NC Transportation Center of Excellence in Advanced Technology Safety & Policy

Center Overview

NC Transportation Centers of Excellence Kickoff Meeting

February 25, 2020

TSAP

TRANSPORTATION SAFETY & POLICY

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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

THE UNIVERSITY OF NORTH CAROLINA HIGHWAY SAFETY RESEARCH CENTER

DIRECTOR

Dr. Randa Radwan

Appalachian State University

ASSOCIATE DIRECTOR

Dr. Elizabeth Shay

North Carolina Agricultural and Technical State University

ASSOCIATE DIRECTOR

Dr. Maranda McBride

NC Central University

ASSOCIATE DIRECTOR

Dr. William Wiener

UNC CHARLOTTE

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

Research Themes

TSAP will conduct 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

Research Projects

- Impacts of CAV-ready infrastructure on Vulnerable Road Users (VRUs): Guidance for North Carolina's Local and State Transportation Agencies
- IOT Solutions for Near Horizon Challenges in Smart City Pedestrian Travel
- Operational and Economic Impacts of Connected and Autonomous Vehicles
- Intelligent Data Exploration & Analysis for New & Existing Transportation Technology (IDEANETT)
- Plan for Advanced Technology Data Readiness

Center-level Communications Highlights

- Leadership team, i.e. Center Director and Associate Directors from partner institutions, will meet in person quarterly at different partner campuses throughout the year, Chapel Hill, Greensboro, Boone, Durham, and Charlotte. PIs and students will be involved.

- HSRC Specific Communication Activities and Products
  - Developing and maintaining the TSAP website
  - Hosting annual Technology Forum events in 2nd and 3rd year to showcase the Center's research
  - Developing and sharing TSAP Research Fact Sheets

Workforce Development

All five projects include workforce development components:

- Supporting internships and fellowships
- Exposing students to advanced technologies and opportunities to engage with stakeholders

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Projects

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Impacts of CAV-ready infrastructure on Vulnerable Road Users

Guidance for NC's Local & State Transportation Agencies

Co-PIs: Dr. Tabitha Combs, UNC-Chapel Hill, and Dr. Elizabeth Shay, Appalachian State University

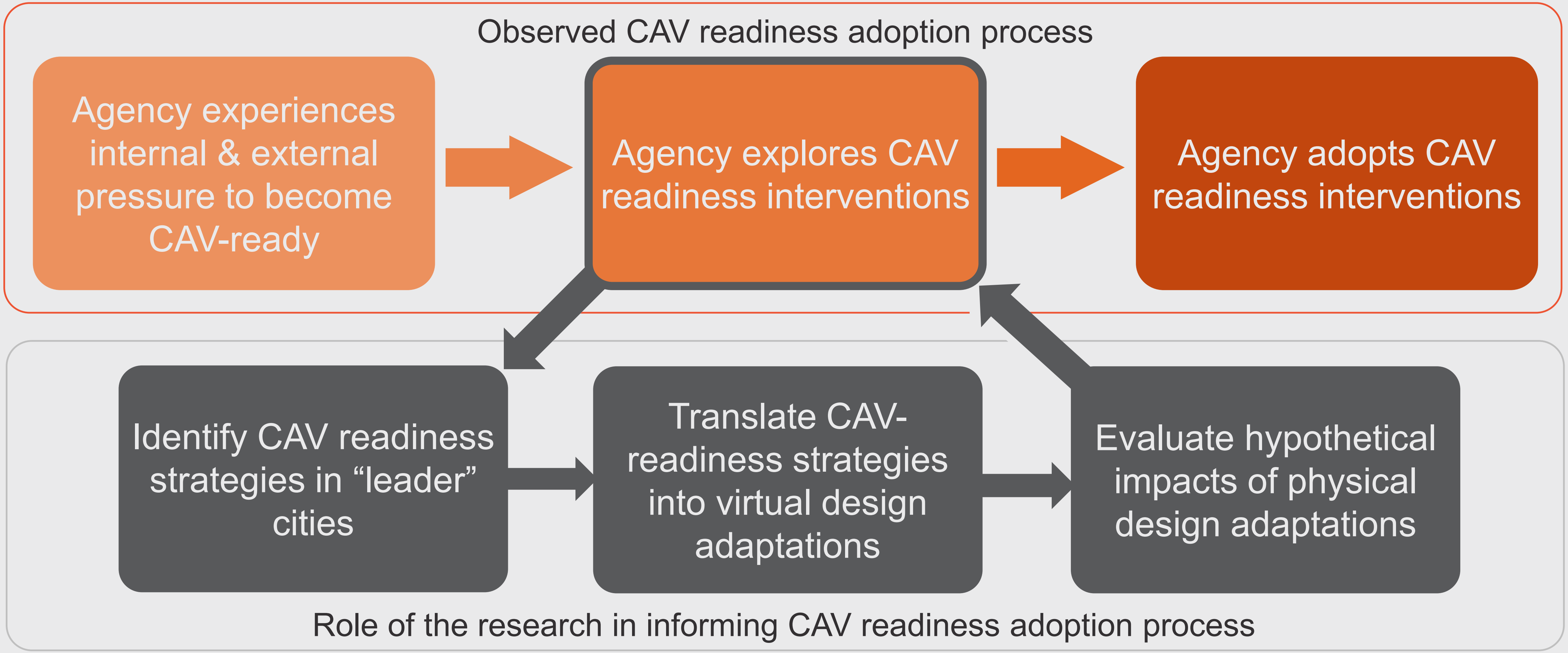
Goals

Research question: How will CAV readiness efforts affect mobility, safety, convenience for NC's vulnerable road users?

Focus: Physical design of intersections

Objective: Provide guidance on context-sensitive CAV readiness strategies that enhance VRU safety & mobility

Goals



Observed CAV readiness adoption process
Agency experiences internal & external pressure to become CAV-ready
Agency explores CAV readiness interventions
Agency adopts CAV readiness interventions
Identify CAV readiness strategies in “leader” cities
Translate CAV-readiness strategies into virtual design adaptations
Evaluate hypothetical impacts of physical design adaptations
Role of the research in informing CAV readiness adoption process

Methods

- Identify candidate CAV readiness strategies, study sites (key informant interviews, literature reviews)
- Translate CAV readiness strategies into virtual design adaptations (2D & 3D visual representation)
- Evaluate hypothetical impacts of design adaptations (quantitative analysis of intercept surveys at study sites)

Communication Tools

- State of the practice report
- Best practices guidebook on CAV ready infrastructure adaptations
- Final report & slide deck
- Peer-reviewed journal article & conference presentations

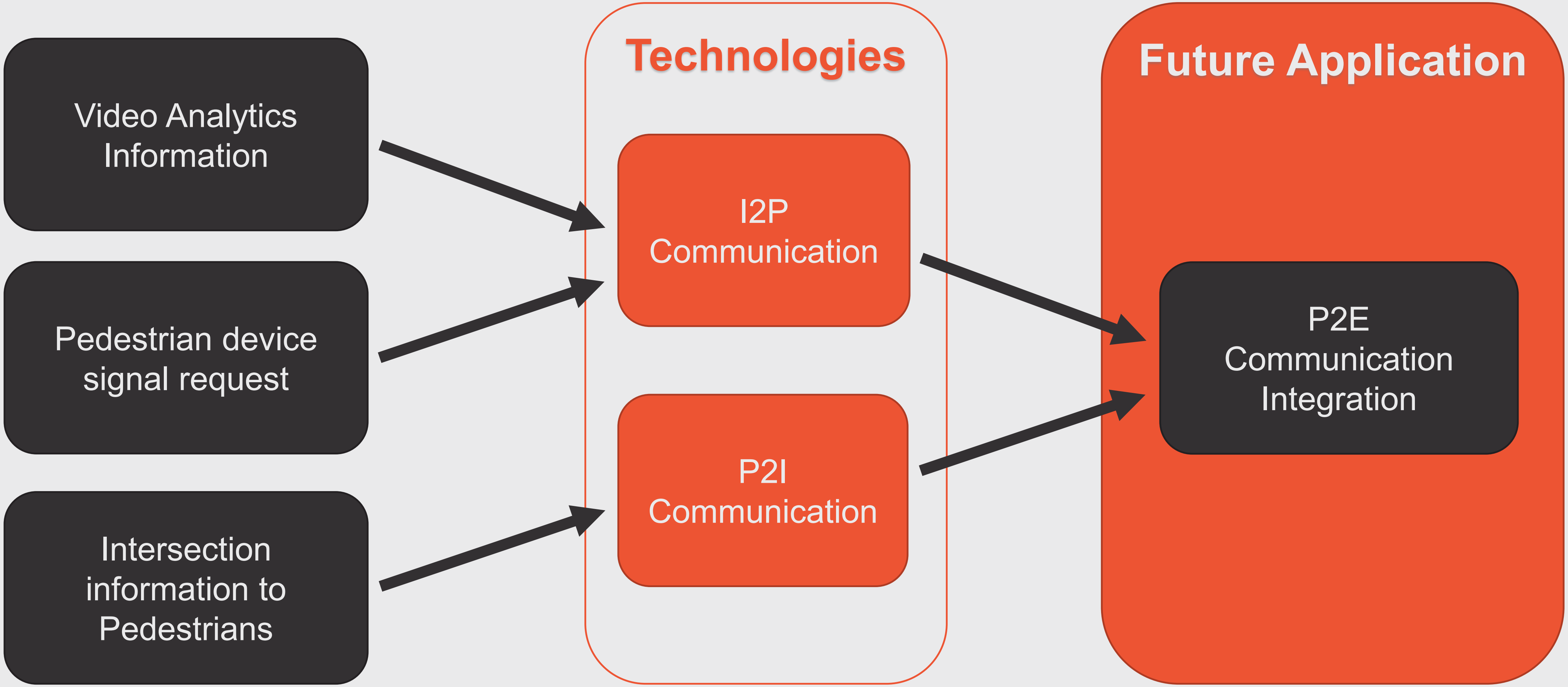
Final outputs

- Document perceptions of infrastructure needs & likely interventions for CAV readiness
- Review & refine visualization aids for communicating physical design to/soliciting feedback from public
- Make recommendations for VRU-supportive CAV readiness adaptations for intersections

IOT Solutions for Near Horizon Challenges in Smart City Pedestrian Travel

PI: Dr. Sean Tikkun, NC Central University

Goals


Video Analytics Information
Pedestrian device signal request
Intersection information to Pedestrians
Technologies
I2P Communication
P2I Communication
Future Application
P2E Communication Integration

Goals

- **Project 2.1:** Assess needs and research on state-of-the-art technologies and analysis for pedestrian safety while preserving privacy.
- **Project 2.2:** Investigate and develop protocol for mobile device communication with traffic control infrastructure, with initial application for pedestrians with a visual impairment.
- **Project 2.3:** Develop protocol to deliver intersection information, to pedestrian devices, via wireless communication with standard allocentric language.

Methodology

- **Project 2.1**: Assess needs and research on state-of-the-art technologies and analysis for pedestrian safety while preserving privacy.
  - Formalize community*/tech functional requirement
  - Explore, develop and illustrate methods to collect data
  - Build mechanism to communicate Infrastructure to Pedestrian (I2P)
  - Assess acceptance and impact of technology on community*

* Community investigations will specifically include a subgroup of individuals with Visual Impairments.

Methodology

- **Project 2.2**: Investigate and develop protocol for mobile device communication with traffic control infrastructure, with initial application for pedestrians with a visual impairment.
  - Identify communication methods for Pedestrian to Infrastructure (P2I)
  - Survey existing technologies using promising methods
  - Develop secure protocol for P2I communication
  - Evaluate P2I communication in a test deployment with the community*

* Community investigations will specifically include a subgroup of individuals with Visual Impairments.

Methodology

- **Project 2.3:** Develop protocol to deliver intersection information, to pedestrian devices, via wireless communication with standard allocentric language.
  - Survey professional in Orientation & Mobility (O&M) for critical features
  - Develop language for communicating features
  - Install location devices to transmit feature language
  - Evaluate language and installation with O&M prof. and pedestrians with visual impairments

Communications tools

- Interdisciplinary review of progress bi-monthly.
- Interdisciplinary team presentation to project group monthly.
- Campus media stories in print and video media regarding project.
- Project outreach to consumer and professional groups for research feedback.

Final outputs

- Project 2.1: Video Analytic system capable of communication with Pedestrians using real-time data of the intersection.
- Project 2.2: Protocol for P2I communication ensuring security and allowing for a diverse set of tools/devices.
- Project 2.3: Language and communication methods for I2P transmission of critical features of an intersection.

Operational and Economic Impacts of Connected and Autonomous Vehicles

PI: Dr. Srinivas Pulugurtha, UNC Charlotte

Co-PIs:

Dr. Amirhossein Ghasemi, UNC Charlotte

Dr. Raghavan Srinivasan, UNC-Chapel Hill

Dr. Michael Clamann, UNC-Chapel Hill

UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE of ENGINEERING

THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER

Introduction

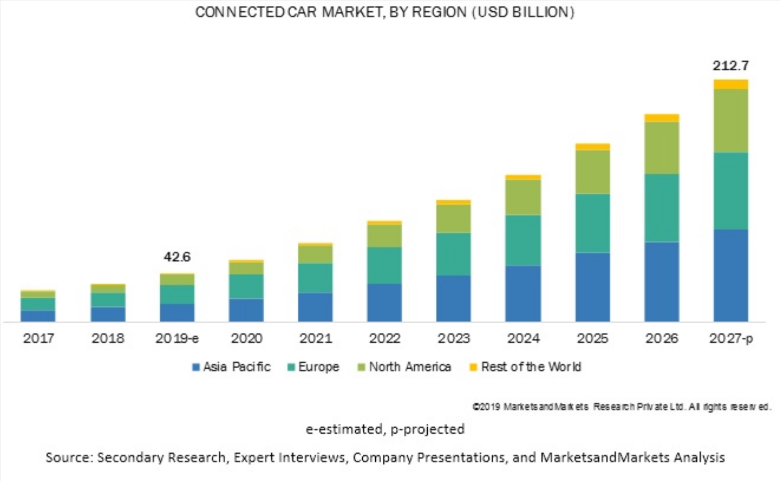
- CAVs – current and expected market share over time
- Positive and negative impacts
  - Travel demand and an increase or a decrease in congestion costs, traffic safety, the unemployment rate in the transportation sector, the effect on the energy market, insurance costs, emissions (air quality), …
- Depends and varies with penetration rates of CAVs over time
  - Heterogeneity

Goals

- Operational and safety performance of the transportation network at various penetration rates of CAV deployment
- Impact of CAVs on the economy

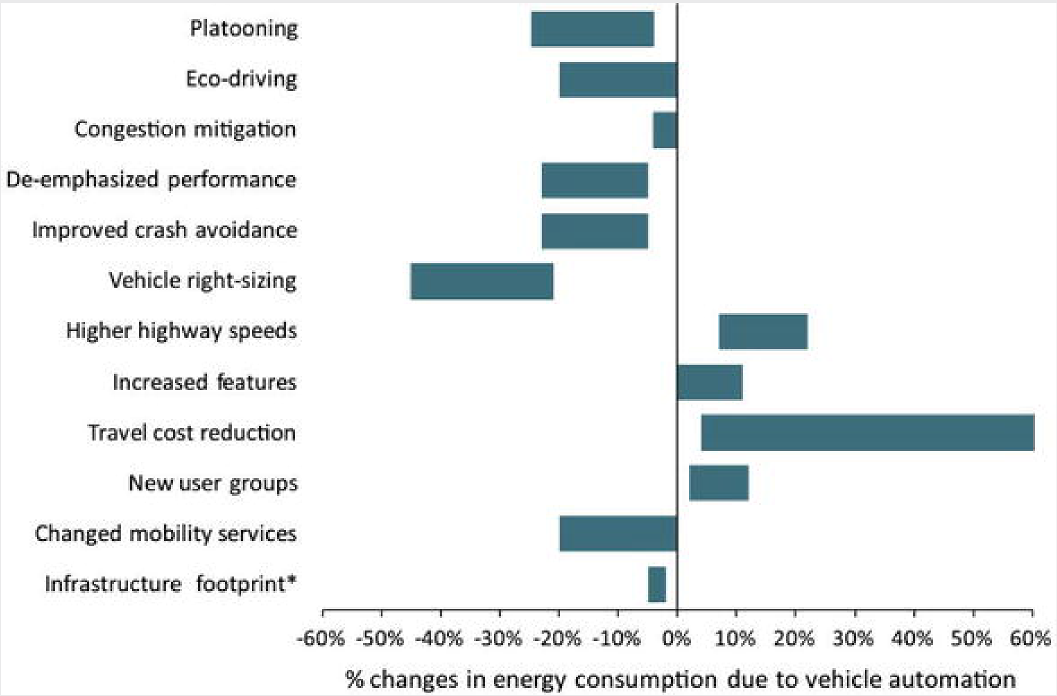
Methodology

- Task 1: Literature review
  - Practices pertaining to CAVs, capabilities of simulation software, and methods to assess economic impacts
- Task 2: Model the operational effect of CAVs
  - Three geographically distributed transportation networks in North Carolina
  - Penetration rate related growth factors
  - Calibrated base model and hypothetical scenarios
  - Estimate operational and safety performance measures for each analytical scenario



Methodology (cont.)

- Task 3: Evaluate the economic impacts of CAVs
  - Operational and safety "impact" of CAVs
  - Impact on the energy industry and other socio-economic factors (unemployment, insurance, manufacturing, etc.)
  - Project to estimate impacts at state-level
- Task 4: Prepare and submit a final report



Final outputs

- Final report with guidance to systematically assess the operational and economic impacts of CAVs
- Recommend suitable microscopic traffic simulation software (PTV Vissim, TransModeler or other) to model and evaluate heterogeneous traffic networks
- Recommends appropriate methods to assess economic impacts

Communications tools

- Periodic meetings to deliver end products that would benefit NCDOT
- Shared-drives and data management protocols
- TSAP’s website
- Presentations at international, national, and regional conferences to reach wider audience

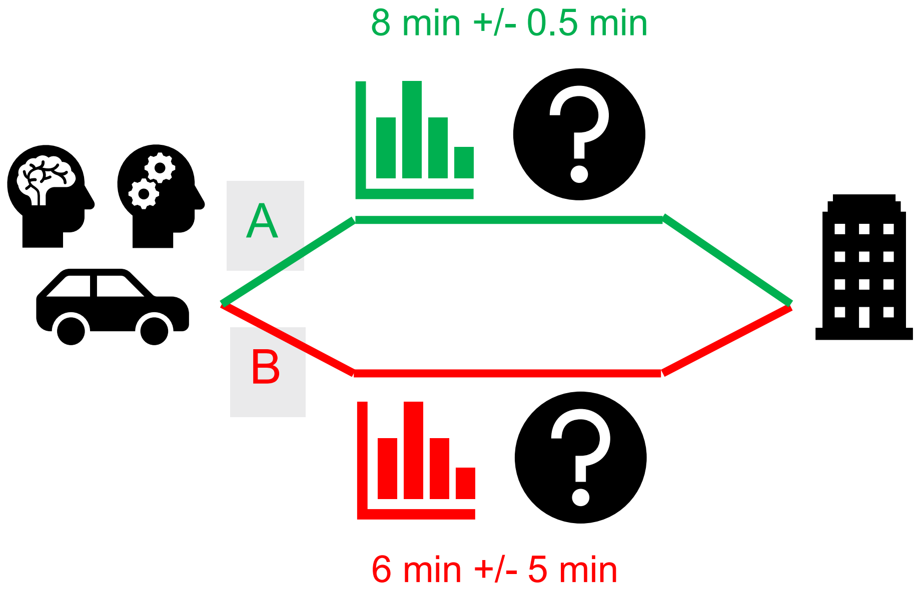
Intelligent Data Exploration & Analysis for New & Existing Transportation Technology (IDEANETT)

PI: Dr. Hyoshin (John) Park, NC A&T University

Motivation

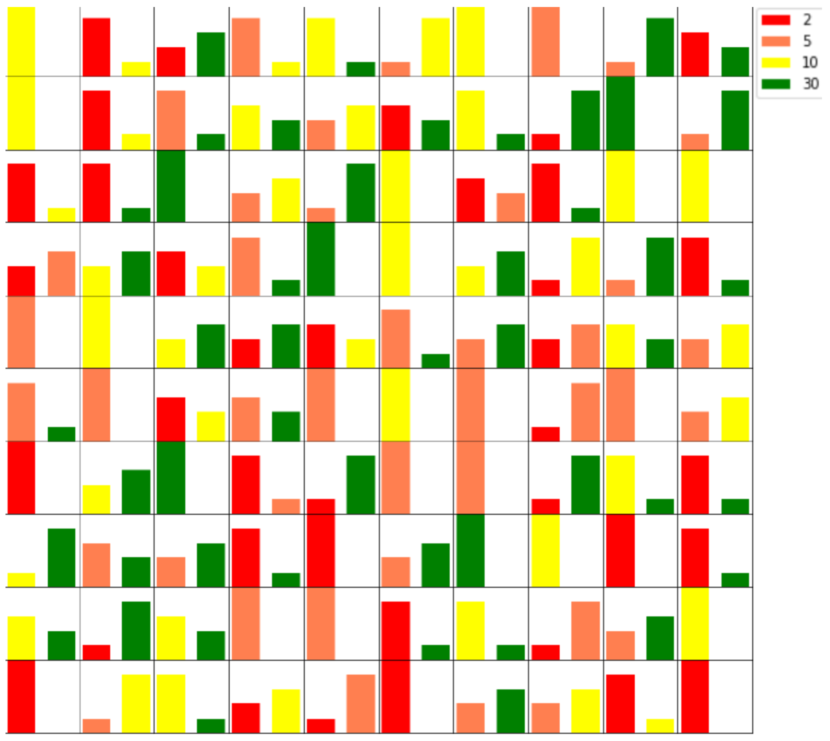
How travelers perceive travel time uncertainty? | How do we assign travelers optimally?

- (1) Road networks contain uncertain travel information.
  - Road A: 8 min, +/- 0.5 min.
  - Road B: 6 min, +/- 5 min.
- (2) Heterogeneous information caused by travelers.
- (3) Areas with fewer travelers (Waze) with low density detectors shows higher uncertainty.

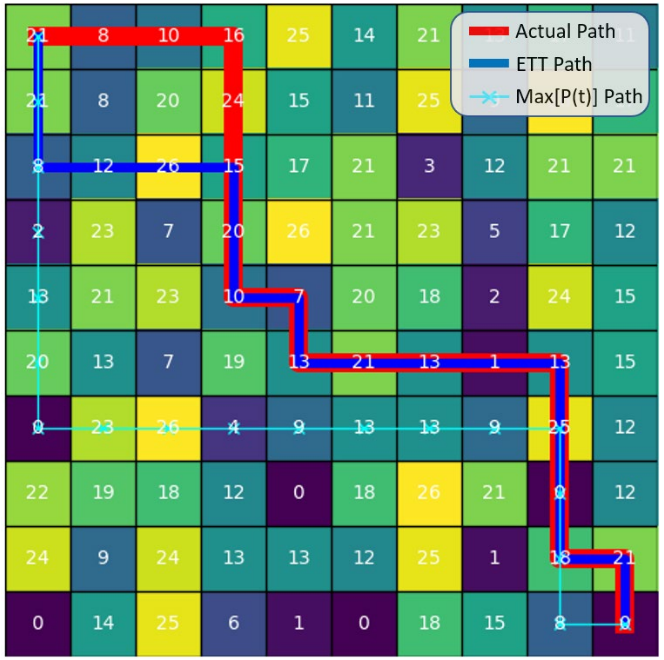


Strategic travel information sharing with travelers:
- Analyze travel time correlation of various locations.
- Information theoretic dynamic traffic assignment framework.

Methodology (Single traveler + travel time correlation)

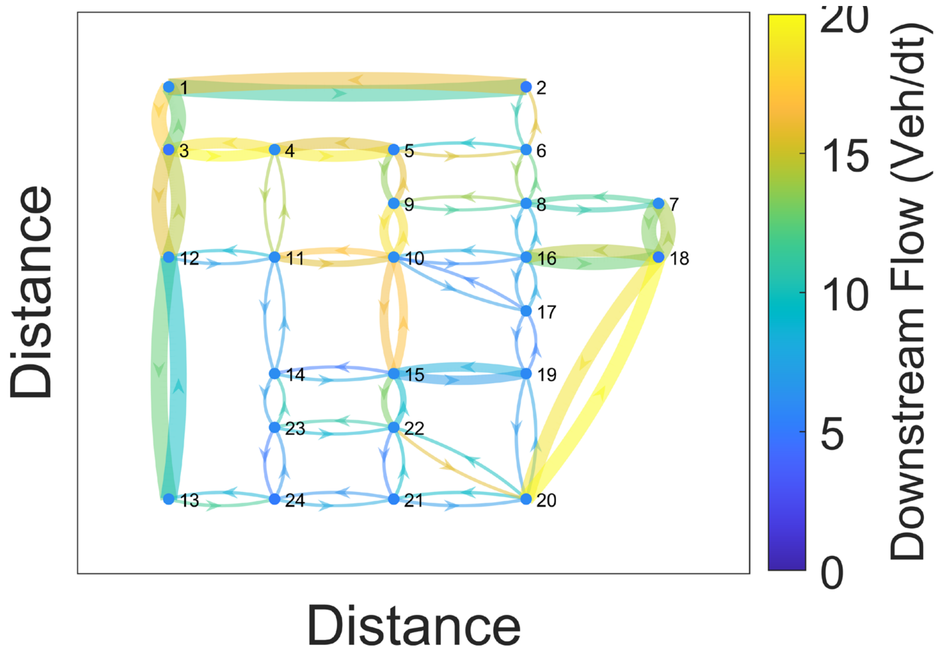


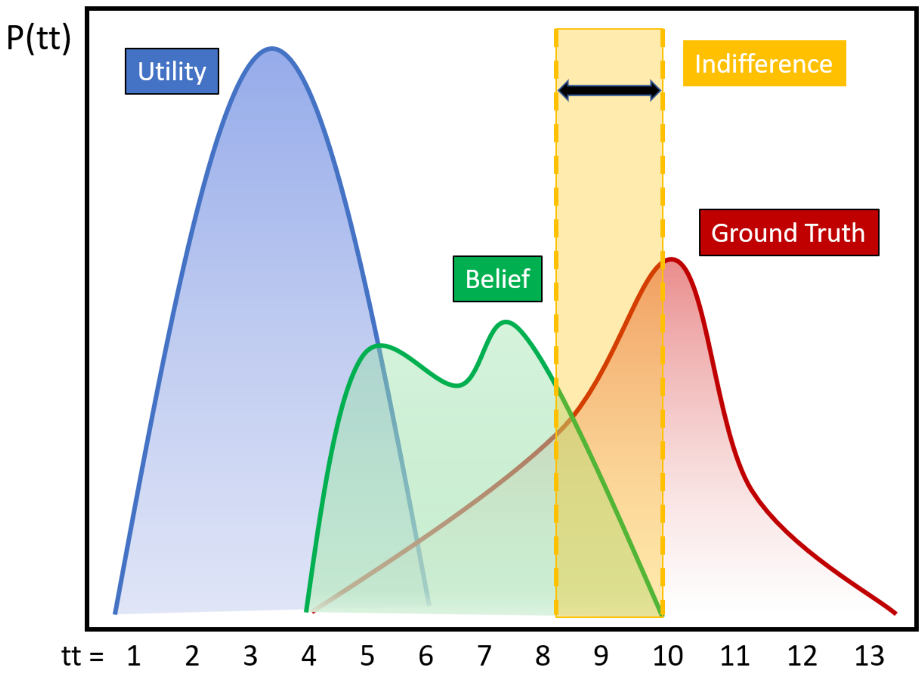
- Travel time probability distribution in each cell of the grid. Bar height indicates probability, while bar color indicates travel time.



- Three paths compared on a grid map with entropy minimization. The **actual path (Utility Function optimized)** based on the Utility Function, the **Expected Travel Time (ETT)** path and the **Max[P(T)] (highest probability classification)**-based travel time.

Methodology (Multi travelers + travel time correlation)



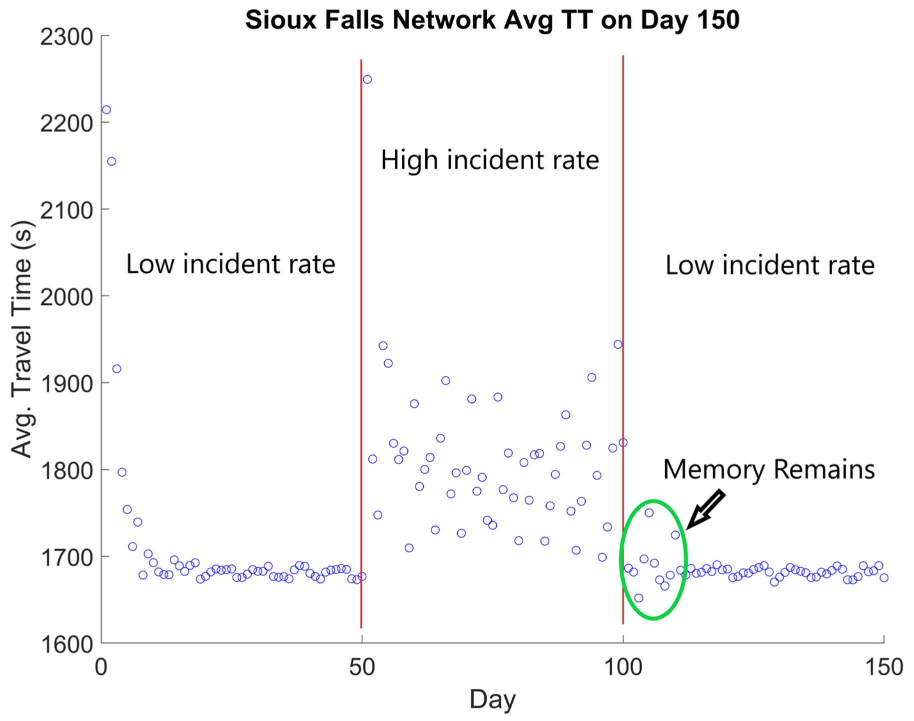


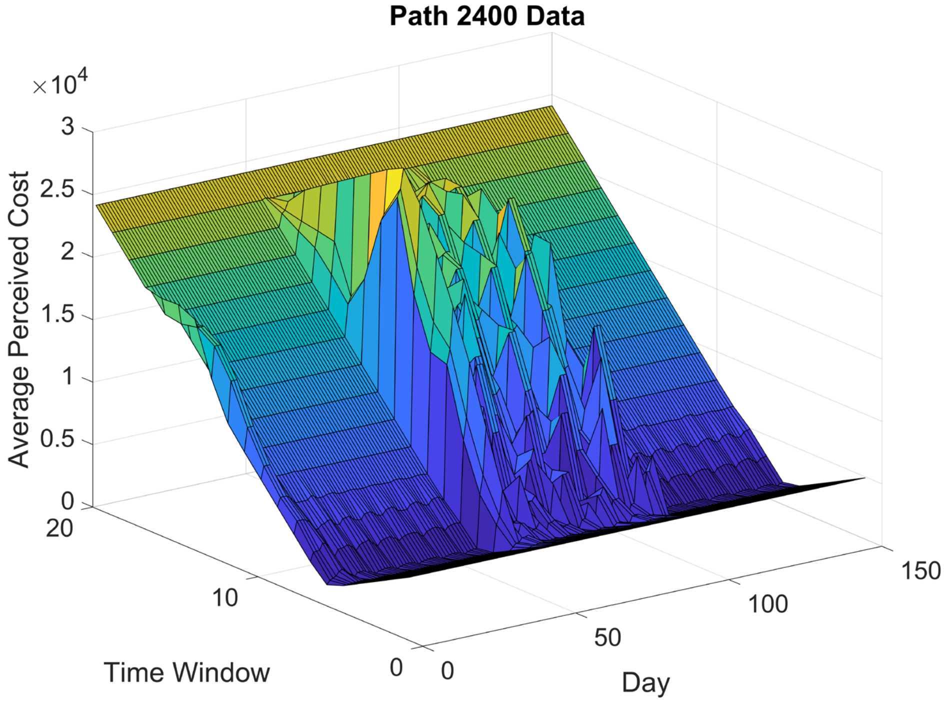
- Travel time correlation visualization with edge weight for link capacity, edge color for total downstream flow for the initial iteration.

- Mixture distribution of utility function and ground truth generate a sufficiently disinformed travel time distribution to present the informed traveler.

Methodology (Multi travelers + travel time correlation)

- Average travel time under bounded rational sequential route and departure time choice model.



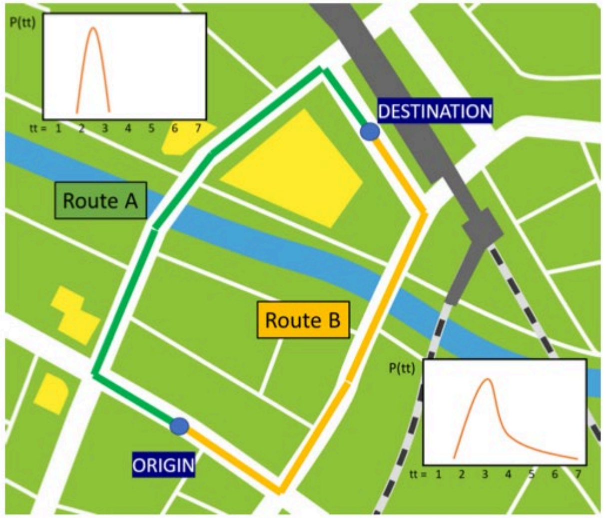


- Disruptive period with high incident rate 50-100 days results in travelers learning the incident patterns, which persists for 6 days after period ends.
- The plot shows average perceived cost for each day and departure time window.

Communications tools

- This mixed-methods research will identify, catalog, visualize, and evaluate CAV-readiness strategies with implications for the physical design and operation of intersections. Findings from the analysis will be used to identify the most promising sorts of intervention from the VRU safety and mobility perspective across a variety of contexts.
- **Research Impact:** This project will guide NCDOT in identifying CAV-readiness strategies to promote safety and mobility across modes, advance best practices in public participation in the design and deployment of safety countermeasures, and position NCDOT as an international leader in multimodal, future-adapted infrastructure innovation.
- Findings from this research will be disseminated via final report, peer-reviewed journal articles, and conference presentations. The project will culminate in a decision guide for local and state policy makers that describes the VRU implications of the most likely forms of infrastructure adaptation.

Final outputs



(a) Example Map 1

- System optimal equilibrium - strategic disinformation into a dynamic traffic assignment.
- Two possible routes each unique travel time probability distribution.
- Travelers have ground truth information + own perceived travel times based on experience and information about the current state of the two routes. Informed travelers choose Route A, while 50% of uninformed travelers take Routes A and B respectively.
- Through strategically misinforming a percentage of informed travelers such that they switch to Route B, the demand on Route A can be reduced sufficiently to prevent congestion.

(b) Example Map 2

- Observations can be made by misinformed source agents to improve travel time estimation and increase system performance.
- For travelers along the main route for the OD pair, there exists a possible detour to reach the destination which contains a link with high travel time uncertainty.
- Information from a source agent about the state of this link reduces the travel time uncertainty for routes containing this link.

Plan for Advanced Technology Data Readiness

Co-PIs: Dr. Michael Clamann, UNC-Chapel Hill, and Dr. Srinivas Pulugurtha, UNC Charlotte

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UNC CHARLOTTE
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APPALACHIAN STATE UNIVERSITY GEOGRAPHY AND PLANNING

Background

- NC Strategic Highway Safety Plan

Emerging Issues and Data

FOCUS AREA: Data and Evaluation

EA DEFINITION: This emphasis area addresses the need to continually collect, analyze, and monitor transportation safety data to support highway safety efforts in North Carolina.

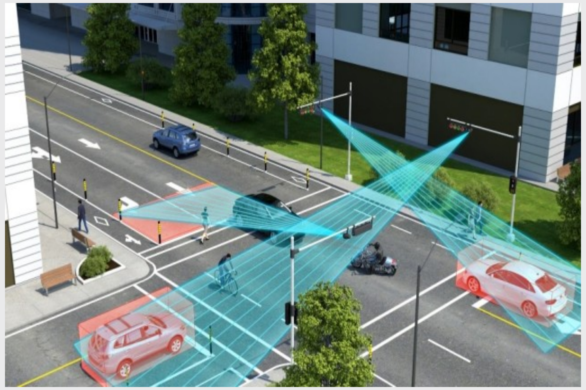
EA GOAL:

1. Increase the quality, accuracy, and integration of the State's existing data, data systems, and data sharing capabilities to communicate emerging safety concerns and move

Identify and leverage new data sources that can assess the impacts of emerging technologies, transportation safety needs, and current data gaps…

Goal

Gap analysis to identify changing data needs for CAV deployment



More Goals

- Understand changing data needs
    - Describe how requirements for CAVs differ from legacy systems
    - Identify CAV data NC public agencies need
    - Prioritize among expanding needs for CAV readiness
    - Develop framework for NCDOT data readiness

Data Types

- Vehicle
  - licensing, registration, insurance, automation capability
- Infrastructure
  - work zones and temporary road closures, traffic counts for functional classes, road characteristics, connected devices, pavement condition
- Crash
  - vehicle, driver, roadway
- Public impression
  - Essential for deployment

National

State

Municipal

Methodology

- Task 1: Literature review
  - Federal guidance
  - State plans
- Task 2: Inventory of North Carolina transportation data sources
  - Infrastructure (UNC-Charlotte)
  - Planning & public opinion (Appalachian State)
  - Crashes, vehicles & licensing (HSRC)
- Task 3: Data needs for CAV development
  - Gap analysis of Tasks 1 and 2
  - Review by NCDOT
- Task 4: Data readiness framework

Final outputs

- Model Plan
  - Summary of data management best practices (Task 1)
- Framework for data readiness
  - Combines best practices of states and USDOT
  - Includes CAV-specific data elements
  - Identifies current and future data management priorities
  - Sets priorities for CAV development

Learn more:

tsap.unc.edu