

# SEMI-ANNUAL PROGRESS REPORT

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## Table of Contents

<b>I. Accomplishments</b>	<b>3</b>
<b>A. Goals and Objectives</b>	<b>3</b>
<b>B. Accomplishments of Goals and Objectives</b>	<b>3</b>
1. Center Administration	3
2. Research	3
3. Education	5
<b>C. Training and Professional Development</b>	<b>5</b>
<b>D. Dissemination and Outreach</b>	<b>6</b>
1. Conferences, Symposia, and Workshops	6
2. Industry and Public Agency Outreach	7
3. Media Coverage and Public Understanding	8
<b>II. Participants and Collaborating Organizations</b>	<b>9</b>
<b>A. Partner Organizations</b>	<b>9</b>
<b>B. Other Collaborators or Contacts</b>	<b>10</b>
1. Collaborations within the Consortium	10
2. Collaborations outside the Consortium	10
3. International Collaborations	11
<b>III. Outputs</b>	<b>11</b>
<b>A. Publications, Conference Papers, and Presentations</b>	<b>11</b>
1. List of Journal Publications	11
2. List of Conference Papers	12
3. List of Presentations	13
<b>B. Policy Papers</b>	<b>15</b>
<b>C. Websites and other Internet Sites</b>	<b>15</b>
<b>D. New Methodologies, Technologies or Techniques</b>	<b>16</b>
<b>E. Inventions, Patents, and Licenses</b>	<b>16</b>
<b>F. Other Products</b>	<b>16</b>
<b>IV. Outcomes</b>	<b>17</b>
<b>A. Increased Understanding and Awareness of Transportation Issues</b>	<b>17</b>
<b>B. New Policies, Regulation, Rulemaking, or Legislation</b>	<b>17</b>
<b>C. Increases in the Body of Knowledge</b>	<b>17</b>
<b>D. Improved Processes, Technologies, Techniques and Skills in Addressing Transportation Issues</b>	<b>18</b>
<b>E. Enlargement of the Pool of Trained Transportation Professionals</b>	<b>18</b>
<b>F. Adoption of New Technologies, Techniques, or Practices</b>	<b>19</b>
<b>V. Impacts</b>	<b>19</b>
<b>A. Effectiveness of the Transportation System</b>	<b>19</b>
<b>B. Technology Transfer – New Practices or Companies</b>	<b>20</b>
<b>C. Increase in the Body of Scientific Knowledge</b>	<b>20</b>
<b>D. Transportation Workforce Development</b>	<b>20</b>
<b>VI. Changes/Problems</b>	<b>20</b>

## I. Accomplishments

### A. Goals and Objectives

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

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

### B. Accomplishments of Goals and Objectives

#### 1. Center Administration

Year 2 funding was authorized by US DOT and the Center subsequently released a Request for Proposals (RFP) to its university consortium partners' faculty in June 2024. The RFP called for projects/initiatives within the Center's overarching theme of Reducing Congestion. Proposals were called for in three tracks: *Track 1: Research Projects Aimed at Reducing Congestion*, *Track 2: Education or Development Program Filling a Gap in Transportation Workforce Development*, and *Track 3: Signature Technology Transfer Activities to Address Congestion Reduction and Transportation System Equity*. Research project selection process employed the Center's three-step review of abstract review by the leadership team for relevance to the Center's theme, full proposal submission with at least two external peer reviewers, and revision(s) by the submitters before finalization. In total, 19 projects were selected for funding to begin in Oct 2024.

#### 2. Research

The following projects were completed during this period, with reporting closeout underway:

#### **Building Intersection Digital Twins via GPU-Accelerated Human Regularized Reinforcement Learning**

– The research team successfully completed its goal of building GPU-accelerated driving simulators. The simulator has been open-sourced, two conference papers submitted, and agents designed up to the intended quality, i.e., their ability to drive long distances without a collision. The team achieved a closed-loop goal rate of 95%, which exceeds the performance of supervised learning methods.

**Control of CAVs for Congestion Reduction in Mixed Traffic: A Learning-Based Approach** – The team developed an autonomous lane-changing control framework that considers safety in mixed traffic scenarios. The team used a small-scale vehicle equipped with GPS, IMUs, and cameras for testing, and results showed smoother and more consistent lane-changing behavior compared to traditional methods.

**Multi-Modal Tripchain Planner for Disadvantaged Travelers to Incentivize Transit Usage** – The team succeeded in incorporating various models for wait time and travel time, addressing capacity constraints, and integrating datasets such as GTFS and OSM in the trip planner, into the agent-based mixed logit (AMXL) model for travelers' choice on whether to use microtransit service versus other modes. The team refined the web app interface based on a feedback survey of over 700 residents in NC conducted in Sep. 2024. Choice-based optimization models were developed to support revenue management policies aimed at increasing transit ridership and applied to a case study of Via microtransit in Arlington, TX.

**Sensor Enabled Calibration of VR-Integrated Co-Simulation Platforms** – The team developed a Car Learning to Act (CARLA) / virtual reality (VR)-based co-simulation system that integrates eye-tracking technology to record authentic full-body movement patterns of workers and drivers, and evaluates the system's usability across three real work zone scenarios. Participants' awareness while passing through work zones was measured by gaze durations and fixation ratios. Results indicate that drivers tend to focus more on workers in work zones compared to other elements such as warning signs or traffic cones/barrels, which has implications for both safety and work zone design.

The following projects are ongoing during this reported period, with updates as follows:

**An AI-reinforced Traffic Digital Twin for Testing Emergency Vehicle Intervention** – Collaborating closely with the New York City Fire Department (FDNY), the team analyzed emergency medical vehicle (EMV) and third-party data, completed the development of base model and EMV model for the traffic digital twin (TDT), and started developing an AI model. The team generated data from the simulation to train the AI model and conducted analysis on FDNY incident data, categorizing incidents as life-threatening or non-life-threatening. The team also looked at Airspace data to understand what happens when EMVs cross an intersection and is now testing multiple EMV interventions selected by FDNY.

**Development of a Vision-Based Landside Traffic Management System at Airports** - The team and PANYNJ agreed to prioritize two key use cases: automatic queue length detection and a frontage curb lane management system. PANYNJ shared sample videos of JFK Terminal 4 for analysis and model development and the research team developed two deep learning-based computer vision models to address the prioritized use cases: queue visualization and zone visualization.

**Development of Guidelines for Implementing the Flipped Left Diamond Interchange Design** – The team analyzed their VISSIM traffic simulation results and compared the Flipped Left Diamond Interchange (FLDI) performance under different traffic conditions with a conventional diamond interchange design. The team also conducted a driver occupancy survey to analyze the equity of the FLDI design and the acceptance of the design by different socioeconomic groups.

**Enhancing Transit Access and Safety Through Equitable Micromobility Solution** – The team selected two underserved communities in the El Paso area and developed a Micromobility Infrastructure Score Sheet that evaluated off-street, on-street, crosswalk, and bus stop conditions on road segments within the two sites. The team also conducted a bicycle and pedestrian crash analysis, considering severity, age, gender, race, time-of-day, light condition, location, and contributing factors. Based on the findings, the team identified micromobility infrastructure improvements and developed safety improvement plans.

**Equitable Flood Impact Analysis Integrating GeoAI and Digital Twin Modeling** – The team's ongoing analysis involves overlaying various geospatial layers, including flood risk zones and transportation

infrastructure, to assess evacuation potential for residents in North Carolina. The team simulated flood scenarios and was able to quantify how increasing flood levels result in increased delays across the network (lane closures and traffic impacts). The team is currently modeling how demand estimates may themselves change when flooding levels intensify.

**Impact of WIM-based Direct Enforcement on the Service Life of Bridges** - The previous amendment to introduce the direct overweight enforcement code into NIST Handbook 44 was advanced to a voting item for the National Conference on Weights and Measures but was not approved. Since then, the team has been collaborating with NYCDOT, NIST, and several other agencies to revise the code, addressing various concerns raised. The NYS Department of Agriculture and Markets, which certifies the scales, validated the current WIM site on the Brooklyn-Queens Expressway for use in direct overweight enforcement.

**Multi-Horizon Urban EV Charging Infrastructure Planning** – The team tested and validated calibration procedures for a base model of EV charging behavior and used calibrated estimates to test different scenarios. Team members developed an optimal power flow model that models charging demand as a function of charging fees and average waiting times, representing charging costs and charger availability, respectively. The team also developed an upper-level electric vehicle charging station (EVCS) planning model that integrates power and transportation networks to optimize the placement of EVCSs.

**Multimodal Multi-scale Urban Traffic Control in Connected and Automated Cities** – The team has been working with MCity for testing the multiscale SVCC framework in simulation and with real-world CAVs, via remote access to the MCity 2.0 facility. Formal testing and a demo were made during the 25<sup>th</sup> International Symposium on Transportation and Traffic Theory. The team also worked on expanding the modeling framework to include active road users and various vehicle types.

### 3. Education

**K-12 STEAM Club Drone Tech in Rural, Tribal Communities** – The drone technology training program for students at Ocosta High School is ongoing, including having Ocosta students learn to pilot a basic DJI drone, collect still images and video of assets, and record their associated narratives with the imagery; assessing their own gameplay motivations and proceeding through the steps of designing a prototype game; and participating in focus groups to reflect on what they learned.

Undergraduate researchers who completed City Tech’s Emerging Scholars Program (ESP) were paired with City Tech and NYU faculty under the **Tech Transfer with Undergrad Research & Workforce Development** cross-institutional mentorship initiative following a March 2024 C2SMARTER Research Social with approximately 30 attendees from both NYU and City Tech.

#### *C. Training and Professional Development*

- The [C2SMARTER Student Learning Hub](#), open to all students attending C2SMARTER Consortium Universities as well as a network of community colleges, offers free courses on applicable skills for students taught by doctoral students in consortium schools. The following classes were offered:
  - Building Interactive Maps with JavaScript, HTML, and CSS
  - Analyzing scope and limitations of using GeoAI Toolbox available in ArcGIS Pro/Online
- C2SMARTER Center continues to support consortium institution Institute of Transportation Engineers (ITE) / Intelligent Transportation Society (ITS) Student Chapters. NYU chapters hosted several events:
  - April 14, 2024 - ITE Northeastern District Traffic Bowl
  - May 2, 2024 - Networking with YPT-NYC
  - July 22, 2024 - ITE International Collegiate Traffic Bowl
  - September 8, 2024 - New York Transit Museum Bus Festival
  - September 12, 2024 - Welcome Party

- On April 4, C2SMARTER and rail technology firm Ikos hosted Engineering Careers with Ikos, where students networked and learned about the firm’s company culture.
- On April 14, C2SMARTER’s Jannie Gao represented the ITE MET Section as well as C2SMARTER at the Tristate engineering event at White Plains High School.
- On May 10, C2SMARTER and City Tech cohosted nearly 40 middle school students from Long Island’s Kellenberg Latin School and showcased computer vision and VR technologies.
- On May 22-23, Prof. Sarah Kaufman served as a panelist on Moving the Masses: Innovations in Transportation during 2024’s NYC Smart City Expo. C2SMARTER NYU students also hosted booths:
  - DT-ATEAM, a Digital Twin-based Advanced Traffic Event Analysis and Management Platform
  - VRoom: Virtual Reality for Traffic Worker Safety
  - A-Eye Urban: Computer Vision for Transportation Analytics.
- Over the summer, NYU hosted six local high school students through the school’s ARISE fellowship. Within the program, the students work with university faculty and other mentors throughout the summer to gain authentic research experience geared to college application prep.
- Participating Ocosta students in UW’s K-12 STEAM Club project formed the Ocosta News Network, a video-journalism club oriented to community information and public service announcements.
- UTEP Prof. Cheu led a one-day Transportation Research Internship Program (TRIP) workshop that exposed 16 community college students to transportation engineering.
- On September 17, NYU CUE Department held a Minors Info Session for undergrads to meet with professors and discuss opportunities to minor in the department.

#### *D. Dissemination and Outreach*

##### 1. Conferences, Symposia, and Workshops

- Over July 14-18, the Rutgers team attended the National Conference on Weights and Measures (NCWM) Annual Meeting in Cleveland, OH. On September 8-12, the Rutgers team also attended the Western Weights and Measures Association (WWMA) Interim Meeting in Las Cruces, NM.
- Eight researchers participated in the NYU Tandon’s Research Excellence Exhibit 2024 held on April 26, which demonstrated research on computer vision, digital twins and robots, and VR tech.
- On April 24, NYU Rudin Center for Transportation hosted the Excellence in Transportation event to further research and conversation surrounding sustainability in transportation.
- On May 20, as part of the **Charting Equitable Outcomes for Highway Communities/Smart Technology & Smart Development** project, Prof. Norman hosted a full-day symposium, free and open to the public, titled Towards a Decarbonized Sustainable Multi-Modal Transportation Network, on Governor’s Island, NY. On June 17, the team and the Institute for Public Architecture cohosted a documentary screening for an audience of more than 300.
- On June 4-6, C2SMARTER and Rutgers cohosted the 14th International Symposium on Ferrocement and Thin Ultra-High-Performance Concrete (UHPC) Composites on the Rutgers campus.
- On June 10, TSU’s Dept. of Transportation Studies hosted a workshop with WaySync; 32 attendees from various local agencies and companies attended.
- On July 15-18, research teams from NCA&T and UTEP attended the 2024 Conference on Advancing Transportation Equity, presenting findings from projects, and learning about equity and accessibility.
- On August 9-12, Prof. Vinitzky organized the Reinforcement Learning Conference 2024 at UMass-Am.
- On September 17, C2SMARTER held its annual Transportation & Urban Systems Fall Welcome Event; undergraduate and grad students learned about the Center and networked with faculty and staff.
- On September 20, Towards Equitable Progress in Transportation Workshop was held in conjunction with SEMPACT Region II UTC. Speakers and attendees included transportation equity stakeholders, such as representatives from DOT, MTA, NYMTC, MOCEJ, academic institutes, and advocacy groups.

- On September 24-27, NYU’s Control of CAVs for Congestion Reduction team presented at the 27nd IEEE International Conference on Intelligent Transportation Systems in Edmonton, Canada.
- On September 26, C2SMARTER cohosted the Mass Transit & Climate Change panel at NYU.
- C2SMARTER hosted the following seminars/webinars during this period:
  - Realizing Benefits at Low Market Penetration of Connected Automated Vehicles, presented by Prof. Brian Park of UVA
  - Leveraging AI to Improve Safety for Personal Mobility Device Users, presented by KAIST’s Prof. Reuben Tamakloe
  - How to Mitigate Risks in Rail Transport of Hazmat, presented by Morteza Bagheri, Associate Professor, Iran University of Science and Technology (IUST)
- Led by Rutgers RIME Bridge Resource Program, C2SMARTER also hosted a webinar series:
  - Digitized Lifetime Concrete Corrosion and Humidity Health Monitoring of Bridges, Parking Decks, and Garages, and Other Important Structures, presented by Kline Engineering’s Dan Kline
  - The Intersection of Cloud Computing and Civil Infrastructure, presented by HNTB’s Erik Zuker, PE, and Rob Wildish, EIT

## 2. Industry and Public Agency Outreach

- As part of the Charting Equitable Outcomes project, Prof. Norman’s team collaborated with El Puente, Segregation by Design, Brooklyn Urban Garden School, and the Regional Plan Association. He also partnered with Brooklyn Assemblymembers and a former Deputy Brooklyn Borough President.
- The Digital Twin Flood team met with staff from Oak Ridge National Laboratory regarding their publicly available datasets and libraries for flood modeling. These interactions provided valuable insights, particularly in understanding the usefulness of digital twins in flood scenarios.
- The FLDI Design research team had several meetings with industry partner Ali Mozdbar, Senior Project Manager with LJA Engineering, to discuss the project.
- The Tripchain Planner team collaborated with the City of Arlington, TX, Replica Inc., and NCDOT.
- Prof. Vinitzky presented a portion of the Building Intersection Digital Twins work to NYCDOT.
- As part of the Multi-Horizon Charging project, the team collaborated with ParkNav Inc., a mobility data provider that specializes in parking.
- Prof. Jiang of the Control of CAV for Congestion Reduction project is collaborating with project partner Dr. Yu Jiang, Clear Motion Inc. to disseminate the team’s findings.
- The UW Urban Traffic Control team communicated with Seattle DOT (SDOT) frequently on CAV testbed and CAV research. SDOT is providing data and other support to the team.
- As part of the Enhancing Transit Access project, the UTEP team collaborated with various organizations and agencies including the City of El Paso’s Street and Maintenance Department, the Texas A&M Transportation Department faculty, and the Sun Metro Newspaper.
- NYU team led by Dr. Gao introduced their computer vision deep learning-based AI techniques for video and images to various divisions within PANYNJ.
- At the US DOT Future of Transportation Summit in August, Center Director Prof. Ozbay chaired a session on Mobility and Reducing Congestion. The session featured speakers from other UTCs, while Dr. Ozbay presented ‘Deployment of a Computer Vision-based Tool to Reduce Urban Congestion and Improve Airport Traffic.’ During his presentation, Dr. Ozbay highlighted several of C2SMARTER’s current research projects, including the effort undertaken in partnership with the Port Authority of NY/NJ at the JFK airport as well the ongoing Automated Enforcement program on the Brooklyn-Queens Expressway (BQE).
- The Rutgers team reached out to the state departments responsible for certifying scales, such as the NYS Dept. of Agriculture and Markets, the California Department of Food and Agriculture, and others. They also contacted local, state, provincial, territorial and federal commercial motor vehicle safety

officials and industry representatives while attending CVSA (Commercial Vehicle Safety Alliance) as well as one national (NCWM) and regional (WWMA) conferences.

### 3. Media Coverage and Public Understanding

- NYU Prof. Kaufman was quoted in several articles:
  - Articles in Wired and [Gothamist](#) regarding a gun-detection AI system in the New York subway.
  - A Wired [article](#) focusing on congestion pricing in NYC.
  - A Bloomberg [article](#) discussing bus companies' new realities after COVID.
  - A New York Times [article](#) discussing congestion pricing and the broader implications of such policies, noting that driving "been amended into the American dream." She was also quoted in [Vox](#), [Axios](#), and [Reasons to be Cheerful](#) discussing the same topic.
  - A Scientific American [article](#), arguing that New York's ability to provide mass transit for riders of all abilities has downstream impacts on current and future senior citizens.
  - A Marketplace [article](#), discussing national deployment plan for (V2X) technology.
  - An article on MTA's OMNY student [plan](#), as well as an [article](#) on 2024's traffic death trends.
  - A Route Fifty [article](#) commenting on the difference between the presidential candidates' transportation policy stances.
- Prof. Kaufman authored an [article](#) in Vital City NYC on October 2; the article, Riding While Female, details safety concerns, needs, and solutions for women (and fem-presenting) transit riders.
- NYU Tandon posted a [story](#) detailing Prof. Joseph Chow's use of synthetic data to best determine New York statewide transit investments.
- NYU Prof. Ghandehari's research project analyzing the concentrations of particulate matter in the New York City subway system has been featured in major outlets like [Bloomberg](#), [Fox 5 \(WNYW-TV New York\)](#), [Newsweek](#), and [The Guardian](#). The Columbia Climate School published an article detailing NYU Prof. Ghandehari's study on NYC subway pollution, which found that black and Hispanic riders are disproportionately affected by polluted air.
- Prof. Ghandehari was featured on a FOX Weather segment discussing how extreme weather is impacting bridges and railways around the country.
- Several articles were published detailing the FDNY Traffic Digital Twin project:
  - [Cities Use AI to Help Ambulances and Firetrucks Arrive Faster](#), Bloomberg
  - [NYC Fire Department Utilizes Advanced Tech for Faster Emergency Response](#), Smart City Connect
  - [Wait time for ambulances in NYC is the longest since the start of COVID-19](#), Gothamist
  - [Case Study: How C2SMARTER helped FDNY understand post-COVID emergency patterns with AirSage](#), AirSage, October 15, 2024
- NYCDOT published a press release announcing the 64% reduction in overweight trucks along the BQE corridor monitored by C2SMARTER sensors. ENR Magazine featured a [story](#) on the Center's efforts on the BQE. The team's direct overweight enforcement at the BQE testbed has received media coverage:
  - [City to close one lane of Staten Island-bound BQE for next 2 weekends to install weigh-in-motion tech](#), Brooklyn Paper
  - [Automated Enforcement Has Led to 64 Percent Reduction in Overweight Trucks Along Brooklyn Queens Expressway](#), NYC.gov Press Release
  - [Brooklyn Heights BQE section gets fewer overweight trucks due to automated enforcement](#), Gothamist
  - [NYC Smart Roads Deter Heavy Trucks on Aging BQE](#), Transportation Topics
  - [Weight Sensor Program on BQE Reduced Overweight Trucks by 64%](#), Brooklyn Eagle



### E. Plans for Next Reporting Period

- In October, C2SMARTER will host the inaugural [NYC V2X & AI Symposium](#), where government officials, industry experts, and academic researchers will gather to discuss the potential future of connected vehicle technology. NYC DOT Commissioner [Ydanis Rodriguez](#) and other transportation leaders from US DOT, ITS America, and more will speak at the event as invited speakers.
- C2SMARTER submitted and will be presenting several papers at TRB 2025, where the Center will also be hosting its semi-annual meeting. The Center also put a call out for 2024 Student of the Year, an honor which includes free admission to the annual conference

## II. Participants and Collaborating Organizations

### A. Partner Organizations

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

**Table 1: C2SMARTER Active Partnerships with Updates during this Reporting Period**

Organization Name	Location	Contribution			
		Financial Support	In-kind Support	Collaborative Research	Personnel Exchanges
AirSage	Atlanta, GA	X	X	X	
Amtrak	New York City, NY				X
City of Arlington	Arlington, TX			X	
City of Bellevue	Bellevue, WA		X		
City of El Paso	El Paso, TX			X	
City of El Paso Street & Maintenance Dept.	El Paso, TX			X	
City of Greensboro	Greensboro, NC				
City of Madison	Madison, WI			X	X
City of Seattle	Seattle, WA			X	
City of Westport	South Beach, WA			X	
ClearMotion	Billerica, MA			X	
Con Edison	New York, NY		X	X	
D.C. DOT	Washington, D.C.			X	
El Paso MPO	El Paso, TX			X	
GLIDE Scooter	El Paso, TX			X	
Institute for Public Architecture	New York, NY		X		X
King County Metro	Seattle, WA			X	
Kistler Instrument Corp.	Buffalo, NY		X		
LJA Engineering	Austin, TX			X	
MCity	Ann Arbor, MI			X	X
Metropolitan Transportation Authority	New York City, NY				
National Endowment of the Arts	Washington, D.C.	X			
National Renewable Energy Laboratory	Golden, CO			X	
NJ Office of Weights and Measures	Avenel, NJ			X	
Noblis	Reston, VA			X	
North Carolina Dept. of Transportation	Raleigh, NC			X	X
NYC Dept. of Cultural Affairs	New York City, NY	X	X		
NYC Fire Dept. (FDNY)	New York City, NY	X		X	
NYC Dept. of Transportation	New York City, NY	X	X		
NYS Dept. of Agriculture and Markets	Brooklyn, NY			X	
NYS Dept. of Transportation	Albany, NY	X		X	

Ocosta Junior High School After School Prog.	Ocosta, WA			X	X
OR Dept. of Agriculture Weights & Measures	Salem, OR			X	
Port Authority of NY & NJ (PANYNJ)	New York City, NY	X	X		
Replica	Oakland, CA			X	
Sun Metro	El Paso, TX		X		
Texas Dept. of Transportation	Austin, TX			X	
Via	New York, NY			X	
Washington State Parks	Olympia, WA		X		
Westport Maritime Museum	Westport, MA				X

## B. Other Collaborators or Contacts

### 1. Collaborations within the Consortium

- Several of the ongoing research projects feature collaborations between consortium researchers:
  - Multi-Horizon Urban EV Charging Infrastructure Planning: Integrating Activity Patterns, Grid Dynamics, and Uncertainty** is a collaboration between faculty at NYU and UW
  - Multi-Modal Tripchain Planner for Disadvantaged Travelers to Incentivize Transit Usage** is a collaboration between faculty at NCA&T and NYU
  - Tech Transfer with Undergraduate Research & Workforce Development** includes faculty mentoring by faculty at NYC College of Technology and NYU
- The NCA&T team brainstormed with experts at NCA&T including Dr. Leila Heshami-Beni in the Department of Built Environment and Computational Data Science and Engineering.
- For NYU’s Knowledge Capture, Dr. Bian collaborated with Prof. Quanyan Zhu from NYU’s Electrical and Computer Engineering Department for the digital twin research and Prof. Zhibin Chen (NYU-Shanghai) for EV charging research.
- Prof. Jiang is collaborating with Profs. Kaan Ozbay and Eugene Vinitzky from NYU’s Department of Civil and Urban Engineering for interdisciplinary research.
- Control of CAVs for Congestion Reduction is a collaboration between the Tandon departments of Civil and Urban Engineering along with Electrical and Computer Engineering.
- Drs. Ozbay and Gao have interdepartmental collaborations with various professors at NYU, including Dr. Feng Chen (MAE) and Dr. Zhongping Jiang (ECE).
- The Rutgers team has ongoing collaboration between the School of Engineering and the Bloustein School of Planning and Public Policy, which involves exploring the potential uses of physical testbeds to investigate the feasibility of utilizing biometric sensors.

### 2. Collaborations outside the Consortium

- The TSU team collaborated with Dr. Aobo Wang, a research scientist at the University of Nevada, Reno, on designing the traffic signal timing for the FLDI project.
- UW is working with MCity within the University of Michigan and Seattle DOT. The latter is providing data-related support to the team on CAV testbeds for the Urban Traffic Control project.
- NYU Prof. and Control of CAVs for Congestion Reduction PI Jiang is collaborating with Prof. Kyriakos G Vamvoudakis, Georgia Institute of Technology.
- For the Enhancing Transit Access and Safety project, team leadership contacted Dr. Natalia Zuniga at Argonne National Laboratory on her research on e-scooter as well as Alex Lee-Warner and Cory Yong at INRIX on possible purchase of e-scooter usage data.
- NYU’s Prof. Kaufman sought feedback from New York Lawyers for the Public Interest (which chose to remain anonymous), as well as two New Yorkers with disabilities for the Transit Accessibility project.
- Prof. Chow of NYU is actively collaborating with Replica and Dollaride, with whom he is working on a NYSERDA-funded project titled Clean Transit Access Program.
- Drs. Ozbay and Gao actively collaborate with ITSJPO, NJDOT, NYCDOT, NYSDOT on various projects.

- PIs submitted joint proposals with NYCDOT, NJSEA, FDNY, Morgan State University, Penn State, Oak Ridge National Laboratory, Northeast Corridor Commission, Replica, and Open Mobility Foundation.
- Drs. Ozbay and Gao have interdisciplinary collaborations with Chang Dae Lee (Indiana University, Occupational Therapy) and aging community agency CICOA.
- Prof. Pandey of NCA&T has collaborated with Dr. Sami Hasnine (Assistant Professor, Virginia Tech) and Dr. Hyoshin (John) Park (Associate Professor, Old Dominion University). Prof. Pandey also collaborated with the Center for Regional and Rural Connected Communities (CR2C2), in particular, Dr. Jidong Yang from University of Georgia, Dr. Sudhagar Nagarajan and Dr. Evangelos Kaiser from Florida Atlantic University, and Dr. Rongfang Liu from NCA&T.
- NYU is collaborating with NYCDOT on WIM site selection through the NYC Town+Gown initiative to prioritize future deployments, as well as red light / speed camera violation + crash analysis.
- NYU PIs have funded projects by NYSERDA on EV charging locations for Dollaride vans, the Equitable Commute Project which analyzes e-bikes for delivery workers and their battery usage, and Creating Community Mobility and Energy Hubs, which is funded to under the SEMPACT Region II UTC.
- Dr. Ozbay's team continues to work with Noblis on US DOT's Benefits/Cost Lessons Learned project.
- Prof. Nassif is working with NJDOT on the Bridge Resource Program, as well as REEFENSE - A Mosaic Oyster Habitat (MOH) for coastal defense (DARPA).
- The UTEP team has numerous ongoing projects with TTI and Texas agencies.
- Prof. Abramson of UW and K-12 STEAM Club project team members collaborated with the Cascadia Coastlines and Peoples Hazards Research Hub, Vanderbilt's Smart & Connected Communities project team, and the UW Climate Impacts Group's Northwest Climate Resilience Collaborative.
- UW's Urban Traffic Control team received data related support from Seattle DOT staff on their CAV testbed. The team also worked with MCity at the University of Michigan on integration and testing; the UW team used MCity's CAV testing facilities.
- The Control of CAVs for Congestion Reduction team continued to collaborate with ClearMotion.
- The Rutgers team collaborated with the University of Michigan to host their Ferro-14 conference in June; they also worked with Auburn University for a project sponsored by NJ DOT.

### 3. International Collaborations

- Prof. Pandey of NCA&T collaborated with Dr. Tarun Rambha with the Indian Institute of Science, Bangalore.
- NYU Knowledge Capture's Dr. Bian collaborated with Prof. Zhenning Li and his group members from University of Macau for the vehicle-based safety and mobility research.
- Rutgers has a collaboration with Prof. Peter H. Bischoff from the University of New Brunswick, Canada. One of the papers was recognized as the Best Theoretical Paper Award at the 16th International Symposium on Fiber-Reinforced Polymer (FRP) Reinforcement for Concrete Structures.
- NYU and Rutgers continue to collaborate with KAIST.
- UTEP reaffirmed their steadfast collaboration with Czech Technical University (CTU) with the extension of the CTU-UTEP Dual Master's Program in Smart Cities for an additional five years.

## III. Outputs

### A. Publications, Conference Papers, and Presentations

#### 1. List of Journal Publications

- Cui, L., Sayan, C., Ozbay, K., and Jiang, Z., 2024. "Automated lane changing control in mixed traffic: An adaptive dynamic programming approach." *Transportation Research Part B: Methodological* 187.
- Cui, L., Sayan, C., Ozbay, K., and Jiang, Z., 2024. "Data-Driven Combined Longitudinal and Lateral Control for the Car Following Problem." Accepted for publication in *IEEE Transactions on Control Systems Technology*.

- Gerges, F., Boufadel, M, Bou-Zeid, E., Nassif, H. and Wang, J. TL., 2024. “Downscaling daily wind speed with Bayesian deep learning for climate monitoring.” International Journal of Data Science and Analytics, Vol. 17, No. 4.
  - Jezzini, Y., Assaad, R.H., Boufadel, M. and Nassif, H., 2024. “Assessing the Costs and Benefits of Green Infrastructure Plans Using Agent-Based Modeling and Scenario Analysis: Evaluating Social and Economic Values.” Journal of Urban Planning and Development, Vol. 150, No. 4.
  - Li, T., Bian, Z., Lei, H., Zuo, F., Yang, Y., Zhu, Q., Li, Z., Ozbay, K., 2024. “Multi-level traffic-responsive tilt camera surveillance through predictive correlated online learning.” Transportation Research Part C: Emerging Technologies 167.
  - Li, Y., Vignon, D., 2024. “Do Ride-hailing Congestion Fees in NYC Work?” Transportation Research Part A: Policy and Practice, Volume 190, 2024, 104274, ISSN 0965-8564.
  - Liao, H., Li, Y., Li, Z., Bian, Z., Lee, J., Cui, Z., Zhang, G., Xu, C., 2024. “Real-time Accident Anticipation for Autonomous Driving Through Monocular Depth Enhanced 3D Modeling.” Accident Analysis and Prevention 207.
  - Lou, P., Yang, C., and Nassif, H., 2024. “Prediction of Maximum Live-Load Effects for Bridges Based on Weigh-in-Motion Data.” Transportation Research Record: Journal of the Transportation Research Board.
  - Nasreddine, W., Obeidah, A., Bischoff, P.H., Nassif, H., 2024. “Immediate Deflection of Cracked Prestressed Concrete Beams Based on Integration of Curvature.” ACI Structural Journal.
  - Sha, D., Tang, Y., Ozbay, K., Gao, J., and Zuo, F., 2024. "Market Penetration Rate Optimization for Mobility Benefits of Connected Vehicles: A Bayesian Optimization Approach." Transportation Research Record.
  - Wang, J., Song, J., Zhao, C., & Ban, X. J., 2024. “Distributionally robust origin–destination demand estimation.” Transportation Research Part C: Emerging Technologies, 165.
  - Xu, C., Gao, J., Zuo, F., and Ozbay, K., 2024. "Estimating Urban Traffic Safety and Analyzing Spatial Patterns through the Integration of City-Wide Near-Miss Data: A New York City Case Study." Applied Sciences (2076-3417), 14.
  - Yang, C., Wang, X., and Nassif, H., 2024. “Impact of Environmental Conditions on Predicting Condition Rating of Concrete Bridge Decks.” Transportation Research Record: Journal of the Transportation Research Board.
2. List of Conference Papers
- Angah, O., Zhang, Y., Ban, X., 2024. “Connected and automated transportation system in a Multi-agent environment.” Presented at the IEEE-IV symposium, June, Jeju Island, Korea.
  - Cornelisse, D., Vinitzky, E., 2024. "Human-compatible driving partners through data-regularized self-play reinforcement learning." Conference on Reinforcement learning.
  - Doldy, S., Holland, R., Ruzsala, M., Nasreddine, W., and Nassif, H., 2024. “Flexure Analysis of Reinforced Concrete One-Way Slabs using UHPC Overlay.” Proceedings of the 14<sup>th</sup> International Symposium on Ferrocement and UHPC composites.
  - Ha, W., Chakraborty, S., Lin, X., Ozbay, K Jiang, Z. P., 2024. “Learning-Based State Estimation for Automated Lane-Changing.” 27th IEEE International Conference on Intelligent Transportation Systems (ITSC), Edmonton, Canada.
  - Hasan, F. and Chowdhury, S. 2024. “Eco-Intelligent Facade Design: An Approach to Generate Environmentally Responsive Adaptive and Self-Propelling Eco Screen System, The Virtual Polis-Interactive Geographies, Immersive Narratives, and Participatory Governance.” Society. Spaces. Screen, Proceeding of AMPs Series, Arizona State University.

- Holland, R., Doldy, S., Ruzala, M., Nasreddine, W., and Nassif, H., 2024. “Investigation of RC Beams Strengthened with SCC, Shotcrete, and UHPC Laminates for Bridge Rehabilitation.” Proceedings of the 14<sup>th</sup> International Symposium on Ferrocement and UHPC composites.
- Jehu-Appiah, D., Park, H., and Pandey, V., 2024. “Optimizing Paratransit Routing Considering Dwell Time Uncertainty.” Presented at the American Society of Civil Engineers' International Conference on Transportation and Development (ICTD 2024), Atlanta, GA.
- Jehu-Appiah, D., Tihamiyu, R., Pandey, V., Ren, X., Chow, J.Y.J., and Park, H., 2024. “Enhancing Mobility and Transit Equity: A Multimodal AI-Enhanced Trip Chain Planner.” Presented at the 2024 Women in Transportation Seminar, Annual Conference, New Orleans, LA.
- Naaman, A.E., Nassif, H., Milenković, M., Waldshlagel, O, and Connelly, G., 2024. “Ferrocement Self-Help Housing Shelters and Shells for Mitigation of Natural Disasters.” Proceedings of the 14<sup>th</sup> International Symposium on Ferrocement and UHPC composites.
- Nasreddine, W., Bischoff, P.H., Nassif, H., 2024. “Deflection Behavior of Beams Prestressed with Bonded FRP Tendons.” ACI Special Publication (SP) 360, Proceedings of the 16th International Symposium on Fiber-Reinforced Polymer (FRP) Reinforcement for Concrete Structures (FRPRCS-16).
- Obeidah, A. and Nassif, H., 2024. “Flexural Behavior of Concrete Beams Prestressed with Hybrid Tendons.” ACI Structural Journal.
- Ren, X., Chow, J.Y.J., and Yuan, H., 2024. “Integrating an agent-based mixed logit (AMXL) approach in microtransit revenue management: A case study in Arlington, TX.” Presented at the 2024 IATBR Conference, Vienna, Austria.
- Ruzala, M., Holland, R., Peltyszyn, A., Nassif, H., 2024. “Investigation of UHPC in Direct Tension using Long Term Loading and Restrained Conditions for Thin Section Applications.” Proceedings of the 14<sup>th</sup> International Symposium on Ferrocement and UHPC composites.
- Sultana, M., Chowdhury, S., 2024. “Evaluating Public Attention in Urban Built Environments: A Comparative Study Using Eye Tracking and Visibility Analysis, The Virtual Polis-Interactive Geographies, Immersive Narratives, and Participatory Governance.” Society. Spaces. Screen, Proceeding of AMPs Series, Arizona State University.
- Tang, Y., Gao, J., Zuo, F., Sha, D., Ozbay, K., 2024. “Connected Vehicle Data-Aided Ramp Metering for Distant Bottlenecks Induced by Traffic Accidents.” The 12th Symposium of the European Association for Research in Transportation.
- Tasnia, R., Ali, M., Hridoy, D. N., Pandey, V., Hasnine, S., and Park, H., 2024. “Impacts of Real-Time Information on Express Lanes Route Choices: Insights from a Joint Revealed and Stated-Preference Survey in Washington DC and Charlotte, NC.” Presented at the American Society of Civil Engineers' International Conference on Transportation and Development, Atlanta, GA.
- Zhang, S., Ergan, S., Zuo, F., Ozbay, K., 2024. “Improving Work Zone Safety: Integrating VR-CARLA Co-simulation and Eye Tracking for Behavior Analysis of Drivers around Work Zones.” 2024 Road Safety & Simulation Conference.
- Zhao, X., Fan, L., Ding, F., Liu, W., & Zhao, C., 2024. “A Distributionally Robust Optimization Framework for Stochastic Assessment of Power System Flexibility in Economic Dispatch.” In 2024 IEEE Power & Energy Society General Meeting (PESGM) IEEE.

### 3. List of Presentations

- On April 1, Prof. Pandey presented at the Autonomous Vehicle Symposium in the World of Artificial Intelligence — Enhancing Autonomous Vehicles Use and Development, hosted by the AI in Society Group at NC State University.
- Over April 5-6, researchers from the Digital Twin Flood team attended and presented at the Fourteenth International Conference on The Constructed Environment in Vienna, Austria.

- On April 9, Prof. Abramson and team presented at the University of Washington Industrial & Systems Engineering Graduate Seminar.
- On April 12, Prof. Chow presented “Fleet operations with transfers: toward sustainable mobility hubs,” ICON Seminar Series, Purdue University.
- On April 17-18, Prof. Pandey and team presented at the Joint CATM and CR2C2 Annual Symposium, hosted at NCA&T.
- Center Director Ozbay presented “An Agent-Based Urban Simulation to Assess the System-Wide, Spatial, and Modal Impacts of the Deployment of an Automated Vehicle Corridor: A Case Study in New York City” at the 13th International Workshop on Agent-based Mobility, Traffic and Transportation Models, April 23-25, 2024.
- Prof. Chow presented on May 5 at Revolutionizing Urban Mobility: Intelligent Transportation Systems, Autonomous Vehicles, Electric Cars, and AI Innovations.
- Prof. Pandey and team presented at the 2024 Women in Transportation Annual Conference, held May 8-10, in New Orleans, LA.
- Prof. Vinitzky was an invited speaker at ICRA Workshop on MAD Games - Multi-agent Dynamic Games on May 13.
- On May 31, Prof. Pandey and team presented at the NSF ERC Proposal Planning Workshop, College of William & Mary Law School.
- Prof. Pandey and team presented “Optimizing Paratransit Routing Considering Dwell Time Uncertainty,” at the International Conference on Transportation & Development in Atlanta, GA, in June.
- Prof. Ban and team presented “Connected and Automated Transportation System in a Multi-agent Environment” at the 2024 IEEE-IV symposium in Jeju, Korea.
- Dr. Gao presented “An AI-Reinforced Traffic Digital Twin for Testing Emergency Vehicle Interventions” during the Digital World panel at the ITS-NY 31st Annual Meeting and Technology Exhibition on June 13-14, 2024, Saratoga Springs, NY.
- On June 17, NYU Equitable Outcomes Co-PI Matthew Kwatinetz served as a panelist for the Story of the BQE documentary screening, which was completed along with a range of interviews with stakeholders and community members.
- On June 18-20, Dr. Ozbay presented “Connected Vehicle Data-Aided Ramp Metering for Distant Bottlenecks Induced by Traffic Accidents” at the 12th Symposium of the European Association for Research in Transportation.
- Prof. Chow presented “Using synthetic data to produce heterogeneous mode choice market share models for equity analysis” at Seoul National University, on June 19, 2024.
- In June, Prof. Kaufman of NYU participated as a panelist for an event hosted by the Pension Real Estate Association (PREA); her panel expertly analyzed plans for New York City’s transportation enhancements over the next 15 years.
- In June, Prof. Chow visited and presented to the innovation team at Studio Galilei, a transportation technology company based in South Korea, to discuss various issues in the mobility field.
- On July 2, Prof. Pandey presented on mobility services during Secretary Buttigieg and NC Governor Cooper’s visit to NCA&T’s transportation research facility.
- On July 15, Prof. Pandey presented at NCA&T 2024 Summer Transportation Institute for HS Students.
- On July 15-17, UW’s Urban Traffic Control team presented a demo of their SVCC algorithm using mixed reality Mcity 2.0 during ISTTT 25 in Ann Arbor, MI.

**Table 2: Outputs Performance Metrics**

Performance Metric	Achieved in period	Annual target
Conferences organized	7	5
Keynote / invited talks	22	15
Peer-reviewed papers	66	40
Workshops, seminars, or forums	15	10

- Two C2SMARTER PIs presented at the Advancing Transportation Equity conference held over July 15-18, in Baltimore, MD.
  - Prof. Pandey presented Differentiable Design of Mileage-Based User Fees for Equitable Benefits
  - Prof. Cheu presented Exploring the Impacts of Micromobility on Transit Accessibility for Underserved Population
- On August 6-8, NYU's Dr. Bian presented "Digital Twin-based Advanced Traffic Event Analysis and Management Platform for Transportation Decision Support" at the Joint Traffic Analysis and Modeling Workshop and Mid-Year Meeting in Raleigh, NC.
- On August 10, NYU Researcher Daphne Cornelisse presented her paper on human-compatible driving agents at the Reinforcement Learning Conference in Amherst, Massachusetts.
- In mid-August, NYU Researcher Dan Lu presented "An Approach for Domain-Informed Generative Architectural Design" at ASCE's i3CE conference.
- Dr. Bian presented "Advancing Equity from New Angles: A Multi-Dimensional Approach to Accessibility and Reliability with Citibike NYC Case Study" at the SEMPACT workshop on September 20.
- Bian presented two presentations 1) "Informed Along the Road: Roadway Capacity Driven Graph Convolution Network for Network-Wide Traffic Prediction" and 2) "Toward an Enhanced Risk Assessment Sensitivity for Autonomous Vehicles with the Safety Potential Field Approach" at the IEEE ITSC 2024 in Edmonton, CA, Sept 26, 2024.
- NYU Student Researcher Dachuan Zuo presented two papers at the IEEE ITSC 2024 Conference, which occurred September 24-27, in Edmonton, Canada.
- On September 24, Prof. Kaufman was on a panel for Luminary Labs as part of Climate Week NYC.
- On September 30, Prof. Pandey presented Transportation Systems of the Future: Planning and Operations in the Era of Information and Connectivity as a guest speaker for the CAEE Graduate Seminar Class at NCA&T.
- The Rutgers team presented at several OTH-25.1, Section 2.26 Weigh-In-Motion Used for Vehicle Enforcement at CVSA and regional and national weights and measures meetings.
  - CVSA Workshop on 4/14/24 – 4/18/24, Louisville, KY
  - AASHTO COBS Workshop on 6/16/24 – 6/20/24, Indianapolis, IN
  - NCWM Annual Meeting on 7/14/24 – 7/18/24, Cleveland, OH
  - WWMA Interim Meeting on 9/8/24 – 9/12/24, Los Cruces, NM

### *B. Policy Papers*

- NCHRP report: Townsend, H., Samach, M., Bare, K., Cetin, M., Ishak, S. and Ozbay, K., 2024. Implementing Machine Learning at State Departments of Transportation: A Guide. Transportation Research Board.
- NCHRP report: Vasudevan, M., O'Hara, J., Samach, M., Silverstein, C., Asare, S.K., Townsend, H., McManus, I., Ozbay, K., Gao, J., Xu, C. and Tang, Y., 2024. Using Cooperative Automated Transportation Data for Freeway Operational Strategies. Transportation Research Board.

### *C. Websites and other Internet Sites*

The [C2SMARTER website](#) disseminates information about the Center's activities and research, with 5,980 unique page views during this reporting period.

- The NYU Tandon team created a website with a description of their faculty research to support matching City Tech students with NYU Tandon faculty mentors. [Tech Transfer through Undergraduate Research & Workforce Development - C2SMARTER Home \(nyu.edu\)](#)
- NYU's JFK Landside team is working to enhance the work zone monitoring web-based [tool](#) developed from the previous C2SMART project. This tool can perform real-time detection of traffic counts by vehicle classification and work zone detection, including worker detection.

- UW's Urban Traffic Control team, along with MCity collaborators, set up a Github for both university contingents to host and share software packages, interface integration method and documentation, data, and testing documents and results.
- To publicize Building Intersection Digital Twins, NYU Prof. Vinitzky's team created a [website](#).
- NYU's Knowledge Capture team designed and created a [platform](#) to allow users to search and chat with LLM models and PDF files.
- Prof. Norman and team created a Google [Drive](#) to house a comprehensive list of content shared on social media, Linked In, press outlets and community organizations.
- The Tripchain Planner project was hosted on [Github](#).
- In collaboration with NYCDOT, Rutgers publicly shared the WIM [data](#) collected from the BQE testbed.

#### *D. New Methodologies, Technologies or Techniques*

- Prof. Abramson and community partners are adapting the SHOWED method for photovoice thematic qualitative analysis to develop a new technique of mappable drone-flown photo and videovoice.
- The FDNY team developed a traffic digital twin, a virtual representation that accurately mirrors a real-world traffic and transportation system. The preliminary information was shared with multiple media.
- The Digital Twin Flood project is integrating geospatial analysis techniques with machine learning for automatic assessment of flood risk vulnerabilities, specifically when available data is sparse.
- The Tripchain Planner project's AMXL model can effectively capture the heterogeneity in travel behavior and preferences, providing a robust tool for policymakers to simulate and evaluate various pricing and subsidy policies. The model's ability to integrate synthetic trip data and real-world usage data offers a comprehensive view of potential outcomes under different scenarios.
- Prof. Vinitzky's team created a new algorithm, human-regularized self-play, that enables the program to create drivers that are highly capable of long-distance driving while still mimicking human behaviors. They also created a new driving simulator, GPU Drive, that runs on GPU and can thus reach simulator speeds of millions of steps per second.
- The Calibration of VR Platforms project has introduced several innovative methodologies and technologies to enhance safety in work zones. The primary advancement is a VR and vision-based co-simulator system integrating the CARLA simulator, eye-tracking technology, and a racing wheel.
- The Urban Traffic Control project resulted in three new methods: 1) new methods in multiscale signal-vehicle coupled control, 2) new testing methods for CAV-related control, and 3) new modeling methods to integrate active road users and multi-vehicle classes in the control framework.
- The Control of CAVs for Congestion Reduction project resulted in experimental validation and application of learning-based control for autonomous vehicle lane changing.
- The Rutgers team implemented scripts to integrate data from various sources, facilitating the identification of overweight trucks, which are subsequently utilized to issue Notices of Liability.

#### *E. Inventions, Patents, and Licenses*

- Drs. Gao, Ozbay, and Zuo of NYU filed a full patent: U.S. Patent Application No. 18/804,316, filed August 14, 2024 (Claims Priority to U.S. Provisional Application No. 63/519,368, filed August 14, 2023), Title: "System and Method for Work Zone Management"

#### *F. Other Products*

- Nothing to report at this time.



## IV. Outcomes

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

- The JFK Landside project highlighted current JFK airport operation issues (e.g., congested landside traffic, needs for non-recurrent incident and frontage vehicle movement/incident detection).
- The FDNY Traffic Digital Twin project increased the understanding and awareness of the degraded emergency vehicle response times through various press releases. This initiated many follow-up discussions among different stakeholders and the general public.
- The Digital Twin Flood project lays the ground work for dynamic, data-driven insights into transportation infrastructure, enhancing the ability to model and predict the impacts of flooding on transportation networks. It does so by establishing interoperability across various software platforms used in interdependent infrastructure space.
- The Tripchain Planner project's focus on equity issues is very relevant to nationwide discussions on social justice and trip planners for travelers with special needs. This work has generated dialogue regarding equity issues associated with different elements of transportation systems.
- The Calibration of VR Platforms project has significantly improved the understanding of driver and worker behaviors in work zones through the integration of VR, CARLA, and eye-tracking technology. These findings advance knowledge in safety, particularly in managing complex hazardous work zones.
- The Control of CAVs for Congestion Reduction project achieved vehicle lane-changing control by using reinforcement learning and adaptive dynamic programming. This allows to develop better controllers to take real-time actions in safety-critical scenarios, leading to less congestion and traffic hazards.
- The Rutgers team consolidated data from various sources, enabling the identification of overweight trucks and quantifying them based on the extent of excess tonnage. This analysis provided insights into the trucking industry's response to the enforcement practice.

### B. *New Policies, Regulation, Rulemaking, or Legislation*

- Over April 14-18, the Rutgers team disseminated the research outcomes related to direct overweight enforcement and sought support from the committee. As a result, the team received a support letter from the Commercial Vehicle Safety Alliance (CVSA). Over June 15-21, the team disseminated the research outcomes and received a support letter from the American Society of Civil Engineers (ASCE).

### C. *Increases in the Body of Knowledge*

- At the ITS-NY Annual meeting, the Traffic Digital Twin project team disseminated knowledge of how digital twin technology can be used for EMV operations and highlighted the importance of applying emerging technologies in transportation systems.
- The FDNY Traffic Digital Twin project's industry partner Airsage published a [case study](#) explaining how their connected vehicle data is used in the project, providing a practical example on how such data can be used for understanding general vehicles' reaction to emergency vehicles.
- The Charting Equitable Outcomes project created a repository for and process by which communities can record and engage with the issues around urban infrastructure and their detrimental effects.
- Research findings from the Digital Twin Flood technologies and GeoAI add to the body of knowledge by shedding light on applying digital twin models in infrastructure and transportation management and integrating artificial intelligence and geographic information systems.
- The Tripchain Planner project contributed toward the efficient optimization-based algorithms for solving multicriteria shortest path problem considering multiple modes, such as incorporating equity concerns. The project is also investigating the role of simulation-based approaches to simulate demand and estimate wait/service time for on-demand transit.

- The paper that resulted from the Building Intersectional Digital Twins project demonstrated a new way to build models of human-driving that improve on the ability to create driving agents that can operate well in complicated scenarios.
- The Control of CAVs for Congestion Reduction project applied adaptive dynamic programming to the automated lane changing problem as well as nonlinear control and adaptive dynamic programming to the car following problem.

#### *D. Improved Processes, Technologies, Techniques and Skills in Addressing Transportation Issues*

- The **Knowledge Capture and Deployment Tracking Platform for UTC Research** team adopted and fine-tuned Mistral-7B v0.3 and developed an automated knowledge synthesis process, including chatbot and semantic search, after a preliminary testing stage of multiple open-sourced candidate LLM models. The platform's front-end leverages semantic search for document retrieval, allowing users to search using partial phrases or sentences. The integrated chatbot generates automated responses based on users' queries, with a focus on transportation-related data summarization.
- The FDNY Traffic Digital Twin team built a unique EMV digital twin using innovative and cutting-edge simulation techniques. Hundreds of EMV trips were simulated in a relatively short duration with key EMV parameter fine tuning (e.g., reaction distance of general vehicles to EMVs), offering a novel approach compared to traditional traffic simulation models.
- Research results in Digital Twin Flood technologies and geoAI can enable more efficient geospatial data analysis, especially when datasets are image based (such as flood inundation maps). It can also enable effective resource allocation and route planning by providing transportation planners with improved insights into traffic patterns.
- The FLDI Design study improved the geometric design and signal timing design for FLDI interchanges.
- The Building Intersectional Digital Twins project created a new driving simulator that can simultaneously evaluate hundreds of scenes. This allows researchers and agencies to evaluate impacts of proposed congestion reduction schemes quickly.
- The Calibration of VR Platforms project improved processes, technologies, techniques, and skills enhance transportation by optimizing traffic management, reducing congestion, and improving mobility through advanced tools, data-driven decisions, and ongoing skill development.
- The Control of CAVs for Congestion Reduction research provided an efficient method capable of realizing combined longitudinal and lateral real-time control for nonlinear vehicle models under car following problem, while the decision-making provides real-time action crucial for safety.
- The Rutgers team showcased the state-of-the-art WIM sensor (Piezo-Quartz sensor) and a software-based ALPR system for identifying overweight trucks, setting the foundation for future enforcement practices and enhancing the protection of our infrastructure.
- A paper submitted by Rutgers was recognized as the Best Theoretical Paper Award at the 16th International Symposium on Fiber-Reinforced Polymer (FRP) Reinforcement for Concrete Structures.

#### *E. Enlargement of the Pool of Trained Transportation Professionals*

- NYU faculty participated in NYU Tandon School of Engineering's Applied Research Innovations in Science and Engineering (ARISE) program, taking local high school students into their labs for experiential training over the summer. This free program is for academically motivated, current 10th and 11th grade New York City students with a demonstrated interest in science, technology, engineering, and math (STEM). 6 students participated in this year's program with NYU faculty
- NYU faculty also participated in NYU's Summer Undergraduate Research Program. Each summer, members of the Tandon School of Engineering faculty open up their labs to allow NYU Tandon, NYU rising sophomore, junior, and senior undergraduate students complete 10 weeks of hands-on research in the labs with faculty mentors and other mentors while also participating in seminars presented by distinguished administrative and academic personnel.

- The JFK Landside project team at NYU is training new student researchers to run computer vision-based models.
- Via the FDNY Traffic Digital Twin project, a student was trained during Summer 2024 as a part of a summer research program to assist in researching and creating the AI model framework.
- Seventeen undergraduate and graduate student researchers were trained and conducted field data surveys for the FDNY Traffic Digital Twin project.
- Through the Charting Equitable Outcomes project and resulting documentary, youth engaged in providing context and personal stories to inform decisions around infrastructural decisions.
- Three students have been trained and mentored throughout the Digital Twin Flood project.
- The students who are working on the FLDI project received extensive training in traffic signal timing design, microscopic traffic simulation modeling, and intersection performance analysis.
- Three graduate students were trained and mentored throughout the Tripchain Planner project.
- Via UW’s Urban Traffic Control project, a student revised the software packages and worked with city engineers and managers for integration and coordination. This project will also help train next-generation practitioners and researchers with emerging CAV technology and systems.
- Through City Tech, undergraduate research is being utilized as a mechanism to increase knowledge of the transportation industry. NYSDOT hired 43 City Tech students out of 80 available positions (54%).

*F. Adoption of New Technologies, Techniques, or Practices*

- As a result of the Rutgers WIM research and testbed implementation, NYCDOT adopted the WIM integration procedure proposed for overweight enforcement.

**Table 3: Outcomes/Impacts Performance Metrics**

Performance Metric	Achieved in period	Annual target
Multi-modal models / systems reducing congestion created	11	5
New or enhanced cyber/physical testbeds created and shared	5	3
Data and technology tools/platforms deployed to agencies or public users	6	5
Tools, methods, or procedures to measure equity	7	5
Community impact projects and deployments	5	5

**V. Impacts**

*A. Effectiveness of the Transportation System*

C2SMARTER’s research is positively impacting the operations and effectiveness of the region’s transportation system, aiding in ITS project prioritization, increasing driver safety, enhancing situational awareness, and reducing delay, among other benefits.

- NYU’s Knowledge Capture framework design can accelerate the process of extracting evaluation results and performance measures from current ITS projects, allowing researchers to better understand the effectiveness of current ITS projects on transportation systems.
- Overweight trucks decreased by more than 50% following the start of direct enforcement on the BQE, due to the Rutgers team’s efforts. This reduction is expected to decrease fatal accidents, traffic congestion, and pollution, while also extending the service life of bridges and improving driver safety.
- By more effectively monitoring landside traffic congestion and non-recurrent traffic incidents, the prototype tool developed by the JFK project team will assist PANYNJ in achieving enhanced situational awareness of traffic conditions at JFK Airport and faster response times.
- The FLDI research will facilitate the implementation of this new design. It can both reduce traffic delays and congestion at the interchanges and also improve the operational efficiency and safety of the entire roadway network and generate overall economic benefits.

### *B. Technology Transfer – New Practices or Companies*

C2SMARTER is facilitating technology transfer to government and industry entities, helping initiate start-up companies and commercializing new processes for transportation operations.

- Prof. Abramson’s research has led to the formation of a new consultancy in the partner community of Westport, WA: Emerald Coast Communications LLC.
- The designed knowledge synthesis framework created by PI Gao and team includes comprehensive technology transfer identification processes. The development of AI vision-based technique for traffic operations has led to a provisional patent application by the team. The team has conducted 20+ customer discovery interviews and applied for the NSF I-Corps summer cohort.

### *C. Increase in the Body of Scientific Knowledge*

C2SMARTER is contributing to the body of knowledge, theory, and research in the transportation field, as demonstrated by the honors bestowed on its researchers:

- NYU Prof. Jiang was honored by the American Association for the Advancement of Science (AAAS) by being included in the newest class of AAAS Fellows.
- The College of Science, Engineering, and Technology (COSET) at Texas Southern University honored C2SMARTER Co-PI Prof. Azimi with the Distinguished Advisement/Mentoring Award.
- At the end of June, the International Transport Economics Association (ITEA) hosted their 2024 Annual Conference. During this meeting, NYU Prof. Vignon was awarded the Richard J. Arnott Best Overall Paper Prize for “Safety, Liability, and Insurance Markets in the Age of Automated Driving.”
- Joseph Chow of NYU was named as a Lead Scientific Advisor of NEXT Modular Vehicles, which is an advanced smart transportation system based on swarms of modular electric vehicles.

### *D. Transportation Workforce Development*

C2SMARTER offers opportunities and skills training to underrepresented groups and provides practitioners and students exposure to the field of transportation:

- As part of the NYU Knowledge Capture project, two students were trained in LLM development, enhancing their capabilities in emerging deep learning AI technologies for transportation applications.
- Training in the AI vision-based tool and video analytics will be included as part of the FDNY Traffic Digital Twin project. Additionally, the student researcher will offer a course through the C2SMARTER Student Learning Hub on techniques used to train students and young professionals in transportation.
- The FDNY Traffic Digital Twin project provided training to student researchers on field survey data collection. Upon completion of the project, the project team will also provide online learning courses and workshops on the TDT and AI model used in the project.
- Researchers involved with the Digital Twin Flood project have been trained to use QGIS, python libraries for geospatial processing, and are working with flood projection software such as OpenFlows Flood and HEC-RAS.
- Students working on the FLDI project received training in traffic signal timing design, microscopic traffic simulation modeling, and intersection performance analysis essential skills for traffic engineers.
- The Calibration of VR Platforms project will contribute to workforce development by training professionals and students in using advanced simulation technologies and expanding their expertise in transportation modeling.
- The Rutgers team delivered presentations to advance truck weight compliance across the industry and organized two webinars on Structural Health Monitoring to train engineers and students.

## **VI. Changes/Problems**

- Nothing to report at this time.