's involvement with the Vertically Integrated Projects (VIP) Program that tasks undergraduate students with leading and executing multi-year research projects, as well as the Applied Research Innovations in Science and Engineering (ARISE) program, which recruits high school students to introduce them to STEM fields and involve them in center research. He is also advising NYU's Institute of Transportation Engineers (ITE) student chapter and coordinating opportunities for professional development for members of the transportation workforce.

Communications Associate. The Center hired a Communications Associate who will aid in expanding our reach, including redeveloping and adding content to the website, planning and facilitating events for outreach and dissemination, and developing a uniform image for C2SMART across its publications and online presence.

Additionally, the center's research projects have supported the hiring of multiple students, post-docs, and other research staff to help execute center research projects. The pool of qualified PIs to participate in the Center's activities is also growing, with Professor Monica Menendez hired as a new transportation faculty member at NYU (Abu Dhabi), and the hiring process for a new transportation faculty member at NYU (New York) underway.

1.3 Data Management

The Center updated its data management plan in response to USDOT feedback and comments. Key updates to the data management plan include:

- Study data will be hosted on a central server at NYU Tandon School of Engineering for the duration of the study, while a permanent version will be added to the Zenodo data repository following completion of each study.
- The Creative Commons Attribution 4.0 International (CC BY 4.0) license[1] will be utilized for all re-use and re-distribution of data, in accordance with federal guidelines[2]. This license allows for users to copy and redistribute data, modify and build upon the material even for commercial purposes, as long as attribution is provided to the authors/creators of the data.
- Production of the derivatives based on software packages (i.e., new development based on the source codes) will be handled on a case-by-case basis, and the GNU General Public License v3.0 will be utilized for all re-use and re-distribution.
- Open-source codes and developmental efforts will also be detailed on and shared via Github as appropriate to the nature of each project or study.

[1] https://creativecommons.org/licenses/by/4.0/
[2] USDOT "Plan to Increase Public Access to the Results of Federally-Funded Scientific Research Results Version 1.1" Published December 16, 2015 https://www.transportation.gov/sites/dot.gov/files/docs/Official%20DOT%20Public%20Access%20Plan%20ver%201.1.pdf

2. Research

2.1 C2SMART-Funded Research Projects

In Year 1, C2SMART funded 12 research projects across its member institutions. Due to time dedicated to setup of the Center and progress with awarding subcontracts, start dates of projects were not uniform, but the majority of the Year 1 projects are now at or nearing completion.

Key updates on the status and progress of each of the Year 1 research projects are presented below:

Urban Mobility and Connected Citizens	**City-scalable Destination Recommender System for On-demand Senior Mobility** NYU, UTEP	This project has developed a prototype recommender system for mobility-on-demand services as well as a framework design of the web application, and initial testing has begun.
	Development of a Mobile Navigation Smartphone Application for Seniors in Urban Areas UTEP, NYU	An application has been developed and slight modifications are being made. An IRB application for the pilot test is in progress, and the team is working with senior centers in El Paso to conduct testing.
	Integrative Vehicle Infrastructure Traffic System (iVITS) Control in Connected Cities CCNY, NYU	Researchers are currently developing models to evaluate CV technologies based on two sites in New York, and calibration of those models has begun.
	Quantifying Uncertainty and Distributed Adaptive Control for Unanticipated Traffic Patterns NYU Abu Dhabi	Researchers have developed a microsimulation network to be used as a testbed for adaptive control algorithms.
	Traffic Signal Optimization and Coordination in Connected Cities UW	Researchers are currently developing signal coordination methods, which will undergo testing and validation.
Urban Analytics for Smart Cities	**Sustainability of Urban Consumption Practices** NYU	Researchers conducted a survey designed to better understand and compare consumption practices and mobility behaviors of residents of Paris and NYC. Results were presented at a project advisory group meeting, with final report and policy recommendations in progress.
	Understanding Mobility Patterns and Decision-making Using an Integrated, Multi-Modal Sensing Platform in a Quantified Community NYU	Researchers have completed data collection and cleaning as well as initial modeling and data analysis, including constructing trajectory models from an urban testbed in New York City.
	Emerging Leaders in Transportation NYU	The program, which develops early-career transportation professionals to promote innovation within their organizations, was held in December 2017, and several participants have implemented ideas conceived during the program in their workplaces.
	Integrated Analytics and Visualization for Multi-Modality Transportation Data NYU	This project aims to develop a pedestrian dynamics model using a data-driven approach. It will involve building a database of images, extracting pedestrian data using deep learning techniques, and developing analytics and visualization tools. This project's start was delayed (see Section V) but is now underway.
Resilient, Secure, and Smart Transportation Infrastructure	**A Trusted Data Platform for Transportation Data Sharing** NYU	Data platforms for the New York metro area, El Paso, Seattle and Newark were created and are now operational.
	Designing & Managing Infrastructure for Shared Connected Electric Vehicles UW	Researchers have acquired data from BMW ReachNow and have begun testing machine learning techniques for modeling destination choices and are acquiring data to begin modeling dwell times.
	Monitoring and Control of Overweight Trucks for Smart Mobility and Safety of Freight Operations Rutgers	The team is working with NYCDOT on field implementation of a WIM system at a site in New York City.

For C2SMART's 2nd year funded projects, a competitive peer-review process described in the original proposal was utilized to ensure only high-quality projects that fit the center's goals and objectives were being funded by the Center. The following competitive RFP and peer-review evaluation process was utilized to help meet this goal:

- A Request for Proposals was put out in November 2017 to solicit proposals from PIs at member institutions for projects that conform with the center's research priorities.
- Institutional coordinators worked with the PIs at their institutions to find synergies between ideas and build teams to request funding within established parameters but without overlapping ideas.
- Received proposals were reviewed by 2-3 external reviewers aligned with their area of expertise.
- Reviewer comments and center feedback were provided to the proposers to improve proposals. Modified proposals were resubmitted and final awards were made beginning in March 2018.

A summary of Year 2 awarded projects and their goals is provided below:

Urban Mobility and Connected Citizens	**Integrative Vehicle Infrastructure Traffic System (iVITS) Control in Connected Cities** CCNY, NYU	This project is a Year 2 continuation to build out a testbed framework to test traffic control. Ongoing work will include the development of a third site model and calibration of the network.
	Dual Rebalancing Strategies for Electric Vehicle Car-sharing Operations NYU Abu Dhabi, NYU	This project will investigate the effectiveness of new rebalancing strategies being developed based on queueing networks for test cases from BMW ReachNow and construct a model of a car-sharing scenario in NYC with the proposed strategies.
	Integrative Vehicle-Traffic Control in Connected/Automated Cities UW	This project aims to investigate key issues for integrative vehicle traffic control (iVTC), in which both individual vehicle characteristics and signal timing are controlled to maximize safety, mobility, and energy efficiency in connected/autonomous vehicle environments.
Urban Analytics for Smart Cities	**Development of an Open-Source Multi-Agent Virtual Simulation Testbed for Evaluating Emerging Transportation Technologies and Policies** NYU	This project will develop and calibrate a virtual testbed that can be used to evaluate new technologies and policies on transportation systems. It will provide resources and a virtual framework that can help fill the gap between basic research and field deployment for public sector decision-makers.
	Emerging Leaders in Transportation / The Future of Mobility Workshop Series NYU	The Emerging Leaders in Transportation program develops early-career transportation professionals to develop and promote innovations within their organizations. The Future of Mobility is a series of three workshops about timely issues in transportation: 1) Autonomous, Shared and Electric Revolutions in New York City; 2) Women's Challenges in Transportation; and 3) Startup Showcase.
	An Artificial Intelligence Platform for Network-wide Congestion Detection and Prediction using Multi-source Data UW	This research aims to extend the functions of DRIVE Net (Digital Roadway Interactive Visualization and Evaluation Network) to develop an artificial intelligence platform for network-wide congestion detection and prediction using multi-source data. The platform is redesigned with new models that can support network-wide analysis to identify solutions for traffic congestion.
Resilient, Secure, and Smart Transportation Infrastructure	**A Multi-Stakeholder Approach to Developing Effective Policies to Reduce the Impact Costs of Overweight Vehicles on Roads and Bridges** NYU, Rutgers	This project will combine the results of modeling transportation infrastructure deterioration related to overweight trucks with economic approaches to estimate the contribution of these vehicles to maintenance costs. It will engage multiple stakeholders to provide viable strategies that can inform policy formation.
	Development of Advanced Weigh-In-Motion (A-WIM) System for Effective Enforcement of Overweight Trucks to Reduce their Socioeconomic Impact on Major Highways Rutgers	This project will implement an advanced weigh-in-motion (A-WIM) system with high accuracy and will investigate the feasibility of using such technology in the U.S. to assist enforcement officials on highways without interrupting the traffic flow.
	Automated Truck Lanes in Urban Areas for Through and Cross Border Traffic UTEP	This project proposes to develop and demonstrate, through microscopic traffic simulations, the concept of operations of autonomous truck lanes along interstate freeways. The ultimate goal is to recommend vehicle management, infrastructure design and policy guidelines for state and local agencies.

2.2 Matching Projects Supporting C2SMART Goals

The following projects are funded by public agencies and are used as matching funds for C2SMART. 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 up larger, more impactful efforts that have direct end-user benefits for state and local agencies as well as other users.

Urban Mobility and Connected Citizens	NYC Connected Vehicle Deployment & Mobile Accessible Pedestrian Signal System Application	NYCDOT/NYSDOT
	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	NYCDOT/NYSDOT
Urban Analytics for Smart Cities	Portable and Integrated Multi-Sensor System for Data-Driven Performance Evaluation of Urban Transportation Networks	USDOT/UTC program
	Calibration/Development of Safety Performance Function for New Jersey	NJDOT
Resilient, Secure, and Smart Transportation Infrastructure	Research on Concrete Applications for Sustainable Transportation: Life Cycle Cost Analysis	USDOT/UTC program
	Bridge Resource Program	NJDOT
	Technical Support Services for the Maintenance Department	NJ Turnpike Authority

2.3 Research Awards and Recognition

C2SMART members received several accolades from the research community for their recent research. These awards included:

- The 2017 Franz Edelman Finalist Award for Achievement in Operations Research and Management Science, for which Director Kaan Ozbay was a recipient for his work on the "Off-Hours Delivery Project in New York City". The Franz Edelman Award is one of the most prestigious awards given by the Operations Research Society, INFORMS.
- The New Faculty Award, presented to Deputy Director Joseph Chow by the Council of University Transportation Centers. The award is given to a tenure-track faculty member who demonstrates excellence in classroom teaching and makes important contributions to research in the transportation field.
- The CUTC Milton Pikarsky Memorial Award, awarded for an exceptional doctoral dissertation, which Dr. Ozbay's former Ph.D. student Kun Xie received for his dissertation, titled "New Opportunities in Urban Safety Analytics Using Advanced Quantitative Methods and Big Data."
- The 2017 IEEE ITSC Best Dissertation Award – Second Prize, which Kun Xie also received.
- The Best Presentation/Paper Award at the International Conference on Intelligent Traffic and Transportation, awarded to Ph.D. student Abdullah Kurkcu and Dr. Ozbay for their paper: A Hierarchical Clustering Based Travel Time Estimation Model in a Connected Vehicle Environment, (2017) International Conference on Intelligent Traffic and Transportation (ICITT), Zurich, Switzerland, September 1-3.

3. Education

C2SMART is involved in supporting a variety of educational initiatives aimed at preparing current and potential future members of the transportation workforce to deal with new and emerging mobility problems. These efforts include:

Vertically Integrated Projects – This program provides a multi-year, multidisciplinary approach to learning that emphasizes project-based, innovative, research-active education. Professor Bringardner leads the Smart Cities VIP, in which research teams design and prototype technological innovations to address the needs of smart cities. The team is currently collaborating with graduate students at C2SMART on a research project with NEXT Future Transportation. The VIP team is building scale models of the company's autonomous pods, and center graduate students are designing en-route transfer algorithms and creating a simulation model to evaluate the performance of autonomous vehicle fleets operating with en-route transfer technology.

Institute of Transportation Engineers (ITE) and Intelligent Transportation Society (ITS) student chapters - Several C2SMART-funded graduate students have leadership roles in these student-run organizations, and the center provides support for their activities. The ITS student chapter at NYU was revived during the previous academic semester with the support of the Center, with the mission of drawing more students across different disciplines into transportation. A Women in Transportation panel hosted by NYU-ITS was held at C2SMART on March 22, 2018.

Applied Research Innovations in Science and Engineering (ARISE) – This full-time, seven-week program is for academically strong, current 10th and 11th grade New York City students with a demonstrated interest in science, technology, engineering and math. 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. C2SMART will host 4 high school students through this program during summer 2018. The students will work on Center research under the direction of faculty and full-time graduate students.

NSF International Research Experience for Students on Smart Cities – This program for graduate students is being coordinated by UTEP in collaboration with the University of Guadalajara. (See section III)

UTEP-Czech Technical University Dual Master's Degree – This international dual degree program will begin in fall 2018, with faculty at both universities co-teaching smart cities courses. (See section III)

NYU Master's in Transportation Planning and Engineering Program Redevelopment - C2SMART faculty at NYU are in the process of updating the current Master's program curriculum to be more in line with the requirements of partnering state agencies.

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 results have also been disseminated through journal papers, presentations, and meetings between the center's principal investigators and agency or industry partners and stakeholders. C2SMART also makes an effort to engage non-technical audiences and enhance public understanding of current developments in the transportation industry through media outreach.

During this reporting period, a **Distinguished Speaker Series** was launched where experts were invited to give talks on emerging research areas and to interact with center students and staff. A YouTube channel was also launched to enable broadcasting of the seminars and other events to wider audiences.

Highlights of the center's recent dissemination efforts include:

Conference Presentations

- The 2018 Annual Meeting of the Transportation Research Board in January 2018, at which C2SMART presented 19 posters, gave 6 presentations and participated in a reception sponsored by the NYU Tandon School of Engineering that provided a venue for students and faculty from across the consortium to gather and discuss emerging issues with other interested researchers.
- Research presentations by the Rutgers team at several conferences, including the American Concrete Institute Conventions and the International Conference on Experimental Vibration Analysis for Civil Engineering Structures.
- A presentation by the team led by PI Bill Raisch (NYU) on its situational awareness platforms and related work on resilience networks at the Continuity Insights Conference in New York City.
- A presentation on research done in collaboration with 6-t by PI Sarah Kaufman at Paris City Hall.
- A presentation by PI Joseph Chow on urban freight systems analysis at Chung-An University in Seoul, South Korea, as well as a presentation at the University of Minnesota on models to operate and evaluate mobility-as-a-service.
- A panel entitled “Planes, Trains and Automobiles” at the AI World Forum in Toronto in Nov. 2017, which PI Sarah Kaufman participated in.

Research Showcases

- NYU Faculty Urban Research Day in March 2018, an event designed to convene faculty from across NYU to present summaries of their urban-focused research to share knowledge and increase collaboration. C2SMART Director Dr. Kaan Ozbay as well as three of the center’s doctoral students presented research at the event.
- Presentations at the NJDOT Showcase, a forum where University research partners and their associates share the research and technology transfer activities being conducted in various sponsored projects. Rutgers researchers presented three topics: Damage cost of overweight truck on highway infrastructure in NJ; New MASH-4 design and full-scale crash testing of historical Pulaski Skyway barrier; and Performance of FR-SCC as repair material for infrastructure applications.

Workshops

- A workshop on the energy impact of connected autonomous vehicles at TRB organized by PI Don MacKenzie of UW. PI MacKenzie is also on the organizing committee for the 2018 Automated Vehicles Symposium.
- The UW team also hosted a Connected Vehicle planning workshop session in collaboration with PacTrans regional UTC.
- The Rutgers team organized a workshop for transportation agency personnel to demonstrate the web-based applications developed to help agency personnel with specific issues.

Industry and Public Agency Outreach

- Transportation Camp NYC, a user-driven event that brought together a range of stakeholders in mobility to foster conversation and collaboration, which C2SMART hosted at NYU in October 2017.
- Meetings of the Advisory Committee for PI Sarah Kaufman’s (NYU) project on freight mobility, which includes public and private transportation stakeholders, during which research findings and recommendations were reviewed.

- Meetings between PI Don MacKenzie of UW and staff from industry partner ReachNow and researchers at Idaho National Lab to discuss progress on research on shared electric vehicle systems.
- Presentations by the UW team to DiDi Chuxing at their headquarters in Beijing about mobile sensing-based urban traffic modeling. The team also submitted a proposal in response to DiDi's research proposal solicitation on using mobile data for traffic signal control.
- A monthly web forum and annual meeting hosted by the Metropolitan Resilience Network at which PI Bill Raisch disseminated information on his team's situational awareness platform and related work. The events attract participants from the private and public sectors, NGOs and academia, including emergency management, risk management, business continuity and resilience professionals.
- Once-a-month meetings between the smart cities faculty group at UTEP and El Paso city staff. Each of these meetings was attended by 15-20 city staff and 7-10 UTEP faculty members.
- Meetings with the team at UW and staff and engineers from Washington State DOT and the Puget Sound Regional Council to discuss their research.

Seminars

- The Rutgers team hosted a seminar at NJDOT on engineering ethics and automated vehicles, which more than 40 engineers attended.
- The recently launched **Distinguished Speaker Series** brought the following experts to the center to give talks to students, staff, and the wider center community. So far, this series has included:
    - Dr. Hani Nassif, professor and director of Rutgers Infrastructure Monitoring and Evaluation (RIME) Group. "The Past, Present, and Future of Structural Health Monitoring (SHM) of Civil Infrastructure." Dec. 2017
    - Dr. Satish V. Ukkusuri, professor and director at the Lyles School of Civil Engineering at Purdue University. "Convergence of Networks, Smarter (Autonomous) Transportation Technologies and Big Data: Recent Advances." Feb. 2018
    - Evangelos Simoudis, founder and managing director of Synapse Partners. "Exploring A New Value Chain for Fleet-Based On-Demand Mobility." March 2018

Media and Public Outreach

- A poster has been designed to promote UTEP's senior mobility app, which will be printed and distributed across City of El Paso facilities. A researcher from the UTEP team also appeared on a segment on a local television show to talk about the app.
- C2SMART published a press release about its partnership with NEXT Future Transportation, which garnered attention from several media outlets and led to an upcoming interview with PI Joseph Chow (NYU) on PBS' SciTech Now.
- Director Kaan Ozbay was interviewed about autonomous vehicles by an editor from the German public broadcaster Hessischer Rundfunk as research for a report for the American Council on Germany and a documentary for the German-French public TV network ARTE.
- PI Sarah Kaufman wrote an op-ed for the New York Daily News advocating for the legalization of e-bikes in New York City.
- Deputy Director Joseph Chow was interviewed for an article in MIT Technology Review.
- Director Kaan Ozbay was interviewed for an article in Connected World magazine.

D. Plans for Next Reporting Period

C2SMART has a range of plans to grow in pursuit of our mission during the next reporting period. We are continuing to expand our network of partners to cover all aspects of mobility challenges and technological advances. The center continues to enter into MOUs (listed in Section III) to share data and algorithmic developments with collaborators and will continue to expand as our research reaches maturity. We also plan to complete development of a New York City simulation testbed framework and expand the model to other cities, in keeping with C2SMART's mission to build a comprehensive living laboratory that provides a means to field test novel transportation solutions.

We have several planned upcoming outreach efforts, including:

- A Future of Mobility Workshop series, to include a panel on autonomous, shared and electric mobility and a panel on women's challenges in transportation.
- A follow-up to the Emerging Leaders in Transportation workshop, to be held in conjunction with Ford Smart Mobility and hosted at the Ford Mobility Hub in May 2018.
- Further events in our Distinguished Speaker Series, including:
    - Justin Schorr, collision reconstruction engineer at DJS Associates. "Ambivalent Automation."
    - Saad Shaikh, general manager at Chariot. "An overview of Chariot and the future of urban mobility."
    - Giancarlo Fortino, Professor of computer engineering at the University of Calabria. "Agents meet the IoT: Towards Cognitive and Interoperable Ecosystems of Networked Smart Objects."
    - Zdeněk P. Bažant, a distinguished professor in concrete mechanics from Northwestern University, to be hosted by Rutgers and broadcast to other centers.
- A multi-day workshop on transportation engineering fundamentals that will be held for city and state DOT staff with the goal of introducing them to emerging concepts in transportation.
- A summit for those engaged with CV/AV implementation issues that extend beyond transportation and planning to areas such as economics, finance, and insurance.

We aim to grow our educational initiatives, including launching a cross-institution VIP challenge, in which student teams from different consortium member universities will collaborate/compete on research challenges. To begin, we will run a joint program between NYU and University of Washington, where students will work on different aspects of one problem that center is tackling. We are also examining a potential extension of the VIP program with other institutions and internationally.

II. Products

A. Publications

C2SMART collaborators authored or co-authored over 40 papers during the reporting period that were presented at conferences or published in journals. They are highlighted below, grouped according to the Center's primary research areas:

1. Journal Publications

Urban Mobility and Connected Citizens

- Allahviranloo, M., Chow, J.Y.J., A fractionally owned autonomous vehicle fleet sizing problem with time slot demand substitution effects, 2018, journal article, under review, yes.
- Dilip, D., Jabari, S.E., and Lin, D. (2018). A random fields approach for learning traffic flow dynamics. Under review.
- Gao, W., Jiang, Z., Ozbay, K. (2017). Data-driven Adaptive Control of Connected Vehicles. IEEE Transactions on Intelligent Transportation Systems, Volume 18, Issue 5, pp.1122-1133. DOI: 10.1109/TITS.2016.2597279
- Kachroo, P., Agarwal, S., Piccoli, B., and Ozbay, K., (2017) "Multi-scale Modeling and Control Architecture for V2X Enabled Traffic Streams," IEEE Transactions on Vehicular Technology, Volume 66, Issue 6, 2017, pp 4616-4626.
- Kurkcu, A. & Ozbay, K., (2017) "Estimating Pedestrian Densities, Wait Times, and Flows with Wi-Fi and Bluetooth Sensors", Transportation Research Record: Journal of the Transportation Research Board, 2644, 77-82. http://dx.doi.org/10.3141/2644-09
- Liu, X., Chow, J.Y.J., Li, S., Online monitoring of taxi travel momentum and congestion effects using projections of taxi GPS-based vector fields, 2018, under review, yes.
- Nourinejad, M., Gandomi, A., Chow, J. Y. J., Roorda, M. J., Optimal discount policies for transit agencies: the case of pass programs and loyalty programs, 2018, under review, yes.
- Sayarshad, H.R., Chow, J.Y.J., Non-myopic relocation of idle mobility-on-demand vehicles as a dynamic location-allocation-queueing problem. Transportation Research Part E 106, 60-77, 2017, published, yes.
- Vechione, M., Mercado, M., Balal, E. and Cheu, R. L. (2018). "Comparisons of discretionary lane changing behavior." Accepted by ITE Journal. To appear in June 2018 issue.
- Yang, D., Ozbay, K., Ban, X., (2017) "Developments in connected and automated vehicles", Journal of Intelligent Transportation Systems, Volume 21, Issue 4. 251-254.

Urban Analytics for Smart Cities

- Bartin, B., Ozbay, K., Maggio, M., Wang, H., (2017) "Work Zone Coordination Software Tool", Transportation Research Record: Journal of the Transportation Research Board, 2617, 60-70. https://doi.org/10.3141/2617-08
- Holguín-Veras, J., Hodge, S., Wojtowicz, J., Singh, C., Wang, C., Jaller, M., Aros-Vera, F., Ozbay, K., Weeks, A., Replogle, M., Ukegbu, C., Ban, J., Brom, M., Campbell, S., Sánchez-Díaz, I.D., González-Calderón, C., Kornhauser, A., Simon, M., McSherry, S., Rahman, A., Encarnación, T., Yang, X., Ramírez-Ríos, D., Kalahashti, L., Amaya, J., Allen, M.S., Allen, B., Cruz, B., (2018) "The New York City Off-Hour Delivery Program: A Business and Community-Friendly Sustainability Program", Interfaces, 48(1) pp.70-86. https://doi.org/10.1287/inte.2017.0929
- Kachroo, P., Gupta, S., Agarwal, S., and Ozbay, K., (2017) "Optimal Control for Congestion Pricing: Theory, Simulation and Evaluation," IEEE Transactions on ITS, Volume 18, issue 5, pp 1234-1240. DOI: 10.1109/TITS.2016.2601245
- Xie, K., Ozbay, K., Zhu, Y. Demiroluk, S., Nassif, H., (2017) "Modeling Salt Usage During Snowstorms: Application of Hierarchical Linear Models with Varying Dispersion" Transportation Research Record: Journal of the Transportation Research Board, 2643, 55-64. https://doi.org/10.3141/2643-07
- Xie K., Ozbay, K., Kurkcu, A. and Yang, H., (2017) Analysis of Traffic Crashes Involving Pedestrians Using Big Data: Investigation of Contributing Factors and Identification of Hotspots. Risk Analysis 37(8): 1459-1476. http://dx.doi.org/10.1111/risa.12785.
- Zheng, F., Jabari, S.E., Liu, H., and Lin, D. (2018). Traffic state estimation using stochastic Lagrangian dynamics. Under review.

Resilient, Secure, and Smart Transportation Infrastructure

- Abdulhameed, H., Nassif, H., and Khayat, K. (2018) "Use of Fiber-Reinforced Self-Consolidating Concrete to Enhance Serviceability Performance of Damaged Beams," Transportation Research Record: Journal of the Transportation Research Board (TRB), (Accepted).
- Demiroluk, S., Ozbay, K., Nassif, H., (2018) "Mapping of Truck Traffic in New Jersey Using Weigh-In-Motion (WIM) Data," Journal of IET Intelligent Transport Systems (Accepted).
- Lou, P., Nassif, H., and Truban, P. (2018) "Development of Live Load Model for AASHTO Strength II Limit State," Transportation Research Record: Journal of the Transportation Research Board (TRB), Structures, TRB of the National Academies, Washington, D.C., (Accepted).
- Raisch, B. and Restrepo, C. (March 2018). "The Metropolitan Resilience Network: A Cutting Edge Approach to Regional Situational Awareness and Collaboration at the Port Authority of New York and New Jersey Office of Emergency Management," International Association of Emergency Managers, IAEM Bulletin, pp. 19-22.
- Su, D., Nassif, H., and Xia, Y. (2018) "Optimization of Deck Construction Staging for Multiple-Span Continuous Steel Girder Bridge," American Society of Civil Engineers (ASCE) Journal of Performance of Constructed Facilities, Volume 32, Issue 1, February.
- Xie, K., Ozbay K., Zhu, Y., and Yang, H,. (2017) Evacuation zone modeling under climate change: A data-driven method. Journal of Infrastructure Systems 23(4): 1-9. http://dx.doi.org/10.1061/(ASCE)IS.1943-555X.0000369.

- Zhu, Y. Xie, K.,Ozbay, K., Zhu, F., Yang, H., (2017) "Data-Driven Spatial Modeling for Quantifying Network-wide Resilience in the Aftermath of Hurricanes Irene and Sandy", Transportation Research Record: Journal of the Transportation Research Board, 2604, 9-18. http://dx.doi.org/10.3141/2604-02

2. Conference Papers

Urban Mobility and Connected Citizens

- Cheu, R. L., Villanueva-Rosales, N., Nunez-Mchiri, G. G., Vechione, M., Vargas Acosta, R. A., Marrufo, C., Jimenez, Gurbuz, O. (2018). "Taking smart mobility to seniors: challenges and solutions in the El Paso Region." The 4th IEEE International Smart Cities Conference (ISC2), Sept. 16-19, 2018, Kansas City.
- Dilip, D. and Jabari, S.E. (2018). "Vehicle trajectory reconstruction using conditional random fields." No. 18-03053. The 97th Annual Meeting of the Transportation Research Board, Washington D.C.
- Gao, W., Jiang, Z., Ozbay, K., Gao, J., (2018) "Data-driven Cooperative Adaptive Cruise Control of Buses on the Exclusive Bus Lane of the Lincoln Tunnel Corridor", 97th Transportation Research Board (Committee AHB15: Advances in Intelligent Connected and Automated Transportation Systems), National Academies, Washington, D.C.
- Jabari, S.E., Zheng, F., Liu, H., and Filipovska, M. (2018). "Stochastic Lagrangian modeling of traffic dynamics." No. 18-04170. The 97th Annual Meeting of the Transportation Research Board, Washington D.C.
- Kurkcu, A., Ozbay, K., (2018) "Analytical Modeling of Information Dissipation in Urban Arterials with Connected Vehicles", 97th Transportation Research Board (Committee AHB15: Advances in Intelligent Connected and Automated Transportation Systems), National Academies, Washington, D.C.
- Ortega, A., Vechione, M., Jimenez, M. G., Martinez, J., Villanueva, N., and Cheu, R. (2017). "Smart mobility for seniors." The 29th Annual HENAAC Conference, Oct. 18-20, Pasadena, California.
- Vechione, M., Balal, E. and Cheu, R. L. (2018). "Comparisons of mandatory and discretionary lane changing behavior on freeways." Presented at The 97th Annual Meeting of the Transportation Research Board, January 7-11, 2018, Washington D.C.

Urban Analytics for Smart Cities

- Gao, J., Xie, K., Ozbay K., (2018) "Exploring the Spatial Dependence and Selection Bias of Double Parking Citations Data", 97th Transportation Research Board (Committee ABJ30: Innovations in Urban Data and Mobility Modeling), National Academies, Washington, D.C.
- Gao, J. (2018) "A Data-Driven and Integrated Evaluation of Area-Wide Impacts of Double Parking Using Macroscopic and Microscopic Models," NYU Tandon Urban Research Day, March 2018.
- Kurkcu, A., Miranda, F., Ozbay, K., Silva, C., (2017) "Data Visualization Tool for Monitoring Transit Operation and Performance", 5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems, Napoli, Italy, June 25-28. http://www.mt-its2017.org/
- Kurkcu, A. and Ozbay, K., (2017) "Investigating Transit Passenger Arrivals using Wi-Fi and Bluetooth Sensors", 12th European ITS Conference, Strasbourg, France, June 19-22.
- Kurkcu, A. (2018) "Big Data Applications in Transportation," NYU Tandon Urban Research Day, March 2018.
- Xie, K. and Ozbay, K., (2017) "Traffic Safety Performance Monitoring Using Hidden Markov Models", 12th European ITS Conference, Strasbourg, France, June 19-22.
- Xie, K., Ozbay, K., Yang, K., Xu, C., Yang, H., (2018) "Modeling Bicycle Crash Costs Using A Grid-Cell-Based Random Parameters Tobit Model", 97th Transportation Research Board (Committee ANF20: Advances in Intelligent Connected and Automated Transportation Systems), National Academies, Washington, D.C.
- Yang, H., Wang, Z., Ozbay, K., Xie, K., Zhu, Y., (2018), "An Improved Methodological Framework based on Probe Vehicle Data for Detecting Secondary Crashes", 97th Transportation Research Board (Committee ANB20: Cycling Safety and Comfort), National Academies, Washington, D.C.
- Zhu, Y. "Hurricane Evacuation Modeling Using Behavior Models and Scenario-Driven Agent-Based Simulations," NYU Tandon Urrban Research Day, March 2018.
- Zuo, F., Kurkcu, A., Ozbay, K., Gao, J., (2018) Crowdsourcing Incident Information for Emergency Response Using Open Data Sources In Smart Cities"' 97th Transportation Research Board (Committee ABE20: Transportation Economics), National Academies, Washington, D.C.

Resilient, Secure, and Smart Transportation Infrastructure

- Gao, J., Ozbay, K., Zuo, F., Kurkcu. A. (2018), "A Life Cycle Cost Analysis Approach for Emerging Intelligent Transportation Systems with Connected and Autonomous Vehicles", 97th Transportation Research Board (Committee ABE20: Transportation Economics), National Academies, Washington, D.C.
- Nassif, H., Na, C., Portela, E., and Bittencourt, T. (2018) "An Approach to Minimize Weighing Error of WIM System Based on Ambient Temperature" Transportation Research Board 97th Annual Meeting, TRB18-05034

3. Presentations

The following presentations were also made by center personnel at events or conferences:

- Abdulhameed, H., Nassif, H., and Khayat, K. Use of Fiber-Reinforced Self-Consolidating Concrete to Enhance Serviceability Performance of Damaged Beams/TRB 18-05860
- Chow, J. "A longitudinal study of bike infrastructure impact on bike-share system performance"/TRB Jan. 2018
- Chow, J. "Route-cost-assignment with joint user and operator behavior as a many-to-one stable matching assignment game/TRB Jan. 2018 and INFORMS Oct. 2017
- Chow, J. "A privacy design problem for sharing transport service tour data"/IEEE ITS Conference, Oct. 2017
- Chow, J. "Real Options Switching Strategies in Dynamic Transport Service Operations"/INFORMS 2017, Oct. 2017
- Chow, J. "An algorithm for preserving the privacy of sharing transport service route data"/INFORMS 2017, Oct. 2017
- Chow, J. "Pass programs and loyalty programs for transit agencies"/INFORMS 2017, Oct. 2017 and TSL Conference 2017
- Kurkcu, A., Ozbay K., (2017), A Hierarchical Clustering Based Travel Time Estimation Model in a Connected Vehicle Environment, International Conference on Intelligent Traffic and Transportation (ICITT), Zurich, Switzerland September 1-3, Best Presentation/Paper Award. (Presented by Kurkcu, A.)
- Kurkcu, A., Zuo, F., Jingqin Gao, Ozbay K., (2017), Simulation Based Quantification of the Potential Impacts of Incidents on Connected Vehicle Applications, INFORMS Transportation and Logistics Society First Triennial Conference Loyola University Chicago, USA, July 26-29. (Presented by Kurkcu, A.)
- Lou, P., Nassif, H., and Truban, P. Development of Live Load Model for Strength II Limit State in AASHTO LRFD Design Specifications/TRB18-00129
- Nassif, H. and Abu-Obeidah, A., Comparison of Model Predictions for SCC with and without Fibers/ACI Spring 2018
- Nassif, H., Na, C., Portela, E. and Bittencourt, T. An Approach to Minimize Weighing Error of WIM System Based on Ambient Temperature/TRB18-05034
- Ozbay, K. The use of big data for the probabilistic modeling of city-wide evacuations due to natural disasters. NYU Tandon Urban Research Day, March 2018.
- Raisch, W. Resilience Networks & Real-Time Situational Awareness: Vital to essential operations and supply chains from blue skies to black/Continuity Insights Conference, October 2017

4. One-Time Publications

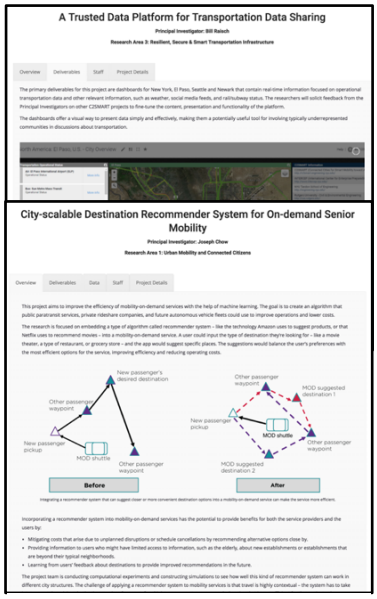
- J. Chow, "Informed Urban Transportation Systems: Classic and Emerging Mobility Methods Toward Smart Cities". 2018, Elsevier. Book.

B. Websites

The C2SMART website (c2smart.engineering.nyu.edu) has undergone significant development, including a new Mission page, increased coverage of C2SMART events, and expansion of the research section. C2SMART has also established a Youtube channel to broadcast seminars and disseminate information about the Center's projects and other activities.

Development of the C2SMART website involves expanding the information available about the center's research projects, including a full overview of the project and its goals, planned deliverables, staff, data, etc. As more projects conclude, this will include making final reports, data, and other relevant materials and deliverables available for download through the individual project webpages.

The Sustainable Transportation Lab website is used to disseminate information about research at PI Don MacKenzie's lab at the University of Washington, including C2SMART-funded work on shared electric vehicle systems. The Rudin Center website disseminates information about research and workforce development by PI Sarah Kaufman, including the Emerging Leaders in Transportation program.



Project Webpage Samples

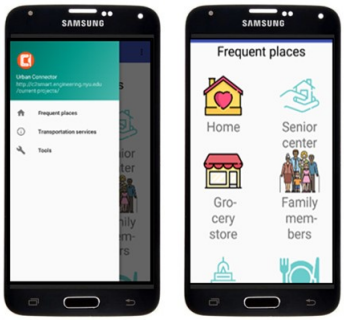
C. Technologies

Weigh-in-Motion (WIM) Technology – C2SMART researchers at Rutgers developed a procedure to minimize the weighing error in WIM systems when using polymer piezoelectric sensors, which are susceptible to temperature. The error-correction procedure considers the ambient temperatures, which can be obtained from weather stations located in proximity to the WIM sensors. The procedure improves the accuracy of WIM truck weights and helps provide a better picture of the actual truck loading on bridges and road pavements.

D. Other Products

Data Platforms for Transportation Data Sharing - The dashboards, designed for information sharing and situational awareness and built for Seattle, El Paso, Newark and New York, display live transportation data flows and other real-time information about the operating environment in each city. The research team for this project conducted presentations and had individual discussions with other C2SMART researchers to introduce them to the platforms and discuss potential additions and future applications for technology.

Urban Connector – This Android-based smartphone application prototype, developed through a C2SMART-funded project at UTEP, is designed to assist seniors with their specific mobility needs and challenges.



Urban Connector App Screenshots

Deterioration Models for Bridge Decks - In collaboration with NYCDOT and based on historic bridge condition data, the Rutgers team is currently developing deterioration models for bridge decks in New York City due to overweight trucks. The deterioration models will be used to estimate the actual service life of the bridges and pavements in NYC under current loading conditions. The models will help determine more appropriate maintenance plans for keeping the infrastructure in good condition.

Prototype Destination Recommender System – The source code for a destination recommender system designed for shared mobility systems has been released as open source software on the BUILT GitHub site.

Multi-Sensor System – Low-cost, portable sensors for data-driven performance evaluation of urban transportation networks were developed. The system includes a network of sensors that can detect particulate matter levels, humidity, and temperature, as well as pedestrian and vehicular traffic. A report on the sensors was produced for NYCDOT.

Simulation-based Testing and Evaluation Platform - C2SMART is in the process of developing an open-source multi-agent virtual simulation test bed for evaluating emerging transportation technologies and policies. Researchers are currently building a platform and architecture using New York City data and have completed an uncalibrated MATSIM model of the city, available through GitHub.

Datasets and other tools – A tool to query from Google Maps API, a tool to monitor real-time bus arrival data, and test data for non-myopic idle vehicle relocation/rebalancing algorithms are all available via GitHub.

Transportation Data-Sharing Platforms

III. Participants and Collaborating Organizations

A. Partner Organizations

During this reporting period, C2SMART has established partnerships with a range of public agencies and private companies. The nature of those partnerships is outlined below:

Organization Name	Location	Contribution		
		Financial Support	In-kind Support	Collaborative Research
NYCDOT	New York City, NY	X		
NYC Mayor's Office of the CTO	New York City, NY			X
NYSDOT	Albany, NY	X		
NJDOT	Newark, NJ	X		
NJ Turnpike Authority	Woodbridge Township, NJ	X		
Washington State DOT	Olympia, WA		X	
Puget Sound Regional Council	Seattle, WA		X	
Port Authority of NYNJ	New York City, NY		X	
City of El Paso	El Paso, TX		X	
Abu Dhabi DOT	Abu Dhabi, UAE		X	
NEXT	Silicon Valley, CA		X	
Bestmile	San Francisco, CA		X	
Parkofon	Alexandria, VA		X	
ReThink Studio	New York City, NY		X	
Via	New York City, NY		X	
Zendrive	San Francisco, CA			X
Nexar	New York City, NY			X
TrafficCast International	Middleton, WI		X	
BMW ReachNow	Seattle, WA		X	
Drive Engineering	Blue Bell, PA			X
Carmera	Brooklyn, NY			X
Ikos Lab	Europe (various)			X
Transpod	Toronto, Canada			X
Foundation for the Future	Brooklyn, NY			X
6-t Bureau de Recherche	Paris, France			X
DiDi Chuxing	Beijing, China			X

B. Other Collaborators or Contacts

Collaborations with other departments and research centers

- Collaboration between the Center for Urban Science and Progress and C2SMART through Professor Ozbay's joint appointment with CUSP and the involvement of Professor Kontokosta in the C2SMART research program through his funded projects.
- A joint effort with the Governance Lab at NYU to study the impact of emerging transportation technologies on women based on a prior Data2x effort.

- A long-term agreement to advise transportation-related companies in the Urban Future Lab incubator at NYU. Deputy Director Joseph Chow also served as a judge for the Smart Mobility category at the lab's Urban Future Competition.

Inter-university collaboration

- Center Director Kaan Ozbay is the co-PI of the NJDOT Bridge Resource Program and is working very closely with its director and center PI, Prof. Hani Nassif of Rutgers University. This joint effort between NYU and Rutgers University will facilitate the implementation of some of C2SMART's research projects in a real-world environment.
- A dual master's degree program on smart cities between UTEP and Czech Technical University, which will begin in fall 2018. Both universities will provide partial scholarships to their own students, and faculty will co-teach two smart cities courses.
- UTEP's collaboration with the University of Guadalajara on:
    - The NSF International Research Experience for Students on Smart Cities. UTEP will send 10 graduate students to the University of Guadalajara for six weeks, during which University of Guadalajara faculty will contribute time to mentor students.
    - A faculty-led study abroad program on smart cities. Both UTEP and University of Guadalajara will recruit a total of 12 students who will study at UTEP for 2 weeks and at the University of Guadalajara for 2 weeks in June-July 2018.

Inter-UTC collaboration

- C2SMART researchers have contributed to projects at the RE-CAST UTC by working with researchers at Rutgers to conduct probabilistic Life Cycle Cost Analysis (LCCA) for both conventional and new construction materials or technologies. The team also developed a user-friendly, web-based LCCA software tool to perform multi-scenario life cycle cost analysis for transportation infrastructure assets.
- C2SMART researchers are working with UTRC Region 2 on research projects such as the CIDNY projects and NYCDOT's Connected Vehicle Pilot program.

IV. Impact

A. Development of the Principal Discipline

PI Joseph Chow's lab has further advanced the study of transportation in several ways using funding from C2SMART. A new algorithm for rebalancing idle vehicles has been proposed and tested. What separates this algorithm from the state-of-the-art is that it is a computationally efficient approach that uses real-time data to anticipate future costs in the rebalancing decision. This has great importance in emerging mobility research, which for the most part is still based on myopic algorithms. It has since been implemented in a subsequent study to optimize ride-hailing service as a last mile option to drop off and pick up passengers from transit stations. Dissemination of the work resulted in interest from BMW ReachNow to test such algorithms on their carsharing operations.

The Rutgers team has made an impact on the field of transportation engineering through their study of truck traffic and weight effects on the roadway network. They have been collecting and processing WIM data to determine truck weight statistics, as well as developing procedures to mitigate inherent errors due to temperature and to identify illegal overweight trucks. The researchers have been evaluating infrastructure damage associated with overweight trucks, the study of which is crucial to understanding

the correlation that may exist between infrastructure damage and vehicular accidents. From a safety perspective, the team has worked to provide advanced cementitious materials for bridge decks to extend the decks' service life. These materials are stronger and more durable, reducing infrastructure maintenance needs and the associated costs.

B. Other Disciplines

Nothing to report at this time.

C. Transportation Workforce Development

C2SMART has supported transportation workforce development by teaching classes, supporting students involved in transportation research projects, providing funding for masters and Ph.D. students, and providing research opportunities for undergraduate students, as demonstrated in our Performance Metrics reports. Our efforts in this area also include:

- Facilitating internships and placements
  - Susan Jia Xu, a Ph.D. student in Deputy Director Joseph Chow's lab, has been accepted to DiDi Chuxing's DiDi-IEEE Joint Graduate Program and is currently working out of the company's Beijing office.
  - Diego Correa, a Ph.D. student in Director Kaan Ozbay's lab, is working at software company AIMSUN on transportation modeling and simulation projects
  - Kun Xie, a former student of Director Kaan Ozbay, has joined the University of Canterbury in New Zealand as a tenure-track faculty member in the Civil and Natural Resources Engineering Department.
  - A former postdoctoral associate under Director Kaan Ozbay, Shaurya Agrawal, has joined California State University, Los Angeles as a tenure-track faculty member in the Electrical and Computer Engineering Department.
- Hosting seminars, conferences and workshops. Highlights include:
  - C2SMART's Distinguished Speaker Series, a seminar series held in C2SMART's lab featuring transportation experts from academia and industry. Four speakers have presented to date, and the seminars have been livestreamed on the center's Youtube channel to allow for remote viewing.
  - The Emerging Leaders in Transportation program, a two-day professional development workshop for early-career transportation professionals. The program has led to the implementation of innovative programs in attendees' workplaces, including a data openness plan by public agency employees.
  - A lecture on engineering ethics and automated vehicles for NJDOT personnel hosted by Rutgers and presented by P.E.-licensed collision reconstruction engineers.
  - A presentation by Dr. Hani Nassif of Rutgers on the new concrete barrier design at a Brown Bag Lunch Session at NJDOT.

Director Kaan Ozbay also served as Chair of the TRB Best Paper Award for the AHB45 Joint Simulation Subcommittee and a member of the TRB Artificial Intelligence and Advanced Computing Applications

Committee. Center Assistant Directors also serve on various high visibility American Concrete Institute and TRB committees.

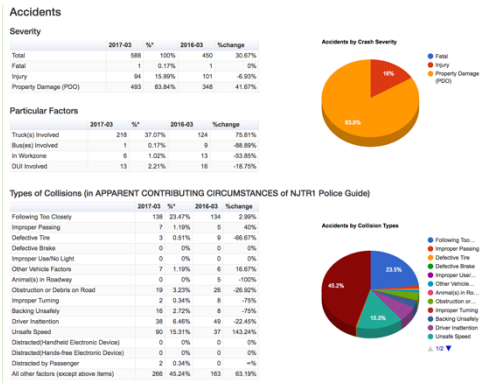
D. Physical, Institutional, and Information Resources

C2SMART is developing a number of informational resources, including:

- Cyber-physical testbeds that will provide a simulation environment for testing models and algorithms for connected vehicles, which can harmonize traffic flow and reduce congestion and vehicular emissions when implemented.
- Data sharing and situational awareness dashboards focused on transportation operations. Created for a Year 1 project, these dashboards will continue to evolve as new applications and opportunities for collaboration with other research emerge.

E. Technology Transfer

NYU researchers developed several tools that have been transferred to and put into use by government agencies including the NJ Turnpike Snow App, which predicts the amount of salt needed for road maintenance when it snows, and a Bus Time Data Platform, used to assemble, process and visualize MTA Bus Time data.

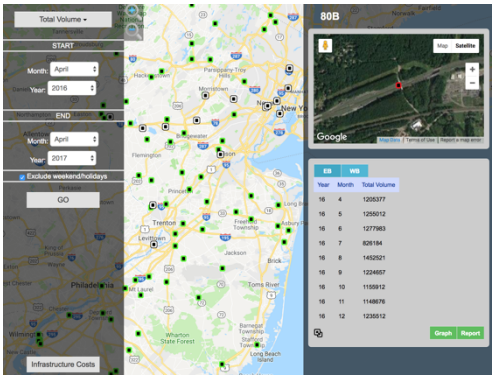


NJTA Safety App

Survey results from the Sustainability of Urban Consumption Practices project were presented at an advisory group meeting, and representatives from the NYC Department of Transportation who attended plan to incorporate these early results into their studies of sustainable freight management. The Rudin Center also co-hosted Accessible Streetscapes with NYCDOT, held in January 2018 and attended by more than 100 transportation professionals and advocates, to educate public employees about improving sidewalk accessibility.

The Rutgers & NYU teams are developing and maintaining multiple web-based apps that help transportation agency personnel with specific issues. The team held a workshop to demonstrate these applications to potential users and continues to update and maintain these apps based on feedback from active users. The apps include:

- NJTA Safety App – roadway safety application
- TRIP – highway asset management application
- AssistME-WIM – application to view NJDOT WIM data and impact of heavy vehicles on roadways



NJDOT AssistME-WIM Application

The Rutgers team proposed a mix design for fiber-reinforced high-performance concrete (FR-HPC) to the New Jersey Turnpike Authority, which accepted the new concrete mix design and implemented it on a major highway in New Jersey. The field implementation provided promising results for minimizing deck cracking,

increasing durability, and extending service life. The agency decided to expand the use of the new material to other bridges owned by the agency.

The Rutgers team also suggested evaluating the damage cost associated with overweight trucks in New York City to NYCDOT. The agency accepted the approach and the team provided preliminary results using limited available data that the service life of bridges in the city is less than 75 years of design life. The agency decided to expand this study to develop deterioration models and evaluate the infrastructure damage cost due to overweight trucks on their bridges. The agency also expressed interest in installing new portable WIM system(s) in the city to establish a larger database for this study.

F. Beyond Science and Technology

Subsequent to the Accessible Streetscapes Summit, NYCDOT will incorporate accessibility measures into their sidewalk and curb programs. Following the publication of an op-ed on the topic and dissemination of the findings of PI Sarah Kaufman's mobility study with 6-t, the agency will also legalize the use of pedal-assist bicycles to assist in deliveries.

C2SMART has also made an impact beyond the engineering and academic worlds by improving public knowledge of new and emerging transportation technologies and urban mobility issues through its non-academic media outreach efforts, which include:

- A segment on UTEP's senior mobility app project featured on a local television show.
- A press release about C2SMART's agreement with NEXT, which was picked up by numerous media outlets.
- An article in *Connected World* magazine on "Realizing the Smart-City Vision," which includes an interview with center director Dr. Kaan Ozbay.
- An op-ed in the *New York Daily News* by Sarah Kaufman in support of legalizing e-bikes in New York City.

V. Changes/Problems

Several projects were delayed as the center was starting up. These projects were given no-cost extensions and are expected to be completed within the next reporting period.

The Kavli HUMAN project was cancelled due to issues with the larger funding of the program and human subjects experimentation approval. As part of the Center proposal, funding was expected to be allocated for a matching project of the HUMAN project's efforts to study people over a long time period, specifically their transportation usage and behavior changes. However, due to the cancellation of the larger effort, this project was not possible. The unused funds will be repurposed for a new research project.

The Year 1 project, "Integrated analytics and visualization for multi-modality transportation data," led by Claudio Silva of NYU, was delayed by one year due to issues with resource availability to do the research. It officially commenced on March 1, 2018.