Request for Research Funding for FY 2021-2022			
Requesting Office	District 1	**Priority**	1 out of 1 (projects may not have the same ranking – no ties)
Proposed Title	Planning for near future multi-modal mixed traffic – Scenario specification and capacity analysis for Florida planning Tools		
Justification	Describe the current situation, why the research is needed, and how the research affects your office's mission critical focus areas Today's new vehicles have become increasingly well-equipped with driver assistance and automated driving features. It is predicted that half of the vehicles sold and 40% of vehicles on the road will be equipped with automated driving features by the 2040s. For example, the most common automated driving feature is adaptive cruise control (ACC) that is available on today's new vehicles, and these vehicles can be seen on the existing roadways. Furthermore, it is also expected that vehicle-to vehicle (V2V) and vehicle-to-infrastructure (V2I) communications will be readily available in the coming years. Similar to planning for changes in driver population and driver behavior, state transportation agencies must also adapt to new developments in vehicle technology that are already occurring, in particular connected and automated vehicle (CAV) technology. However, the effects of CAV on vehicle behaviors and roadway capacity characteristics remain unclear. Particularly, as the advancements of these technologies are uncertain and may either enhance or compromise traffic operations and roadway capacity. For example, besides the different levels of automation, the FHWA CARMA program specifies different connected vehicle (CV) levels (e.g., no communications, one-way communications, two-way cooperative communications). Due to such technological variations, the FHWA CAV scenario planning study proposes different CAV scenarios, including Enhanced Driving Experience, Slow Roll and Driver Becomes Mobility Consumer. Further, most existing planning tools focus on passenger cars and do not address other modes of transportation (e.g., trucks, buses, RVs, etc.) in detailed capacity analysis. Particularly, future heavy-duty vehicles may be capable of automated driving and platooning, which may further impact traffic characteristics and road capacity. Thus, it is important to begin assessing the impact and the potential changes that multi-modal CAV technology could bring. Otherwise, it would be difficult for relevant agencies (e.g., MPOs and state DOTs) to make appropriate and cost-effective long-term planning decisions in the coming decades where the ongoing developments in CAV technology could rapidly progress and fundamentally change the characteristics of transportation facilities. For instance, in an optimal scenario, CAV technology could increase roadway capacity and reduce the need for additional infrastructure spending. Whereas in a conservative scenario, CAV could even compromise roadway capacity and demand more infrastructure investment. To address this need, this project aims to develop methods to enable existing transportation planning models to incorporate the impacts of mixed multi-model traffic with CAVs. To achieve this goal and address these challenges, research is needed to establish a framework for mixed CAV traffic flow capacity analysis compatible to Florida planning tools (e.g., the traffic assignment step in the regional models). The following proposed research tasks will also complement the introduction of FHWA CARMA program in the state of Florida. • Specify Florida CAV planning scenarios based on the CARMA AV/CV levels and FHWA scenario planning study. • Develop BPR-like capacity functions for the identified scenarios. • Conduct field experiments to collect data on existing CAV technology (e.g., vehicles with Adaptive Cruise Control and V2V communications) for calibrating and validating the developed capacity function. • Develop a procedure to integrate the developed capacity function into Florida planning models • Conduct a case study (e.g., FDOT D1 regional planning model) This will be a collaborative research with USF and FAU. USF will lead the effort and FAU will help collect relevant AV mixed data and conduct related analysis with their AV fleet in conjunction with the USF testbed. *The proposers include the director and faculty members of the National University Center housed at the University of South Florida, National Institute for Congestion Reduction (NICR). We expect to have projects from NICR on connected automated vehicles, multimodal transportation, planning & policies to match this proposed research.*
Impact	How shall the results impact practice? Consequences of not doing the research? The study expects to benefit Florida transportation and metropolitan planning agencies by allowing them to better adapt to the ongoing and future changes and introductions of new CAV vehicle technologies. The agencies will be able to make

	better informed and more-cost effective decisions when they account for the potential capacity impacts that the existing and future CAV technology could bring. It will establish the leadership of Florida in preparing for the transportation challenges that involve the current and emerging connected and autonomous vehicles. The successful initiative in Florida will also benefit other state DOTs. Without this development, FDOT and relevant Florida planning agencies do not have methods and models for planning for ongoing and near future mixed multi-modal traffic, while their long-term planning tasks mandate them to incorporate mixed traffic scenarios. This could lead to mis-informed and less cost-effective long-term planning decisions. For example, FDOT could incur more spending associated with building more capacity than necessary on certain facilities or underinvest in other facilities where additional capacities are much needed. Without such methods and models, the relevant stakeholders may not be able to complete pressing tasks on developing planning models incorporating future mixed traffic scenarios.
Affected Offices	Identify any office that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise data/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings. **If the requesting office will not be the implementing office, please identify which office will have to serve in that capacity—has it been involved?** Office of Policy Planning; Office of Freight and Multimodal Operations; Office of Traffic Operations (Connected Vehicles)
Existing Work	TSMO/Cooperative-ADS Working Group. (2019 February 12) Development of Cooperative Automation Capabilities: Prototype II. FHWA Presentation Overview of FHWA Scenario Planning Study. FHWA Ghiasi, A., Hussein, O., Qian, S.Z. & Li, X. (2017). A mixed traffic capacity analysis and lane management model for connected automated vehicles: a Markov chain method. Transportation Research Part B, 106, pp. 266-292. Ghiasi, A., Hussain, O., Qian, S.Z. & Li, X. (2019). Lane Management with Variable Lane Width and Model Calibration for Connected Automated Vehicles. Journal of Transportation Engineering Part A, forthcoming; DOI: 10.1061/JTEPBS.0000283 CV Pool Fund Studies, 2019 "Cav Capacity Modification Factors" Oregon State DOT. Stern, R., Gunter, G., & Work, D. B. (2019, June). Modeling and assessing adaptive cruise control stability: experimental insights. In 2019 6th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS) (pp. 1-8). IEEE. Despite existing efforts in incorporating CAV in planning practice, the proposed research has the following unique aspects. 1. While most existing studies made various assumptions on mixed traffic characteristics, we will use field experiments and real-world data to calibrate and verify the model. 2. While most existing studies speculate future connected autonomous vehicles technologies that yet have various uncertainties and risks, the mainstream and currently available production vehicles with automated features (e.g., adaptive cruise control) are already operating on Florida highways. Their market penetration is expected to increase rapidly. For example, some of the best-selling affordable mainstream vehicles (e.g., 2020 Toyota Corolla) already have these automated features. Field tests showed that these production vehicles have different traffic characteristics from regular vehicles driven by humans and will significantly change traffic dynamics in the near future (Stern et al., 2019). However, few related studies made any attempt to address the presence and growth of these automated production vehicles. The proposed research will fill this gap by collecting relevant data and conducting field experiments in calibrating the capacity model.
Keywords Used In Existing Work Search **(Cannot leave blank)**	Connected vehicles, autonomous vehicles, mixed traffic, multi-modal transportation

Related Contracts (Give contract numbers)	N/A		
Funding Request	Estimated cost: 200,000	**Anticipated Duration**	24 months
Project Manager	Christopher Simpron	**Contracting Method**	RFP to universities only or RFP to all registered vendors
Urgency	Score 1; 1= highest, most immediate need	Comments* (elaborate as appropriate on justification/impact comments to explain the urgency of the need . . . is a solution needed immediately, needed within a certain period of time or by a known or anticipated deadline, desired for enhancement, etc.) The district office is in an urgent need to have a method of incorporating automated vehicles in mixed traffic in their planning models, given the fact that an increasing number of vehicles with automated vehicle features (e.g., ACC) are already running on the state highways. This project will enable District 1 office (as well as other districts in FDOT) to be able to estimate the impacts of automated vehicle technologies and make wise infrastructure investment for decisions that are to be made imminently.	
Implementability	Score 1; 1=greatest likelihood of and proximity to implementing results	Comments* (consider both the likelihood of implementation and the length of time and resources required to implement the results of the research.) Identify any prerequisites to, requirements for, or barriers to implementing the anticipated results of this research (e.g., new or change to existing specifications, development of production units of prototype device, legislative change); please indicate if multiple phases of work shall be required The preliminary results for passenger vehicles have already been implemented in FDOT District 1 Regional Planning Model as well as our white paper. The outcomes from this project can be immediately incorporated into our planning model traffic assignment module and other related components. While the implementation might request some script/programming effort, our contracting team on the planning model has rich experience in incorporating these methods in their planning models.	

Project Benefits (Succinct, complete explanation)

- Improve planning agencies' preparedness for future multi-modal traffic
- Reduce future investment cost
- Improve future traffic mobility and safety

Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc…if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits
o Materials Enhancement		
o Materials Savings	Optimizing investment on CAV infrastructure	Data: FDOT D1, D7 and Turnpike regional planning models Method: Analyze future infrastructure investment alternatives on costs
o Time Savings	Travel time improvements due to improve future mobility	Data: FDOT D1, D7 and Turnpike regional planning models Method: Analyze future infrastructure investment alternatives on travel time
o Lives Saved/Injuries Prevented	Improved safety with advanced CAV technologies	Data: FDOT D1, D7 and Turnpike regional planning models Method: Use the literature on CAV safety (e.g., injury reduction) to predict CAV safety benefits in the future planning scenarios

o Other (Explain)		

*Comments should explain and support urgency, financial benefit, and implementability scores