

NC Transportation Center of Excellence in Advanced Technology Safety & Policy

Center Overview

2020 NCDOT Research and Innovation Summit

October 13, 2020




Learn more:
tsap.unc.edu

Our Team

- TSAP is a consortium of partners encompassing diversity in disciplines and representation
- TSAP is a collaborative, multidisciplinary group of traffic safety research professionals, human factors experts, planners, public administrators, educators, computer scientists/systems engineers, and civil and electrical engineers

Our Team




DIRECTOR
Dr. Randa Radwan



ASSOCIATE DIRECTOR
Dr. Elizabeth Shay



ASSOCIATE DIRECTOR
Dr. Maranda McBride



ASSOCIATE DIRECTOR
Dr. William Wiener



ASSOCIATE DIRECTOR
Dr. Srinivas Pulugurtha

Research Areas of Emphasis

- Advanced Technology Solutions and Pedestrians
- Connected and automated vehicles (CAV) Operational and Economic Impacts
- CAV Data and Travel Efficiency

Poll Question

- When do you expect the infrastructure in North Carolina will be ready for connected and automated vehicles (CAVs)?
 - within the next year
 - in 1 to 5 years
 - in 5 to 10 years
 - in 10 to 20 years
 - over 20 years
 - never

Research Themes

TSAP has five research projects with two key themes:

- Using and improving existing infrastructure to advance safety and mobility and help North Carolina communities, particularly vulnerable road users
- Using CAVs to advance mobility, with a focus on economic impact and data

P1: Impacts of CAV-ready infrastructure on Vulnerable Road Users (VRUs)

- **Focus:** Guidance for local and state transportation agencies for implementation of CAV infrastructure with a focus on safe interactions with VRUs
- **Motivation:** Little empirically based guidance on impacts of CAV-adapted infrastructure on VRU safety or mobility
- **Research:** Identify, catalog, visualize, and evaluate CAV-readiness strategies with implications for the physical design and operation of intersections
- **Findings** will be used to identify the most promising types of interventions from the VRU safety and mobility perspective across a variety of contexts
- **Co-PIs:** Dr. Tabitha Combs, UNC-Chapel Hill, Dr. Elizabeth Shay, Appalachian State University
 - **The project team welcomes inquiries from transportation planners, engineers, or elected officials with knowledge of CAV planning, who may want to contribute to a developing knowledge base**

P2: IoT Solutions for Near Horizon Challenges in Smart City Pedestrian Travel

▪ **Motivation:**

- Currently, most consumer level solutions at the automobile level tend to ignore pedestrian analytics beyond collision avoidance
- Development of Pedestrian to Infrastructure (P2I) and Pedestrian to Vehicle (P2V) communications and analytics, in the Internet of Things (IoT) domain, can substantially improve safety and pedestrian travel in a dynamic and responsive environment.

▪ **Research goals:** to explore three areas-

- Analysis of pedestrian habits to improve safety
- Establishing communication methods between pedestrian smart devices with traffic infrastructure
- Establishing a method of communicating intersection information to pedestrians

▪ Research expertise in pedestrians who are blind and visually impaired will be leveraged to promote universal design in solutions

▪ **PI:** Sean Tikkun (NCCU), **Team:** Srinivas Pulugurtha (UNC Charlotte), William Wiener (NCCU)

▪ **Research products will serve as foundation for a connected environment that includes pedestrians as a node of information & for future deployment and development that can interface with existing infrastructure to allow for more fluid pedestrian traffic**

P3: Operational and Economic Impacts of CAVs

- **Focus:** Long-range planning models for NCDOT and other public agencies to assess the safety and economic impacts of CAV infrastructure investment
- **Motivation:** Based on penetration rates, CAV impacts could be positive or negative when factors are considered at a micro-level: travel demand and an increase/ decrease in congestion costs, traffic safety, unemployment rate in transportation sector, effect on energy market, insurance costs, and emissions
- **Research goals:** Model and evaluate operational & safety performance of the transportation network at various penetration rates of CAVs, and to assess the impact of CAVs on the economy.
- **PI:** Dr. Srinivas Pulugurtha, UNC Charlotte, **Team:** Dr. Amirhossein Ghasemi, UNC Charlotte, Dr. Raghavan Srinivasan and Dr. Michael Clamann, UNC-Chapel Hill
- **Potential outcomes include microscopic simulation models to analyze heterogeneous traffic networks, and a framework for systematically assessing the operational and economic impacts of CAVs**
- These outcomes will provide valuable insights for proactively planning, designing, and operating North Carolina's transportation network

P4: Intelligent Data Exploration & Analysis for New & Existing Transportation Technology (IDEANETT)

- **Focus:** Integration of CAV fleet data with NCDOT data infrastructures to create a publicly beneficial travel time visualization and information system
- **Research goals:** Develop a data-driven vehicle routing algorithm to reduce travel time of in-vehicle navigation systems in a simulation environment, for 1) a time-dependent transportation network, 2) with spatial-temporal map dependencies, and 3) a priori time-varying least travel time
 - IDEANETT simulates driver responses to sudden road network perturbations by applying Dynamic Traffic Assignment (DTA) to two groups of drivers; informed and uninformed
 - A navigation app that provide within-day route suggestions to informed drivers using information about the time-varying decision-making habits of uninformed drivers
- **PI:** Dr. Hyoshin (John) Park, NC A&T, **Team:** PhD Candidate Larkin Folsom, NC A&T
- **Outcome:** A visualization system to estimate and predict short-term and long-term travel time by links and paths levels in North Carolina, through spatiotemporal correlation map. NCDOT will be capable of handling an unprecedented amount of data significantly enhancing reliability of travel time information.

P5: Plan for Advanced Technology Data Readiness

- **Focus:** Identify CAV data needed by public agencies, and map such data to agency use cases for an NCDOT-specific data readiness framework
- **Motivation:** To understand how data requirements for CAVs differ from traditional vehicles prior to deployment, e.g. in crash analysis, vehicle registration, tracking and revenue. CAVs expected to have different requirements on infrastructure, and maybe new data requirements on land use and the built environment
- **Research goal:** Develop an NCDOT-specific framework for data readiness by (1) identifying the CAV-specific data NC public agencies need and (2) mapping the data to public agency use cases. Because “data” is a broad term, four categories are being analyzed: vehicle, infrastructure, crash, and public impression data.
 - Students support from Appalachian State and UNC Charlotte graduate and undergraduate courses in Planning Methods and Techniques; Planning Studio; Transportation Planning; Advanced Traffic Engineering; Transportation Planning; Traffic Control & Operations; Intelligent Transportation Systems, Computer Applications for Transportation Engineers, Traffic Safety
- **Co-PIs:** Dr. Michael Clamann, UNC-Chapel Hill, Dr. Srinivas Pulugurtha, UNC Charlotte
- **Outcome:** A draft model data readiness plan summarizing best practices for CAV data collection and tracking, and a recommended framework for data readiness, developed in cooperation with NCDOT

Workforce Development

- Supporting internships & fellowships and/or engaging students in classes
- Exposing students to advanced technologies and opportunities to engage with stakeholders

Highlight: Two TSAP researchers presented at the NC A&T 2020 Summer High School Transportation Institute* (STI), held virtually in July.

- Dr. Sean Tikkun, assistant professor in the Department of Education at NCCU, gave a presentation on GPS and GIS for the visually impaired
- Dr. Srinivas Pulugurtha, professor and research director of the IDEAS Center at UNC-Charlotte, discussed an array of careers in Civil Engineering

*The NCA&T STI is traditionally a 5 ½ week on-campus non-residential program during which local high school students engage in activities that allow them to learn more about the transportation profession

THANK YOU!

Learn more:
tsap.unc.edu



NCDOT Center of Excellence on Mobility and Congestion

Center Introduction

**North Carolina Department of Transportation
Research & Innovation Summit**

October 13, 2020

Outline

- Foundational principles
- Team formation
- Project development
- Team structure
- Center communications

Foundational Principles

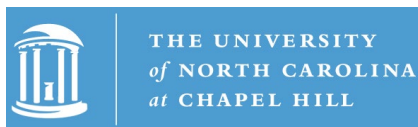
- Exploit ITRE and NC State's expertise and leadership in traffic operations, management, and control
- Build a team fully responsive to the NCDOT goals of –
 - Leveraging **“multi-disciplinary skills and knowledge across multiple universities”**
 - Drawing on strengths in North Carolina's **“Historically Black Colleges and Universities and Minority Serving Institutions”**
 - Providing **“a long-term view and cutting-edge approach”**
 - Exploring multifaceted research as outlined in the CoE RFP

Team Formation

- Goal of at least two HBCU/MSI team members
- Build on current relationships
- Nurture new relationships

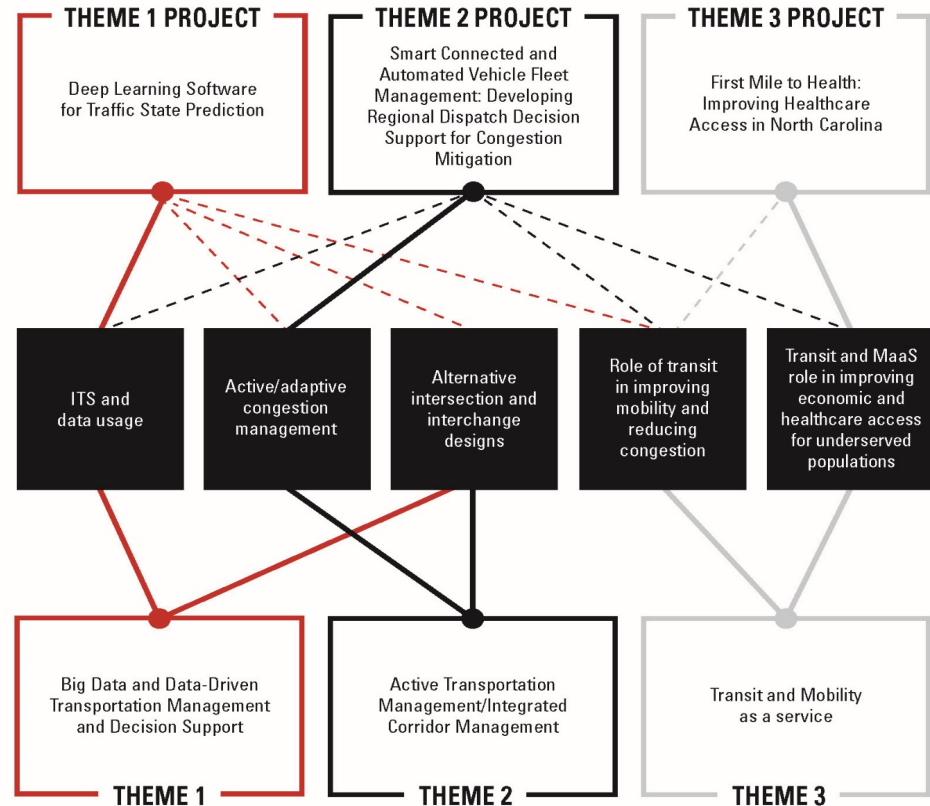
Team Institutions

NC STATE
UNIVERSITY



Project Development

- The RFPs five research areas were mapped to three themes
- All interested researchers (~40) across the five universities were invited to submit research ideas
- Fourteen research ideas emerged and were evaluated and ranked by all participants
- This process resulted in the three projects included in the center proposal – One project for each theme



Team Structure – Center Leadership

- Director
 - Billy M. Williams, Ph.D., P.E. – NC State University/ITRE
- Associate Directors
 - Mary (Missy) Cummings, Ph.D. – Duke University
 - Sambit Bhattacharya, Ph.D. – Fayetteville State University
 - Maranda McBride, Ph.D. – NC A&T State University
- Co-Associate Directors
 - Noreen McDonald, Ph.D. – University of North Carolina at Chapel Hill
 - Randa Radwan, Ph.D. – University of North Carolina at Chapel Hill

Collaborative Project Team Structure

- **NCSU/ITRE**
 - Leading Project 3
 - Co-PI on Project 3
 - Researchers on all projects
- **Duke**
 - Leading Project 2
- **Fayetteville State University**
 - Leading Project 1
 - Researchers on Project 1 and Project 3
- **NC A&T State University**
 - Co-PI on Project 1 and Project 3
 - Researcher on Project 3
- **UNC-CH**
 - Co-PI on Projects 1 and 3
- **Project 1**
 - Led by **Fayetteville State University**
 - Collaboration from **NCSU/ITRE** and **NC A&T State University**
- **Project 2**
 - Led by **Duke**
 - Collaboration by **NCSU/ITRE** and **UNC-CH/HSRC**
- **Project 3**
 - Led by **NCSU/ITRE**
 - Collaboration by **Fayetteville State University**, **NC A&T State University**, and **UNC-CH/DCRP**

Center Website



<http://go.ncsu.edu/mobility-congestion>

Center of Excellence – Theme 1

- Theme Title: ***Big Data and Data-Driven Transportation Management and Decision Support***
- Project Title: ***Deep Learning Software for Traffic State Prediction***

Project Team

- Principal Investigator – **Sambit Bhattacharya, Ph.D.**
 - Professor of Computer Science – Fayetteville State, Dept of Math & Computer Science
 - Director – Intelligent Systems Lab (ISL)
- Co-Principal Investigators
 - **Ali Hajbabaie, Ph.D.** – NC State, Assistant Professor in the Department of Civil, Construction, and Environmental Engineering
 - **Noel Greis, Ph.D.** – NC State, Research Full Professor, Poole College of Management
 - **Hyoshin (John) Park, Ph.D.** – NC A&T, Assistant Professor in the Department of Computational Science & Engineering
- Senior Researchers
 - **Murat Adivar, Ph.D.** – Fayetteville State, Associate Professor, Broadwell College of Business & Economics
 - **George List, Ph.D.** – NC State, Professor in the Department of Civil, Construction, and Environmental Engineering
 - **Thomas Chase, Ph.D.** - NC State, Research Associate in the Institute for Transportation Research and Education

Methodology

- Deep/machine learning AI approach to prototype software design
- Research activities will include –
 - Data collection on real and simulated traffic
 - Developing single and multi-stream video analytics
 - Developing data fusion methods
 - Testing the hypothesis that advanced traffic signal control algorithms can provide a higher level of optimization with this traffic state estimation technique

Summary of Progress to Date

- Literature review on intersection control using different sources of traffic data
- Literature Review on traffic state estimation methods
- Traffic state estimation - What are the key variables? How do we estimate these variables from raw remotely-sensed data?
- Literature review about state-of-art in using deep neural networks (DNNs) and other machine learning methods for object detection and tracking in video and other data

Center of Excellence – Theme 2

- Theme Title: ***Active Transportation Management and Integrated Corridor Management***
- Project Title: ***Smart Connected and Automated Vehicle Fleet Management: Developing Regional Dispatch Decision Support for Congestion Mitigation***

Project Team

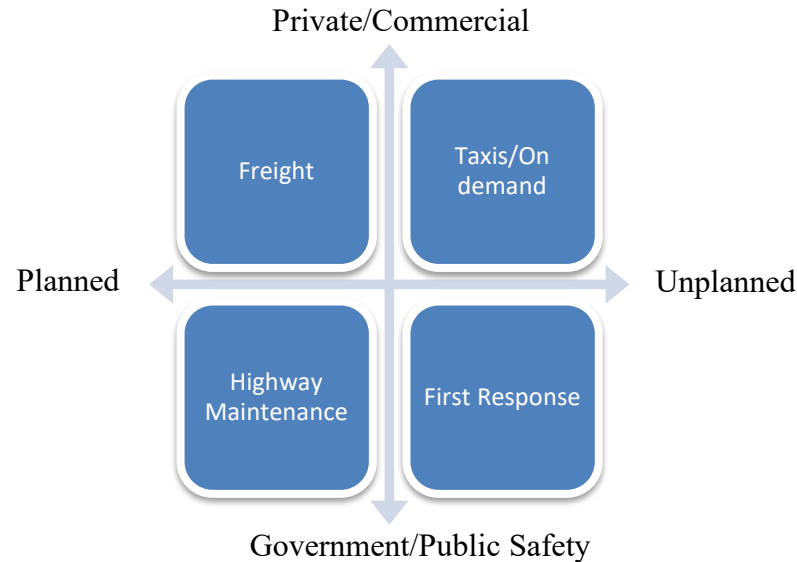
- Principal Investigator – **Mary “Missy” Cummings, Ph.D.**
 - Professor – Duke University
 - Department of Electrical and Computer Engineering
 - Department of Computer Science
 - Duke Robotics
 - Duke Institute for Brain Sciences
 - Director – Humans and Autonomy Lab (HAL)
- Co-Principal Investigators
 - **Eleni Bardaka, Ph.D.** – NC State, Assistant Professor in the Department of Civil Construction and Environmental Engineering
 - **Raghavan “Srini” Srinivasan, Ph.D.** – UNC-CH, Senior Transportation Research Engineer at the Highway Safety Research Center
- Senior Researcher – **Nagui Rouphail, Ph.D.** – NC State, Distinguished University Professor Emeritus in the Department of Civil Construction and Environmental Engineering

Methodology

- Systems engineering approach to prototype system design
- Prototype design steps will include –
 - Concept of operations (CONOPS) analysis for NC's statewide and regional traffic management centers
 - Develop a dispatch operator interface linked to traffic flow models and AI-empowered solution searching
 - System testing across various concept of operations and edge case scenarios

Summary of Progress to Date

- Completion of initial literature review and CONOPs
 - Joint with UNC CSCRS UTC



Note – Attend the Student Lightning Talk - *Congestion-Aware Vehicle Routing Based on Wireless Networking Paradigms* by Vishwa Alaparthi, Duke postdoctoral associate, tomorrow at 2:30 pm

Five Possible Types of CONOPS

- Original Equipment Manufacturing (OEM) AV Dispatch Support
- Robo-Taxi Dispatch
- Autonomous Trucking Dispatch
- Public Transportation AV Dispatch
- State/Regional AV Management and Dispatch
- Note: These options are **not** mutually exclusive



Center of Excellence – Theme 3

- Theme Title: ***Transit and Mobility as a Service (MaaS)***
- Project Title: ***Transit and MaaS Role in Improving Economic and Healthcare Access for Underserved Populations***

Project Team

- Principal Investigator
 - **Kai Monast, MRP**, Director, Public Transportation Group – NCSU/ITRE
- Co-Principal Investigator
 - **Noreen McDonald, Ph.D.** – Thomas Willis Lambeth Distinguished Chair, UNC-CH, Department of City and Regional Planning
 - **Hyoshin (John) Park, Ph.D.** – Assistant Professor, NC A&T, Department of Computational Science and Engineering
- Senior Researchers –
 - **Eleni Bardaka, Ph.D.** – Assistant Professor, NCSU, Department of Civil, Construction, and Environmental Engineering
 - **Burcu Adivar, Ph.D.** – Assistant Professor, Fayetteville State University, Broadwell College of Business and Economics
 - **Trung Tran, Ph.D.** – Assistant Professor, Fayetteville State University, Department of Intelligence Studies, Geospatial Sciences, Political Science, and History

Methodology

- Mixed method approach combining:
 - Historic quantitative spatial data trip origins and destinations with tabular data operating statistics
 - Contemporary qualitative perspectives of transport system users and health care systems
 - Operational models for scenario planning
 - Stated preference surveys

Summary of Progress to Date

- Determined the essential criteria for study site selection
- Repositioned research pending Medicaid Transformation
- Pivoted to align with the **Mobility for All** grant

Mobility for All

- USDOT \$350,000 capital purchase grant to NCDOT
- Pilot project in the Elizabeth City region to evaluate future statewide deployment
- Connect the software to NC DHHS's NC Care 360 care management platform
 - Allows care providers and customers to book transit trips
 - Directly matches transit trips and healthcare appointments
- Implement same-day transportation service in Elizabeth City
- Assess changes in healthcare outcomes

Advantages of CoE Project Alignment with Mobility for All Grant

- Combines policy changes with service enhancements
- Almost guaranteed to be implemented
- Partners are fully engaged and invested in success
 - Transit system is highly motivated
 - Transit system is embedded in a regional health authority
 - NC DHHS is highly motivated
- Access to information for research should be streamlined
- Medicaid Transformation will be included if and when it happens
- Great value for understanding future implications of statewide deployment

Thank you!

Billy Williams

Director, ITRE

NC State University

billy_williams@ncsu.edu



NC Transportation Center of Excellence on Connected and Autonomous Vehicle Technology (NC-CAV)

<https://www.nccav.com/>



Ali Karimoddini, PhD
E-mail: akarimod@ncat.edu
Website: <http://akarimod.info>

TCE2020-03
CoE Session at the R&I Summit
October 2020



Outline



- Center Overview
- Project 1: CAV Impacts on Traffic Intersection Capacity and Transportation Revenue
- Project 2: Assessing North Carolina Readiness for CAVs in Traditional and Emerging Infrastructure Needs
- Project 3: Developing and Implementing CAV-UAV Collaboration for Advancing the Transportation Systems
- NC-CAV Education and Outreach
- Questions



Research needs



The transportation industry is undergoing a transformation

Autonomous Vehicles By 2030

5G communication ✓

Cloud computing ✓



Technologically, we are ready to use connected autonomous vehicles as soon as autonomous vehicles are operationalized!



Are we ready?

Research Needs:

- What are the impacts of CAVs on the transportation systems, the users, and revenue?
- What are the infrastructure needs for CAV technologies?
- What will the transportation system look like with deployment of CAVs and what are the emerging applications of CAVs?

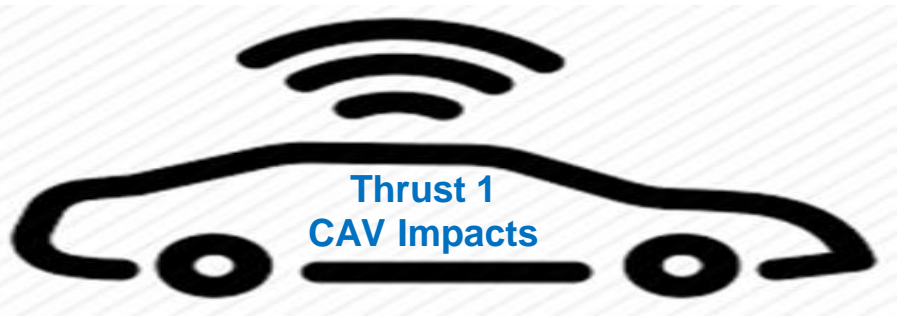
About NC-CAV

NC-CAV brings together a strong and diverse team of NCAT, NCSU, and the UNCC to conduct innovative, cutting-edge, synergistic, interdisciplinary research on connected autonomous vehicles which will prompt revolutionary transformations in the transportation systems by providing increased capacity, reliability, affordability, and sustainability.

Goal: To seek long-term vision and cutting-edge multidisciplinary approaches to **investigate the adoption, utilization, and deployment of CAVs and their impacts** on the transportation system in North Carolina and the nation.

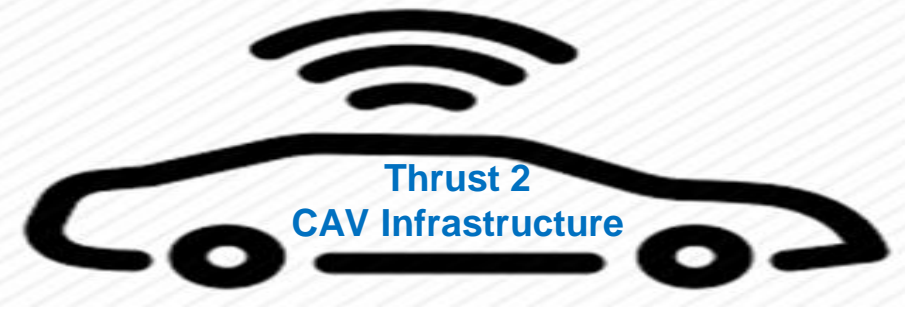


Research Approach



Thrust 1
CAV Impacts

Thrust 1 investigates the impact of Connected and Autonomous Vehicles (CAV) on North Carolina's transportation system, and associated revenue.



Thrust 2
CAV Infrastructure

Thrust 2 assesses North Carolina's readiness for CAVs in terms of traditional and emerging transportation infrastructure.



Thrust 3
CAV Applications

Thrust 3 explores emerging applications of CAVs and develops and deploys CAVs and Unmanned Aerial Vehicles (UAVs) for advancing transportation systems.



NC-CAV: Research Institutes and Laboratories



NC A&T State University

- Autonomous Control and Information Technology (ACIT) Institute
- Autonomous Cooperative Control (ACCESS) Laboratory

NC State University

- Institute for Transportation Research and Education (ITRE)
- Signal Control Laboratory
- Mobile Remote Sensing and Data Collection Lab



UNC Charlotte

- USDOT Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE)
- ITS, Traffic Operations and Optimization Lab (ITS-TOOL)



Research Thrust 1: CAV Impacts

Project 1: CAV Impacts on Traffic Intersection Capacity and Transportation Revenue

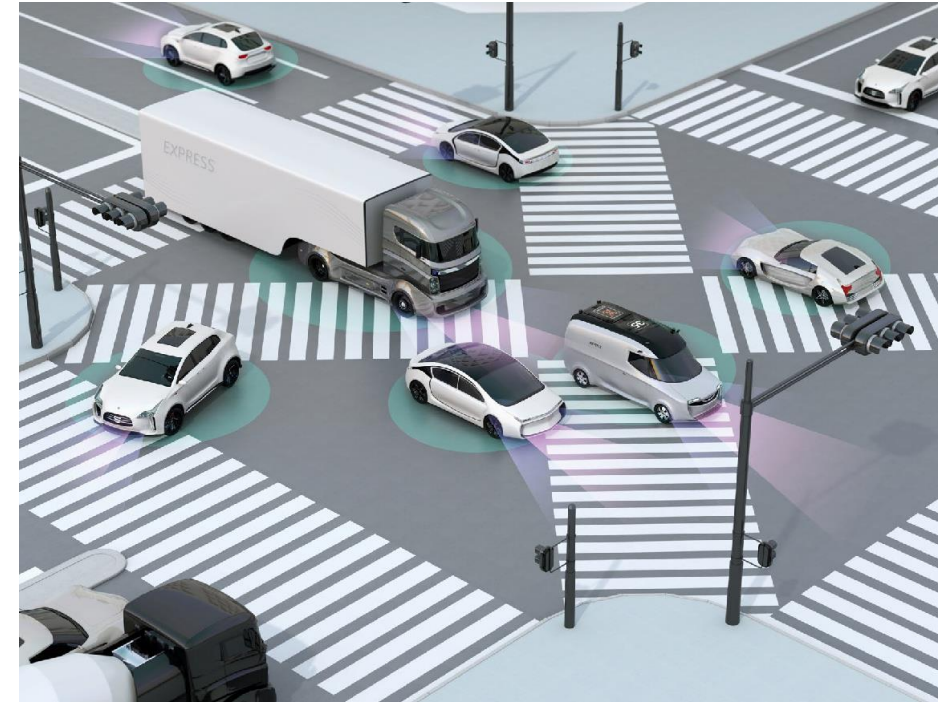
Principal Investigator: W. Fan (UNCC)

Other Investigators: NCAT: S. Jiang; ITRE: A. Hajbabaie, D. Findley, S. Bert, N. Norboge

Scope: Thrust 1 investigates impacts of CAVs on the **transportation system's performance**, particularly on intersection capacity adjustments while accounting for mixed vehicle fleets with different levels of CAV adoption. This project will also assess the **fiscal revenue** impacts of the transition to CAVs on North Carolina's cities, towns, and households.

Objectives:

- Surveying CAV technologies and their impacts on intersection capacity and the associated transportation revenues;
- Develop case studies to illustrate the impacts of CAVs on the traffic systems, particularly at the intersections, suitable intersections will be identified for the case study;
- Analyze the impacts of the CAV technologies on intersection capacity and provide recommendations for future research directions;
- Analyzing the revenue impacts and opportunities of deployment of CAVs at various adoption rates and policy scenarios in NC.



Research Thrust 2: CAV Infrastructure



Project 2: Assessing North Carolina Readiness for CAVs in Traditional and Emerging Infrastructure Needs

Principal Investigator: T. Chase (ITRE)

Other Investigators: NCSU: S. Lin; NCA&T: J. Kelly, A. Eroglu

Scope: Thrust 2 researchers will analyze the readiness of the existing transportation infrastructure and maintenance programs to support CAV deployment and will investigate the emerging infrastructure required for the adoption of future CAV technologies.

Objectives:

- Document NCDOT Infrastructure Programs Impacted by CAV Needs
- Develop and test a 5G architecture for secure V2I applications
- Recommend Program Enhancements to Advance NC CAV Infrastructure Readiness



Research Thrust 3: CAV Applications



Project 3: Developing and Implementing CAV-UAV Collaboration for Advancing the Transportation Systems

Principal Investigator: Abdollah Homaifar (NCA&T)

Other Investigators: Ali Karimoddini, Leila Hashemi (NCA&T), Nagui Roupail, Chris Cunningham (NCSU)
Wei Fan (UNCC)

Scope: Thrust 3 develops and experimentally validates cooperative control techniques for CAVs and UAVs. In particular, Thrust 3 will develop cooperative control techniques for On-Demand mobility applications, will prototype a testbed of a network of CAVs to implement emergent applications of CAVs, and will explore the application of UAVs for transportation systems such as aerial traffic monitoring and accident or emergency management.

Objectives:

- Developing Cooperative control of heterogeneous CAVs and UAVs for on-demand mobility applications
- Prototyping a testbed of a network of CAVs
- Aerial monitoring using CAVs





NC-CAV Use-Cases

Use-case 1: Feasibility study for deployment of CAVs between NCA&T campus and Greensboro downtown



Use-case 2: Prototyping and deploying a CAV-testbed



Use-case 3: demonstration of the UAV application for traffic management

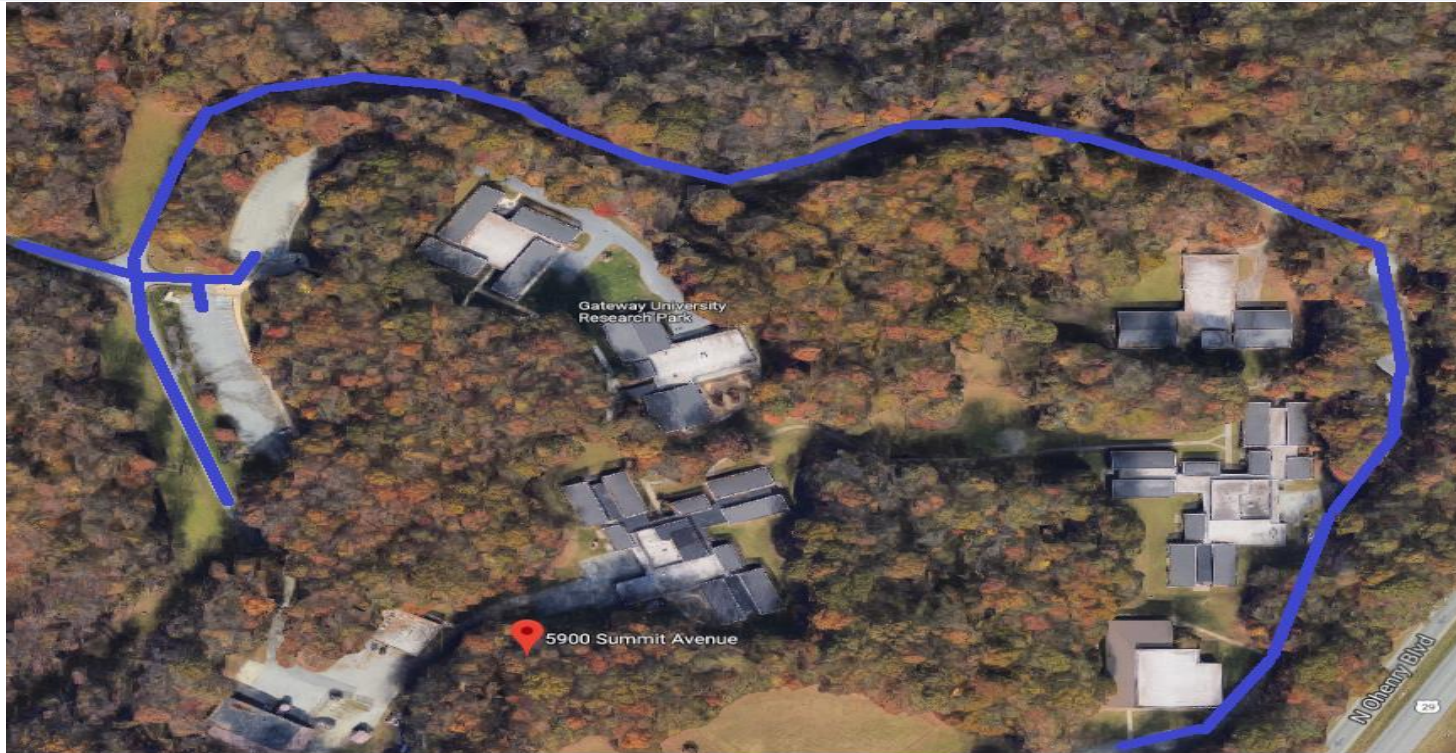


NC-CAV Use-Cases: A Testbed of Connected Autonomous MicroTransit Vehicles Activities

- Through a joint support from NSF, NCDOT, and DGI, NCCAV research team will develop and deploy a Testbed of Connected Autonomous MicroTransit Vehicles in the form of three self-driving shuttles and associate communication and computation parts.



NC-CAV: Test Track Facility for CAVs



North Carolina A&T
State University

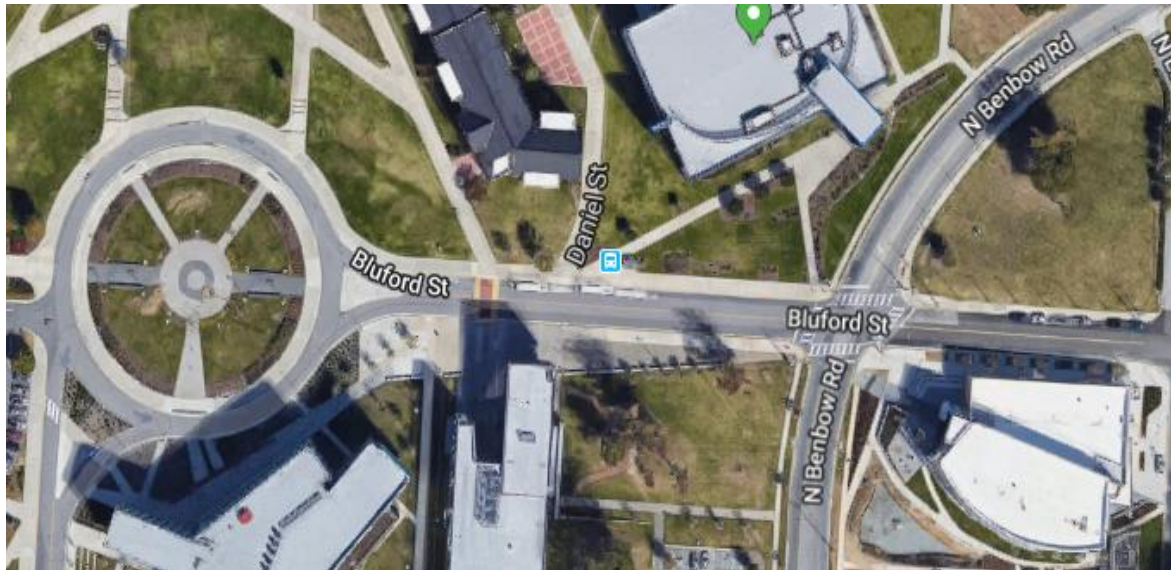
Gateway University Research Park - North Campus
Autonomous Vehicle Test Track

5900 Summit Ave.
Browns Summit, NC 27214

NC-CAV: Road Intersection Testing Facility



- Access to the intersection of Benbow Rd. and Bluford St is provided by GDOT for installing smart signaling equipment to connect with CAVs. This intersection will be used for testing the CAVs developed under the Center.



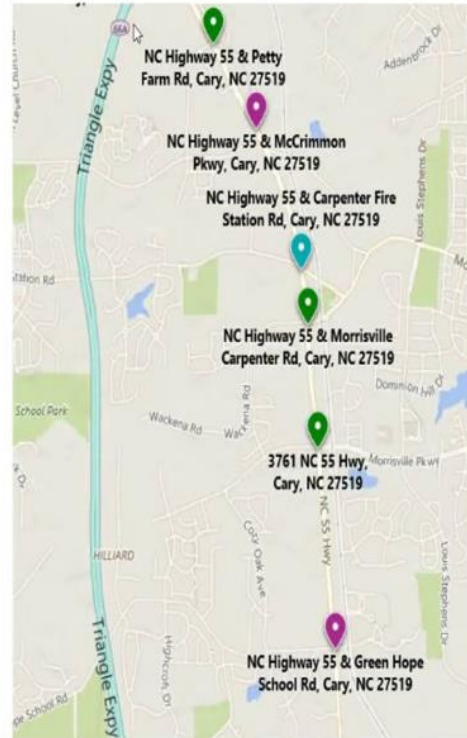
NC-CAV: Other CAV Testing Facilities



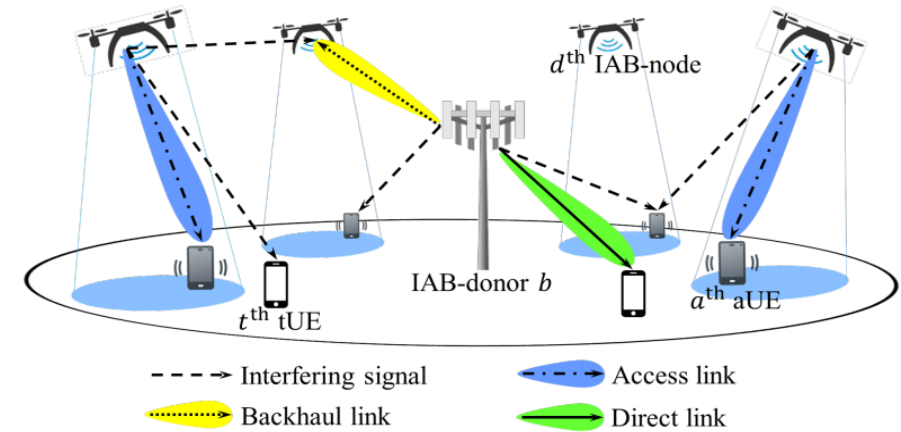
NCDOT SPaT Challenge Corridor on NC-55

Locations

- NC Highway 55 & Petty Farm Rd
- NC Highway 55 & McCrimmon Pkwy
- NC Highway 55 & Carpenter Fire Station Rd
- NC Highway 55 & Morrisville Carpenter Rd
- NC Highway 55 & Morrisville Pkwy
- NC Highway 55 & Green Hope School Rd



UAV Communication Networking: AERPAW



NCSU CENTMESH Mesh WiFi Network



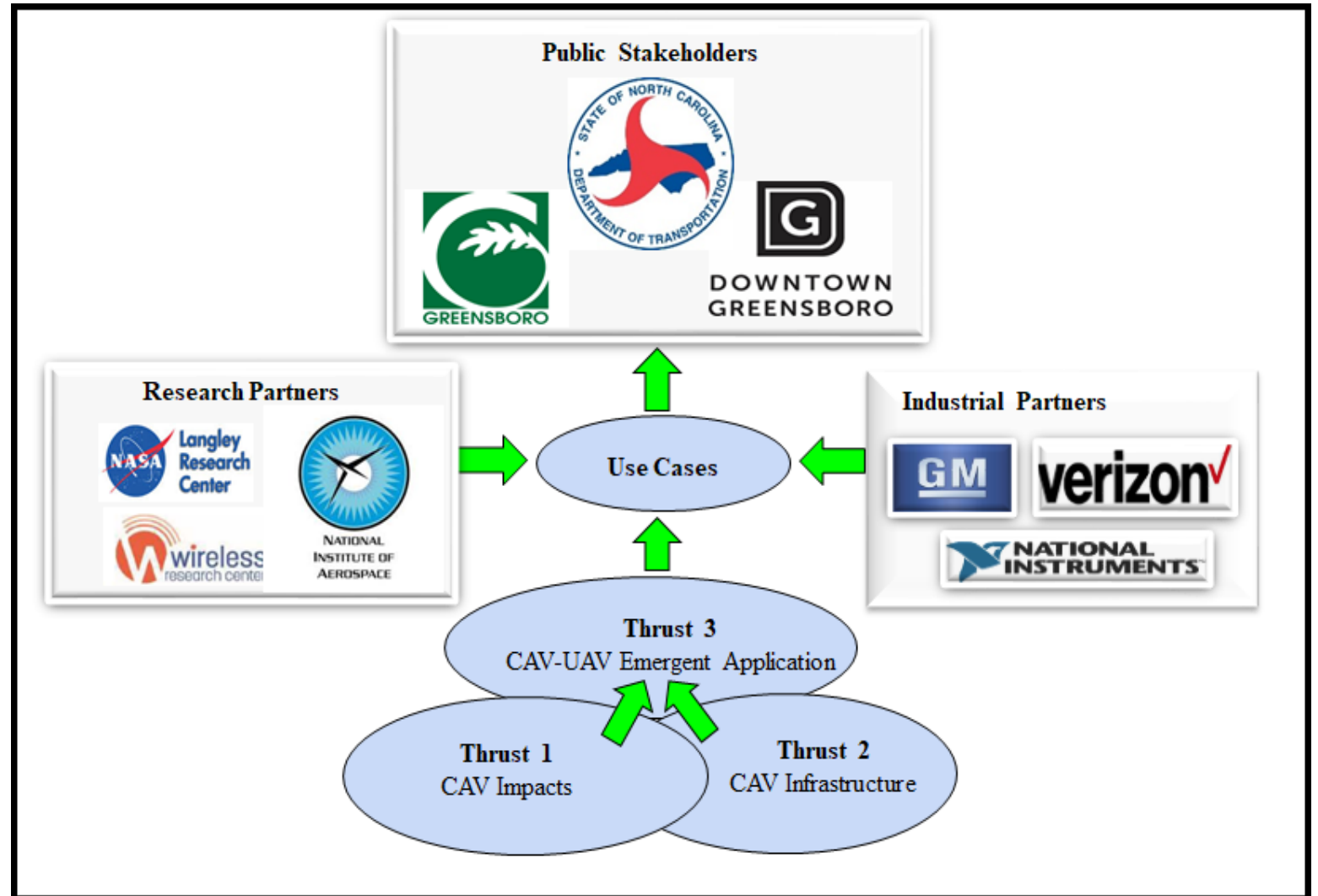


Engagement of Stakeholders



Within NC-CAV, we will work closely with our internal and external stakeholders to ensure that the developments under the NC-CAV effort are aligned with the stakeholders' objectives and are addressing their real needs.

- **Public stakeholders:** NCDOT, DGI, GDOT
- **Research partners:** NIA, NASA Langley Research Center, WRC
- **Industrial partners:** GM, NI, Verizon





NC-CAV: Education and Outreach

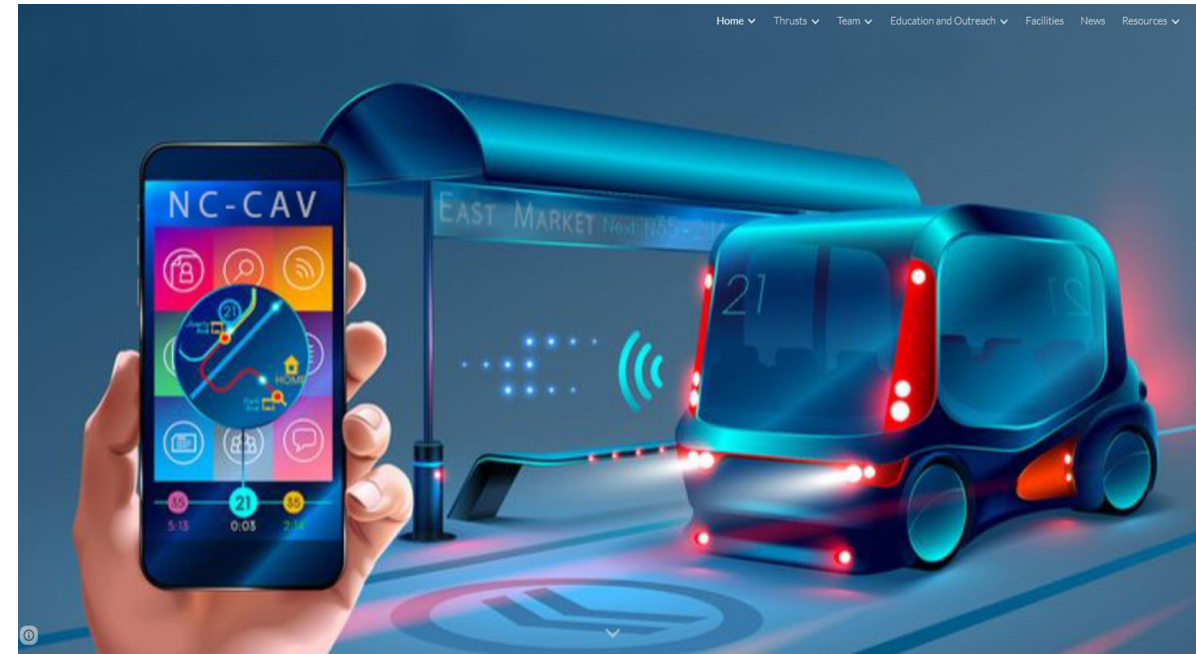


- The outcome of research will be used to develop new graduate and undergraduate courses and/or for integration into existing courses. Some of the related courses being taught at the three participating universities are listed below:
 - NCAT: “Modeling and Control of Drones,” “UAV Data Processing,” “Advanced Imaging,” “Advanced Robotic Systems,” “Decision-making and Supervisory Control,” “Introduction to Telecommunications,” “Computer Vision Intelligence for Robotic Applications,” “Advanced Geospatial Analysis,” and “Methodologies of Remote Sensing.”
 - NCSU: “Highway Design,” “Traffic Engineering,” “Sensors, Instrumentation, and Data Analytics for Transportation Networks,” “Intelligent Transportation Systems,” “Advanced Topics in Wireless Networking,” and “Optimizations and Algorithms.”
 - UNCC: “Introduction to Transportation Engineering,” “Advanced Traffic Engineering,” “Intelligent Transportation Systems,” “Transportation Systems Analysis,” “Urban Transportation Networks: Operations and Optimization,” and “Connected and Autonomous Vehicles.”

NC-CAV Research Dissemination Activities



- NC-CAV website (<https://www.nccav.com/>) is being maintained to provide online access to the presentations, publications, technical reports, developed softwares and toolboxes, and other materials produced during the research.
- Project findings will be broadly disseminated both nationally and internationally via
 - Seminars and conferences
 - Peer-reviewed journal publications
 - Special sessions and workshops organization
- Visually accessible products are designed at the NC-CAV Center for executive and public consumption about the NC-CAV's research accomplishments and implementations
 - A booklet was designed and prepared to share with the steering committee as well as public audience. The booklet is available at <https://online.fliphtml5.com/gdoly/kryn>.
 - Research reports summaries
 - Newsletters
 - Pamphlets and videos for NC-CAV research products will also be prepared





NC-CAV: Seminar Series



Date	Presenter	Tentative Title
9/25/20	Redwan Newaz	Anomaly Detection for Autonomous Driving
10/30/2020	Thomas Chase	Introduction to Connected Traffic Signals
12/4/2020	Nicolas Norboge	Transportation Funding in a World of CAV: Implications and Lessons Learned from COVID that are instructive?
1/29/2021	Ali Karimodini	Autonomous Cars: From Sensing to Control
2/26/2021	Daniel Findley	Public Perceptions of Transportation Fees and Taxes
3/26/2021	Shih-Chun Lin	Machine Learning-Enabled and Ultra-Low Latency Connected Transportation
4/30/2021	Ali Hajbabaie	TBD
5/28/2021	Chris Cunningham/Evan Arnold	Use of UAV for Long-Term Monitoring and Data Collection
6/25/2021	Leila Hashemi-Beni	TBD
7/30/2021	Steven Jiang	TBD
8/27/2021	Wei Fan	Disruptive Technologies in Transportation: Implications and Opportunities



NC-CAV Sustainability Activities

Effort sare being directed toward sustaining the Center's research activities:

- A team of researchers from NC-CAV Center received funding from NASA for a 4-year \$8M ULI grant to develop Safe and Secure Assured Autonomy.
- A team of researchers from NC-CAV Center received funding from NSF for \$1M to develop Real-time Fault Diagnosis for Self-Driving Vehicles.
- A research team from NC-CAV Center received funding from NSF on to develop a Testbed of Connected Autonomous MicroTransit Vehicles comprised of three self-driving shuttles.





Q&A



NC Transportation Center of Excellence on Connected and Autonomous Vehicle Technology (NC-CAV)



Ali Karimodini
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