



NORTH CAROLINA
Department of Transportation



NCDOT's Connected Autonomous Shuttle Supporting Innovation (CASSI) Program

Maryland CAV Working Group Meeting

Last updated: November 30, 2023

Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina

North Carolina Department of Transportation (NCDOT)'s Integrated Mobility Division (IMD)



Integrated Mobility Division
N.C. DEPARTMENT OF TRANSPORTATION

Mission:

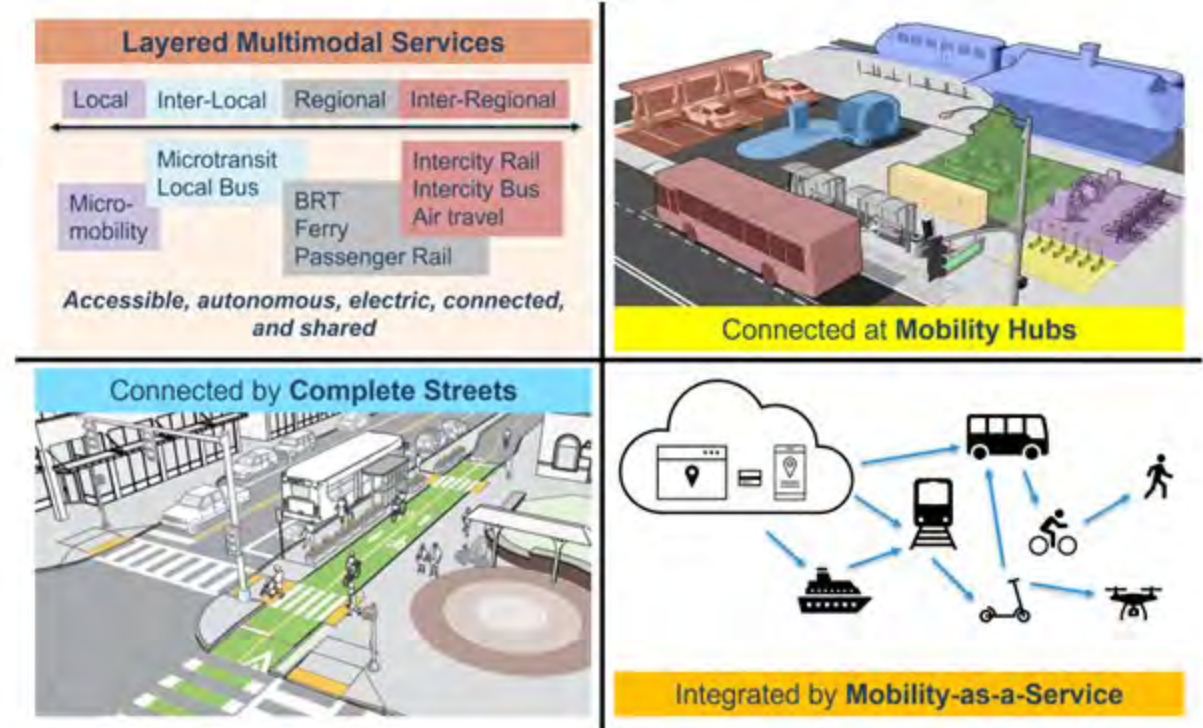
Provide leadership for safe, affordable, and innovative multimodal transportation throughout North Carolina.

Vision:

- Transportation barriers and unmet needs are minimized.
- Equal access to opportunities and services.
- Multimodal options rival driving in terms of time, convenience, and cost.
- Zero transportation-related fatalities, injuries, or greenhouse gas emissions.

Goals:

- Increase access.
- Enhance quality of life.
- Ensure safety.



Everyone should have equal access to opportunities and services through transportation systems that make traveling across shared modes and to destinations near and far as easy and convenient as driving.

CASSI Advances Shared Autonomous Mobility Technologies in NC

NCDOT's **Connected Autonomous Shuttle Supporting Innovation (CASSI)** is a program (not a product) that **demonstrates the capability of shared autonomous vehicles** to prepare for the future of mobility and enhance public transportation services.



CASSI evaluates how autonomous vehicles can best be used by riders with different needs and in different environments.

Examples include:

- Transit applications such as first mile/last mile solutions
- Connected vehicle infrastructure

ncdot.gov

CASSI in Cary's Bond Park

13-week pilot from March 6-June 2, 2023

Special features of the project included:

- ❖ Shared stop with GoCary Routes 4 and 8 at the Cary Senior Center
- ❖ Temporary traffic signal that demonstrated the shuttle's vehicle-to-infrastructure communication capabilities



CASSI in Cary's Bond Park – Partnerships and Teamwork

The pilot was the result of strong partnerships, teamwork, and collaboration.

North Carolina Department of Transportation

- Integrated Mobility Division
- Contract Unit and Purchasing Section
- Communications Office
- Transportation Mobility and Safety Division – Intelligent Transportation Systems (ITS) and Signals Management Section
- Division of Highways – Fleet and Materials Management
- Division of Motor Vehicles

Cary

- Transportation
- Transit
- Traffic Services
- Town Manager's Office
- Town Clerk's Office
- Town Attorney's Office
- Specialized Recreation and Inclusion Services
- Public Works
- Police and Fire Departments
- Parks, Recreation, and Cultural Resources
- Marketing
- Information Technology
- Finance
- 311

Kimley-Horn

- Consultant support to NCDOT



CASSI in Cary's Bond Park – Ridership and Operations Results

Beep provided weekly data reports that included ridership and operations data.

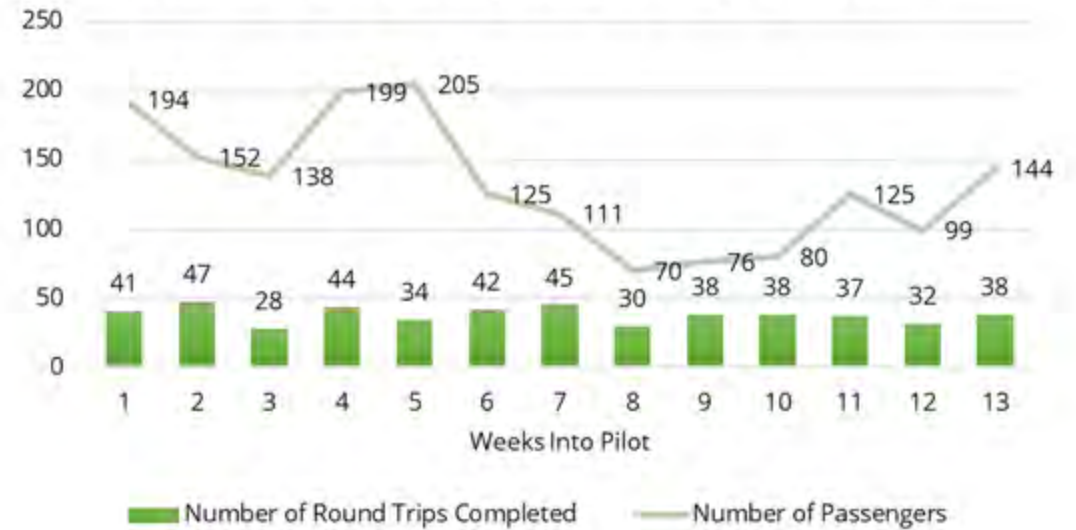
For the 13-week pilot period (March 6-June 2, 2023):

1,718 Total Riders Served	494 Total Trips	86%* Uptime
98.3%** Time Spent in Autonomous Mode	5.4 mph Average Vehicle Speed on Route	11.4 mph Maximum Vehicle Speed on Route

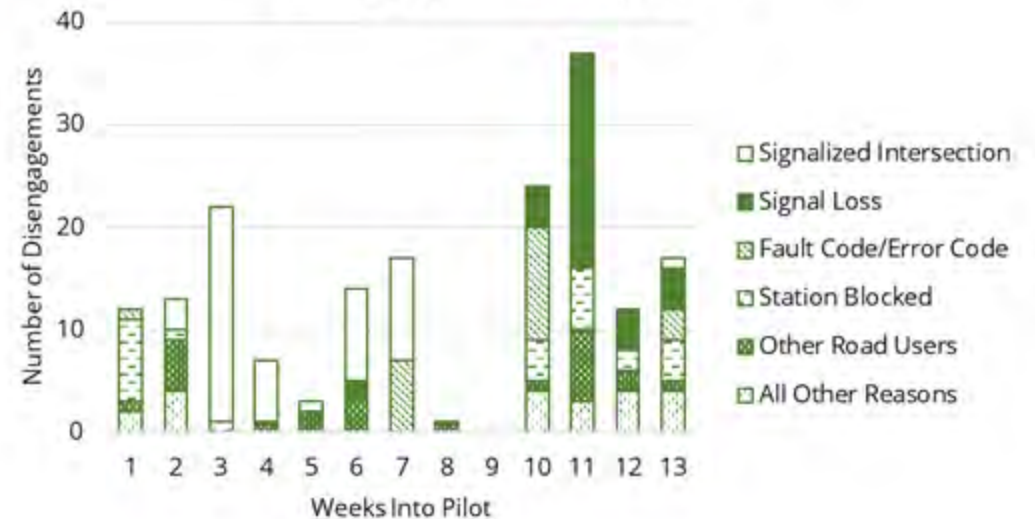
*The shuttle was in operation for 331 out of 384 scheduled hours of service.

**The leading causes of disengagement from autonomous mode into manual mode were lost connection or miscommunication between the shuttle's Onboard Unit (OBU) and the Roadside Unit (RSU) at the signalized intersection and signal loss between the shuttle and the Global Navigation Satellite System (GNSS) base antenna installed within the park for the pilot.

Number of Passengers and Trips by Week



Disengagements by Week

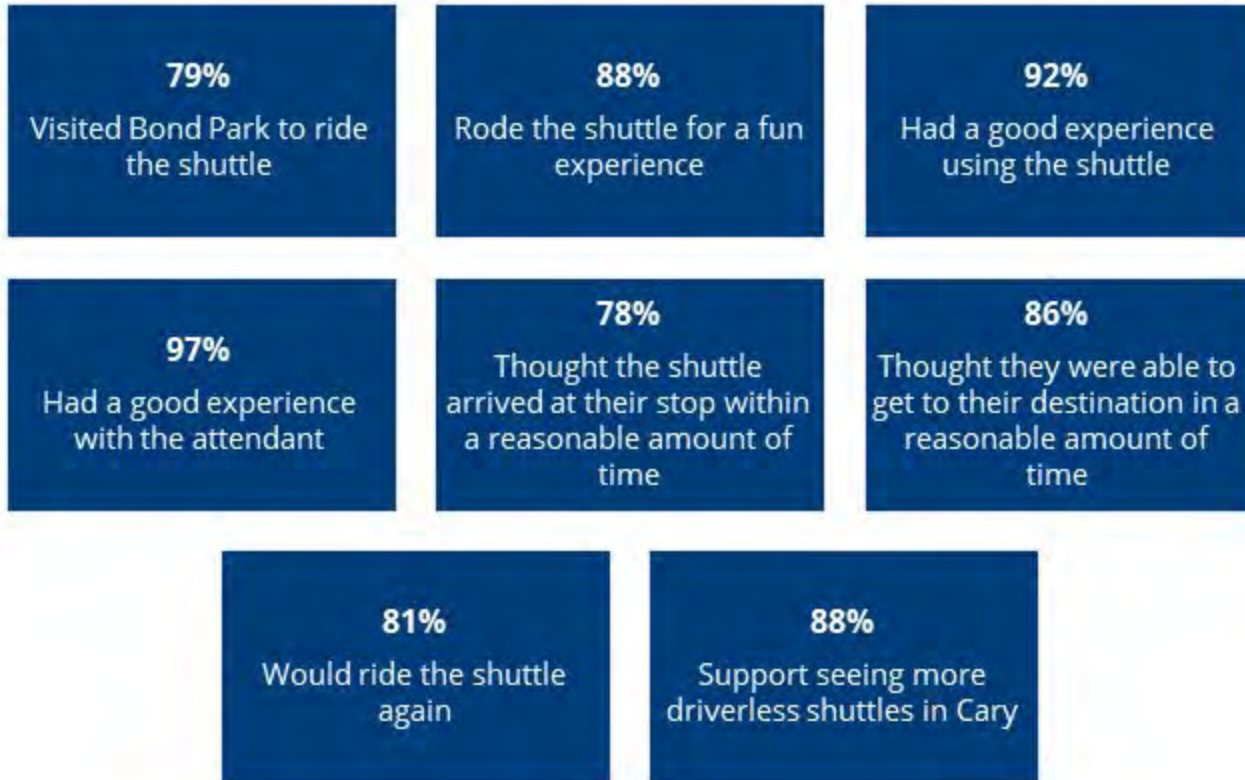


CASSI in Cary's Bond Park – Rider Survey Results

NCDOT administered an online rider survey.

160 responses total – 145 rode the shuttle, 15 did not ride the shuttle.

For the 13-week pilot period (March 6-June 2, 2023):



CASSI in Cary's Bond Park – Community Engagement Results

NCDOT administered an exit survey to community members with disabilities and their caregivers.

Feedback gathered from eight respondents included:

What works well for you in the shuttle?

- Beautiful, clean, modern, lots of windows, open
- Good size and speed
- Smells nice, no exhaust that may trigger asthma
- Not too noisy inside, easy to understand friends talking onboard, quiet, no noise
- Wide entrance accommodates bariatric wheelchairs/walkers
- Easy to get on and off
- Air conditioning works well

How could the shuttle work better for you?

- Automatic ramp, automatic wheelchair restraints
- Better kneeling to make the ramp less steep
- Room for more than one wheelchair so friends can ride together
- Smaller gap at platforms for wheelchairs
- Audible stop announcements
- Shoulder harness, handrails, grab bar for taller passengers, wider seats with curved cushion
- Separation among seats, cup holder, radio
- Dedicated assistance from the attendant
- No hard brakes
- No signal loss, modernization from 3G to 5G



Feedback will inform a Request for Information (RFI) on automated bus technologies including automated wheelchair securement systems.

CASSI in Cary's Bond Park – Lessons Learned

Successes, challenges, and lessons learned are documented in the final report that was published in October 2023.

Key lessons learned include:

Lessons Learned

State of the Technology

Traffic Signal Integration

Accessibility

- An on-board attendant and an exemption from Federal Motor Vehicle Safety Standards (FMVSS) are required for low-speed automated shuttles like the one piloted in Bond Park – the technology is still under development, not commercialized, and not ready to be mainstreamed or scaled as a conventional transit service.
- The most common cause of the shuttle's disengagement from autonomous mode into manual mode was the signalized intersection – more testing prior to launch would have been beneficial to minimize issues or intervention during the pilot period and to maximize learning related to the signal integration.
- Most low-speed automated shuttles do not include the full set of accessibility-related features needed to serve people with disabilities – feedback collected during the pilot will inform future automated shuttle pilots and a Request for Information (RFI).



CASSI in Cary's Bond Park – Final Report, Datasets, and Data Story

NCDOT and Cary published a final report, datasets, and a curated data story for the pilot in October 2023.

<https://www.ncdot.gov/CASSI> → **Completed Projects**



Connected Autonomous Shuttle Supporting Innovation
(CASSI) in Cary's Bond Park

Final Report

October 2023



CASSI at UNC Charlotte

23-week pilot from July 12-December 22, 2023

Compared to previous pilots under the CASSI program:

- ❖ Most signals (four total)
- ❖ Longest route (2.2 miles)
- ❖ Longest duration (6 months)
- ❖ Most complicated mixed traffic environment
 - Includes bicyclist, scooter, pedestrian, motor vehicle, and transit interactions and shared stops with the existing campus bus fleet





CASSI is Evolving to Include Latest Technological Advancements

CASSI includes the **continued demonstration of novel-design, low-speed automated shuttles** and the **testing and integration of Automated Driving System (ADS)-equipped conventional vehicles** into high quality, on-demand transit services.



Novel-design, low-speed automated vehicles



(3) Completed Projects
2020-2021



NPS Report



USDOT Report



(1) Completed Project & (1) Active Project
2023

Automated Driving System (ADS)-equipped conventional vehicles



Connected, Rural, Equitable, and Autonomous Transportation for Everyone (CREATE)

FY 2022 USDOT Advanced Transportation Technology and Innovation Program Grant Application



Grant Application Information

Connected Autonomous Vehicle (CAV) Testbed



NCDOT is supporting N.C. A&T State University to develop **shared autonomous vehicles, an innovative rural test track, and an automated shuttle pilot** between the university and downtown Greensboro.



Autonomy at A&T



Request for Information (RFI) on Automated Bus Technologies

Automated transit technologies have not been commercialized and are currently in the research and development (R&D) (includes prototyping and testing) and demonstration (includes pilots) phases of development.

Automated Driving Systems (ADS) for Transit Vehicles



Connecticut DOT's
CTfastrak ABRT
(Operations expected to
begin in 2023)



Scotland's
CAVForth
autonomous
bus pilot
(May 2023
until 2025)



Michigan
State
University
(MSU)'s
Autonomous
Bus
(May 2022
until April
2023)

Want to learn more about NCDOT's **Integrated Mobility Division** and the **CASSI Program**?

Contact Us




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 <https://www.ncdot.gov/divisions/integrated-mobility>


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