

NCDOT Center of Excellence on Mobility and Congestion

Center Overview

Outline

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

Foundational Principals

- Exploit the ITRE/NCSU expertise and leadership in traffic operations, management, and control to build and lead a Mobility and Congestion CoE team
- Select the team members and develop the center projects to be fully responsive to the NCDOT goals of –
 - Leveraging “multi-disciplinary skills and knowledge across multiple universities”
 - Including “Historically Black Colleges and Universities and Minority Serving Institutions”
 - Providing “a long-term view and cutting-edge approach”
 - Addressing the multifaceted research areas outlined in the request for proposals

Team Formation

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

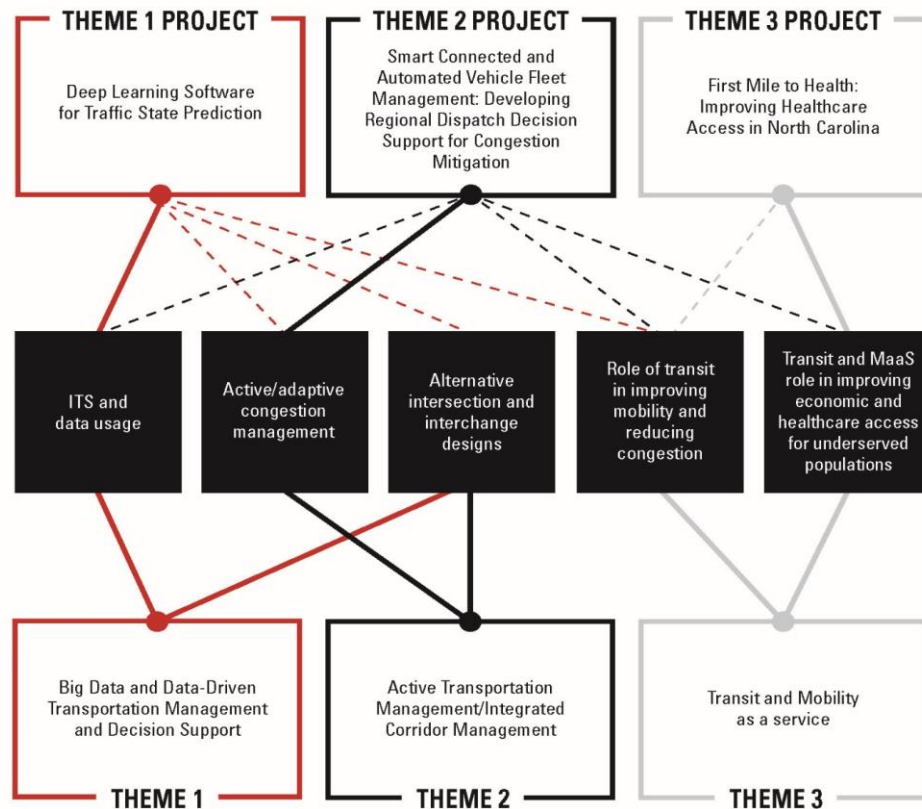
Team Institutions

**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 Communications

- A secure Google Shared Drive is established
- Monthly center meetings timed to follow project meetings
- Most meetings will be held using the Zoom video conferencing system
- Face-to-face meetings will be held as needed
- Meetings with NCDOT will be coordinated as needed with Dr. Curtis Bradley

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Project 1

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

Project Goals

- Develop edge computing and deep learning software which utilizes video, loop detector and Bluetooth sensor data to better estimate traffic states on arterials
- Test software with traditional signal control and a CV-enabled signal control algorithm in VISSIM
- These capabilities will assist in
 - improved performance measures for integration into existing tools like ATSPM
 - temporary deployment for signal retiming or loop detector calibration
 - driver information through connected vehicle applications

Methodology

- Deep/machine learning AI approach to prototype software design
- Steps will include –
 - Data collection on real and simulated traffic
 - Develop single stream video analytics
 - Develop multi stream video analytics
 - Develop data fusion methods
 - Test hypothesis that advanced traffic signal control algorithm performs better optimization with this traffic state estimate

Communication Tools

- Bi-weekly team meetings – Teleconference and face-to-face
- NCDOT & Committee Members - interim meetings
- External communication
 - Leverage existing educational programs for high school and undergraduate students targeted at STEM majors
 - Key results made available to transport policy organizations at both the state and federal levels

Final Project Outputs

- Video analytics pipeline
- Robust data fusion techniques
- Prototype application that integrates software and hardware using “edge-computing” design
- Simulation environment for loop testing
- Comprehensive dataset to include all data collected
- Presentation and recorded webinar on the project findings and results
- Final report that documents all findings of the research

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Project 2

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
 - Robotics program
 - 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, Professor in the Department of Civil Construction and Environmental Engineering

Project Goals

- Develop a supervisory capability in regional dispatch center
- Provide state and/or local authorities with monitoring of and direct communications with traditional, connected, and autonomous vehicles
- These capabilities will assist dispatcher/operators in –
 - Developing mitigation actions to reduce congestion
 - Managing planned and urgent/emergent scenarios

Methodology

- Systems engineering approach to prototype system design
- Prototype design steps will include –
 - Concept of operations 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

Communication Tools

- Monthly team meetings – Teleconference and face-to-face
- External communication
 - Journal and conference papers
 - Participation in appropriate conferences and symposia
 - Outreach events
 - Internship opportunities for undergraduate and high school students
 - Participation in regional STEM activities such as NC A&T's Summer Transportation Institute

Final Project Outputs

- Concept of Operations (CONOPS) for regional monitoring and dispatch in a mixed traffic (TV/CV/AV) environment describing the –
 - Operational needs
 - System characteristics
 - Functional requirements
- AI-based algorithms for managing mixed traffic flow
- Prototype decision tool that embeds the AI algorithms and focuses on resource allocation and path planning
- Documentation of algorithm and decision tool testing
- Recommendations for state-level implementation

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Project 3

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

Project Goals

- Determine how changes in health care policy (e.g. Medicaid Transformation) and transportation service delivery (e.g. MaaS) impact:
 - Individuals
 - Health systems
 - Public transportation
- Identify how transport system innovation impacts health care access by:
 - Modeling existing services
 - Developing operational scenarios
 - Conducting pilot analysis of patient travel preferences based on the scenarios
 - Assessing needs for transportation information aggregation for patients and care managers
 - Building a decision support tool

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

Communication Tools

- Monthly team meetings – Teleconference and face-to-face
- Quarterly meetings with the NCDOT and the project committee
- External communication
 - Journal and conference papers
 - Participation in appropriate conferences and symposia
 - Outreach events
 - Webinar on the methodology, findings and implementation concerns

Final Project Outputs

- Final report:
 - Detailing the efforts
 - Interpreting the findings
 - Assisting with implementing the findings/recommendations
- Simulation code, parameters, models, and databases
- Journal article(s)