TIER 1 CENTER
Primary Focus:
Reducing Congestion

USDOT STRATEGIC GOALS
Transformation (Primary)
Equity (Secondary)

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Connected Communities for Smart Mobility towards Accessible and Resilient Transportation for Equitably Reducing Congestion

C2SMARTER

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RESEARCH ABSTRACT

Transportation systems must respond to the extremely dynamic and complex needs of communities to ensure sustainable, adaptable, and equitable cities. However, congestion arising from competition for limited physical, financial, and human resources often leads to unsustainable and inequitable systems. These adverse mobility outcomes have serious long-term impacts on the communities they serve, with significant disparities in access to services and opportunities.

Reducing Congestion is the main research area of the proposed University Transportation Center (UTC), **C**onnected **C**ommunities for **S**mart **M**obility towards **A**ccessible and **R**esilient **T**ransportation for **E**quitably **R**educing *Congestion* (**C2SMARTER).** Under the prior grant as the C2SMART UTC, the team's unique and successful experience conducting research towards meeting agency and industry partners' goals revealed a pressing need for reducing congestion and its negative impacts. It is evident that congestion limits the mobility of people while imposing significant direct and indirect costs on society. In the last decade, we have seen new micro-mobility modes, shared transportation services, connected, autonomous, and electric vehicles take off, while new travel demand in terms of last mile deliveries and changing home-to-work trip patterns have emerged. These have resulted in major benefits but have come at a cost, especially to already underserved communities.

One common thread for all these changes is that they compete for the same, limited, resources. This not only leads to transportation network congestion – the most direct and obvious impact – but also hidden impacts such as strains to telecommunications and power networks. Moreover, the system-wide effects of these socio-technological changes can be even more drastic and unpredictable when coupled with external highly stochastic forces, such as the COVID-19 pandemic or extreme weather events due to climate change. Two years after first encountering the pandemic, road traffic volumes have largely recovered, but crashes have drastically increased, and transit usage is struggling to recover to pre-pandemic levels. The congestion both looks different from pre-pandemic patterns, and is less predictable, making its related problems—such as greenhouse gas emissions, cost of deliveries, ever-increasing competition for curb space, crashes, and the reliability of transit—harder to tackle. The impacts of the responses to these negative effects are further unclear; zero-emission electric vehicles, for example, could lack sufficient charging capacity, and connected and automated vehicles may increase congestion due to drastic changes in the new ways people use them. Decision-makers are struggling to devise effective and equitable solutions that balance these derivative effects while also deploying contextual, community-centric, solutions. Thus, research to identify and quantify this ever-changing landscape, and to deploy implementable solutions, is now more needed than ever.

Proposed Solution: 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.

Importantly, this work will build on the Center's earlier success, resources, and diverse partnerships, to enable accelerated transfer to communities that most need it. The main tool we will employ is our previously developed unique testbeds, both physical and cyber, to validate and synthesize insights across cities, in partnership with local agencies and the communities they serve. This Center will build on top of the foundational creation, calibration, and validation of these testbeds, and focus on ***transitioning research into practice*** for positive, equitable, impacts. Among the many successful examples of this approach is our Brooklyn-Queens Expressway testbed in New York, where big data from a variety of advanced sensors, combined with novel decision support models, are being used to extend the life and resilience of a critical infrastructure asset. Our research led to the passage of a landmark state law in 2021 for autonomous ticketing of overweight trucks, which facilitates ubiquitous weigh-in-motion enforcement to reduce truck and car congestion on a narrow but vital freight corridor. This research obviated the need for a full reconstruction—as well as the congestion and environmental impacts that disruption would have had on neighboring communities.

We thus seek to understand how the various testbeds and models we have established can serve as cross-cutting resources across different systems and geographies. C2SMARTER built its consortium with members whose access to existing and planned cyber-physical testbeds can harness the diversity of their institutions and their cities to learn from and develop transformational, equitable, and accessible solutions, replicable in a wide array of communities. An important aspect of this approach is the integration of shared experiences and developed research tools among consortium members. Our large-scale cyber-testbed of New York City (NYC) has been the precursor of similar cyber-testbeds in two other consortium member cities, Seattle and El Paso; we will leverage this unique experience to build and improve testbeds in other member communities, particularly where minority-serving consortium institutions are located.

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.