

Request for Research Funding for FY 2021-2022

Requesting Office	State Traffic Engineering and Operations	Priority	9 of 15
Proposed Title	Evaluating DSRC and C-V2X Technologies for Florida’s CAV Initiative		
Justification	<p>V2X technologies hold tremendous potential to significantly reduce traffic crashes and improve mobility across freeways and arterials. Although it has been over 20 years since FCC allocated the 75MHz spectrum to DSRC (IEEE 802.11p) in the 5.9GHz band, the spectrum remained underused, resulting in many automakers either abandoning the DSRC plan or switching to Cellular-V2X technology. While both DSRC and C-V2X are radio access technologies using the same message payloads (V2V and V2I applications expected to work the same way), the difference in their electronics forbids them to be interoperable. While DSRC has been available for many years now, the C-V2X has emerged and matured recently. In December 2019, FCC voted to reallocate the lower 45MHz of the 5.9GHz band for unlicensed broadband applications leaving the only 30MHz for ITS applications. Further, it is proposed that out of this 30MHz spectrum, 20MHz will be reserved for C-V2X, while only the remaining 10MHz would be allocated to the DSRC.</p> <p>Florida has been at the forefront of adopting V2X technology to improve safety and mobility under the CAV initiative. The FCC spectrum reallocation plan prompts for an urgent reassessment of the technology adoption roadmap for the CAV initiative by FDOT. At present, most of the operational and planned CV testbeds in Florida are based on DSRC technology. The exceptions include the US-19 corridor in Pinellas County, I-75 FRAME (Ocala), and the PedSafe project where RSUs can/will support dual-mode.</p> <p>Although at present, it is uncertain if the FCC will split the spectrum in the proposed fashion or some another way, the emerging trends suggest that C-V2X technology is here to stay (with major players like Ford and Qualcomm backing it). C-V2X uses the same technologies used in 4G LTE (can support 5G) and can outperform DSRC in certain aspects. While C-V2X's communication capability with cellular networks has potential for V2P and I2P applications – the radios can also directly communicate with each other. This direct communication, referred to as 'sidelink', has the potential to match latency requirements for safety-critical BSMs.</p> <p>Going forward, it is critical for the policymakers and CAV initiative leadership in Florida to have a clear understanding of emerging technological trends. It is an urgent requirement to understand the pros and cons of both DSRC and C-V2X technologies with respect to the envisaged V2X applications in Florida. Hence, <u>we intend to:</u> 1) study the suitability of DSRC and C-V2X technologies for Florida, 2) investigate the efficacy of C-V2X for V2P and I2P applications using its cellular capabilities, 3) investigate the efficacy of C-V2X for time-critical safety applications using its 'sidelink', 4) develop an optimal V2X technology selection plan that is compatible with emerging technologies, and 5) create an optimal hardware (RSUs) placement plan taking into account the technological attributes to ensure robustness. The findings will be documented in the form of a comprehensive report. The success of this project will support all the current and upcoming CV projects in Florida, which in turn, not only result in enhanced safety and mobility across the state but also lead to cost and time savings.</p> <p><u>Clarification on Approach:</u> The project objectives will be achieved through a rigorous literature review, industry coordination, and discussion with vendors and OEMs. Laboratory experiments will only be conducted in case a gap emerges in the understanding, necessitating experimentation. The technology selection plan will look at the functional requirement and crosswalk them with the capabilities of bands (not individual products). The RSU placement plan will examine at a sample section of a project to understand how different technologies may influence the process (we do not intend to examine all FDOT projects, but outcomes will be applicable to all).</p>		

Impact	<p>The project will provide insights for FDOT 1) to contrast the strengths and weaknesses of DSRC and C-V2X technologies in the Florida context, 2) to understand emerging trends in V2X technologies and their impact on Florida's CV projects, 3) to select appropriate V2X technologies, sensors, and communication devices, 4) to ensure seamless integration of existing and upcoming V2X technologies, 5) improve safety and mobility across arterials and freeways.</p> <p>If the project activities are not performed, it will be challenging to understand the current V2X technological trends and suitability of DSRC and C-V2X communication technologies for Florida's CAV initiative. It will create challenges in adopting appropriate technologies and best practices, thus creating a risk for the existing and upcoming CV projects in Florida. The lack of in-depth technical assessment may lead to sub-optimal use of time and resources. It would eventually have negative impacts on safety and mobility benefits that the state is seeking to reap from technological advancements in the V2X space.</p>		
Affected Offices	State Traffic Engineering and Operations Office, State Safety Office , Transportation Technology, District Traffic Operations		
Existing Work	<ol style="list-style-type: none"> 1. Spatiotemporal Analysis on Broadcast Performance of DSRC with External Interference in 5.9 GHz Band https://arxiv.org/abs/1912.02537 2. Performance Analysis of Cellular-V2X with Adaptive and Selective Power Control https://arxiv.org/abs/2008.03453 3. Review on V2X, I2X, and P2X Communications and Their Applications: A Comprehensive Analysis over Time https://www.mdpi.com/1424-8220/19/12/2756 4. The Cost in Fatalities, Injuries and Crashes Associated with Waiting to Deploy Vehicle-to- Vehicle Communication https://trid.trb.org/View/1595509 5. Adequacy of DSRC in 5.9 GHz Band for GDOT's Connected Vehicle Infrastructure (Ongoing project, https://trid.trb.org/View/1717048) 		
Keywords Used In Existing Work Search (Cannot leave blank)	<p>DSRC CV2X in safety critical applications (google scholar)</p> <p>DSRC C-V2X (TRID database)</p>		
Related Contracts (Give contract numbers)	-		
Funding Request	\$165,000	Anticipated Duration	18 months
Project Manager	Mr. Jeremy Dilmore Mr. Tushar Patel	Contracting Method	Direct contract with the University of Central Florida (Dr. Shaurya Agarwal)
Urgency	1	The project should get the highest priority as FCC's proposed spectrum reallocation will have direct implications for all the current and planned CV projects across Florida. Any delay in the project may lead to the adoption of outdated technology and potential interoperability issues. It would, in turn, significantly delay envisaged safety and mobility benefits.	
Implementability	1	The project will develop a roadmap for V2X technology adoption and implementation for Florida's CAV initiative. Upon project completion, we will know the competing DSRC and C-V2X technologies' exact strengths and weaknesses and which technology to implement going forward. The project will also investigate the efficacy of C-V2X for V2P/I2P applications using cellular network, thus providing insights on integration of pedestrian safety applications on current and planned CV projects. Outcomes of investigation on optimal selection of technology and optimal placement of RSUs will be ready for immediate implementation and incorporation in ongoing CV projects.	

The benefit to the Department is the removal of unknowns on how to proceed with the connected vehicle program. The Department has placed almost 200 DSRC units in the field and is on the verge of placing an additional 400+ C-V2X units. This infrastructure is expensive to purchase, install, and maintain. There is some uncertainty as to how to best leverage available technology. Knowing this can help the Department develop a plan for the upgrading, replacing, or maintaining of existing infrastructure. This adds in work program stability.

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
<input type="radio"/> Materials Enhancement		
<input type="radio"/> Materials Savings	RSUs and related I2X apparatus	The project will identify and recommend appropriate hardware technology for future CV projects. The project will also study existing I2X infrastructure and create a roadmap for its integration with emerging technologies. This will avoid the multiple iterations of implementation, leading to materials savings in all the current and planned CV projects in Florida.
<input type="radio"/> Time Savings	Delay at intersections and freeways	One of the primary objectives of the CV projects in Florida is to reduce congestion and improve mobility. This project supports all the existing and upcoming CV projects by making them more technologically compatible with emerging trends. E.g., the appropriate selection of technology would mean that more vehicles on the road will be able to reap the benefits of V2X communication. Thus, resulting in improved mobility and time savings.
<input type="radio"/> Lives Saved/Injuries Prevented	Number of crashes	One of the primary objectives of the CV projects in Florida is to reduce crashes and improve safety. This project supports all the existing and upcoming CV projects by making them technologically compatible with emerging trends. E.g., the appropriate selection of technology would mean that more vehicles on the road will be able to reap the benefits of V2X communication. Moreover, the project may also indirectly support I2P applications with a pedestrian safety focus. Thus, resulting in safer roads with fewer crashes.
<input type="radio"/> Productivity		

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