ADVANCE MOBILITY NC

STRATEGIC PLAN

APRIL 2024

Laying the Groundwork for Advanced Mobility

ACKNOWLEDGMENTS

NCDOT Leadership:

State of North Carolina Department of Transportation

Integrated Mobility Division
N.C. Department of Transportation

Division of Aviation
North Carolina Department of Transportation

NCDOT Rail Division

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With support from CROWN

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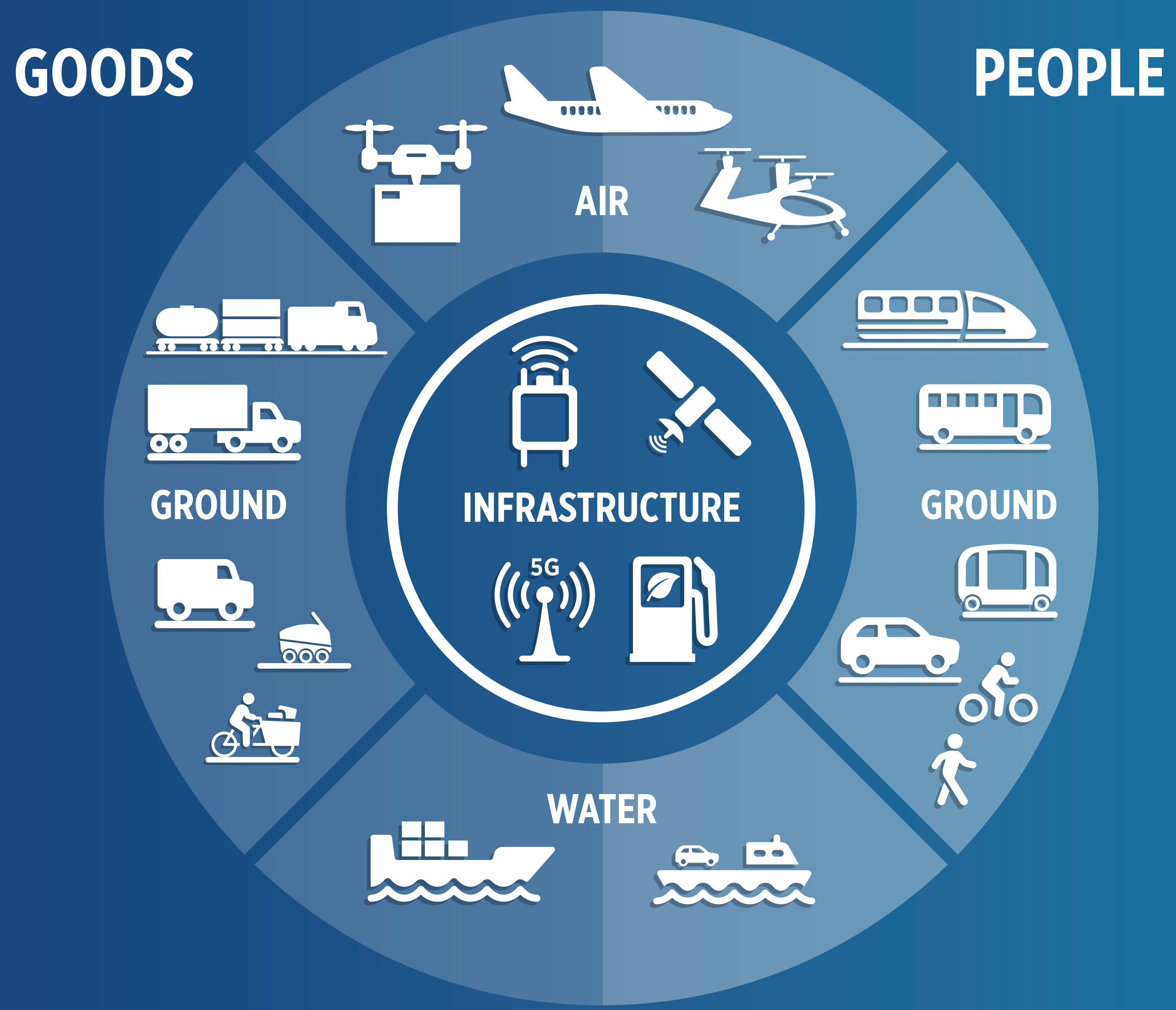
ABBREVIATION OR ACRONYM	DEFINITION
AAM	Advanced Air Mobility
ACE	Aviation Career Education
AGL	Above Ground Level
API	Application Programming Interface
ATCT	Air Traffic Control Tower
ATM	Advanced Transportation Mobility
ATMS	Advanced Traffic Management Systems
AUVSI	Association of Uncrewed Vehicle Systems International
AV	Autonomous or Automated Vehicle
AWOS	Automated Weather Observing System
BVLOS	Beyond Visual Line-of-Sight
CASSI	Connected Autonomous Shuttle Supporting Innovation
CAV	Connected and Automated Vehicles
CHIPS	CHIPS for America Act
CII	Center for Accelerating Innovation and Impact
CLT	Charlotte Douglas International Airport
CORS	Continuously Operation Reference Stations
CRFC	Critical Rural Freight Corridors
CTOL	Conventional Takeoff and Landing
CUFC	Critical Urban Freight Corridors
DOT	Department of Transportation
eCTOL	Electric Conventional Takeoff and Landing
ECU	East Carolina University
EDO	Economic Development Organization
eVTOL	Electric Vertical Takeoff and Landing
EV	Electric Vehicle
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FLOW	Freight Logistics Optimization Works
FMVSS	Federal Motor Vehicle Safety Standards
FTA	Federal Transit Agency
FY	Fiscal Year
GA	General Aviation
GIS	Geographic Information Systems
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSO	Piedmont Triad International Airport
IASMS	In-time Aviation Safety Management Systems
ID	Identification
IIJA	Infrastructure Investment and Jobs Act
IMAP	Incident Management Assistance Patrol
IMD	Integrated Mobility Division
IPP	Integration Pilot Program
IRA	Inflation Reduction Act
ITRE	Institute for Transportation Research and Education

ABBREVIATION OR ACRONYM	DEFINITION
ITS	Intelligent Transportation Systems
LAAM	Low Altitude Air Management
LiDAR	Light Detection and Ranging
MaaS	Mobility-as-a-Service
MPO	Metropolitan Planning Organization
NAS	National Airspace System
NC	North Carolina
NC A&T	North Carolina Agricultural and Technical State University
NC Commerce	North Carolina Department of Commerce
NCDEQ	North Carolina Department of Environmental Quality
NCDIT	North Carolina Department of Information Technology
NCDPI	North Carolina Department of Public Instruction
NCDPS	North Carolina Department of Public Safety
NCDOT	North Carolina Department of Transportation
NCPHFN	North Carolina Priority Highway Freight Network
NCPMFN	North Carolina Priority Multimodal Freight Network
NCUC	North Carolina Utilities Commission
NEVI	National Electric Vehicle Infrastructure
NHFN	National Highway Freight Network
NHFP	National Highway Freight Program
NPS	National Park Service
OEM	Original Equipment Manufacturer
PDD	Personal Delivery Devices
PEA	Programmatic Environmental Assessment
PHFS	Primary Highway Freight System
PII	Personally Identifiable Information
RADAR	Radio Detection and Ranging
RDU	Raleigh-Durham International Airport
RPO	Rural Planning Organization
SAV	Shared Autonomous Vehicles
SFAC	Statewide Freight Advisory Committee
SMFP	Statewide Multimodal Freight Plan
STEM	Science, Technology, Engineering, and Mathematics
STOL	Short Takeoff and Landing
sUAS	Small Uncrewed Aircraft System
TMC	Transportation Management Center
TOP	Trusted Operator Program
TPD	Transportation Planning Division
TSMO	Transportation Systems Management and Operations
UAS	Uncrewed Aircraft Systems
UAS-CTI	Uncrewed Aircraft Systems Collegiate Training Initiative
UAM	Urban Air Mobility
UAV	Uncrewed Aerial Vehicle
UNC	University of North Carolina
UTM	Uncrewed Aircraft System Traffic Management
VTOL	Vertical Takeoff and Landing

Executive Summary

North Carolina's diversity and quality of landscape, from the Blue Ridge Mountains to the Atlantic coastal beaches that enabled the world's first powered flight, provide a wide variety of opportunities for demonstrating and commercializing new transportation technologies. This Advanced Mobility NC Strategic Plan focuses on the advancement of key air and ground mobility technologies that, when integrated into the existing transportation ecosystem and adopted at scale, hold the potential to save lives, improve quality of life, and create access and opportunity for all North Carolinians (see **Exhibit ES-1**). While this Strategic Plan focuses on multi-modal and ground mobility, the benefits of these technologies extend to watercraft.

Exhibit ES-1. North Carolina's Transportation Ecosystem



With a vision of leveraging innovative advanced mobility technologies and platforms to provide a safe, sustainable, efficient, resilient, and equitable transportation system that works for all North Carolinians, the team, led by the Division of Aviation and the Integrated Mobility Division (IMD) focused on three goals:

- Improve Quality of Life
- Create Economic Opportunity
- Be a Transportation Trailblazer

STAKEHOLDER FEEDBACK

A market sounding was conducted to understand the latest industry opportunities, pressures, and trends. Stakeholder perspectives are summarized in **Exhibit ES-2**.

Exhibit ES-2. Advance Mobility Stakeholder Feedback

TECHNOLOGY

Focus on high-value use cases that can provide tangible results today.

Use technology to **leverage cost-effective and scalable options** for freight movement and last-mile solutions.

COLLABORATIONS

Cross-sector collaboration is key for facilitating innovation, testing and deployments, and workforce development.

Advanced mobility **creates economic opportunity** by attracting new companies to NC and creating high-quality jobs.

Encourage apprenticeships and short-term training programs focused on industry needs that **incorporate immediate job placement**.

POLICY

In the face of ongoing rapid technological change, **standards and guidelines** are needed to **ensure interoperability** and **mitigate the risk of obsolescence**.

True Beyond Visual Line-Of-Sight operations (BVLOS) flight is needed to **unlock the Advanced Air Mobility market's significant growth potential**. Limited BVLOS authorizations and supporting infrastructure is restricting adoption.

NCDOT can **provide guidance to local agencies** on land use and airspace planning, complete streets, and mobility hub integration of air and ground modes and secure consensus at all levels within the department.

INFRASTRUCTURE

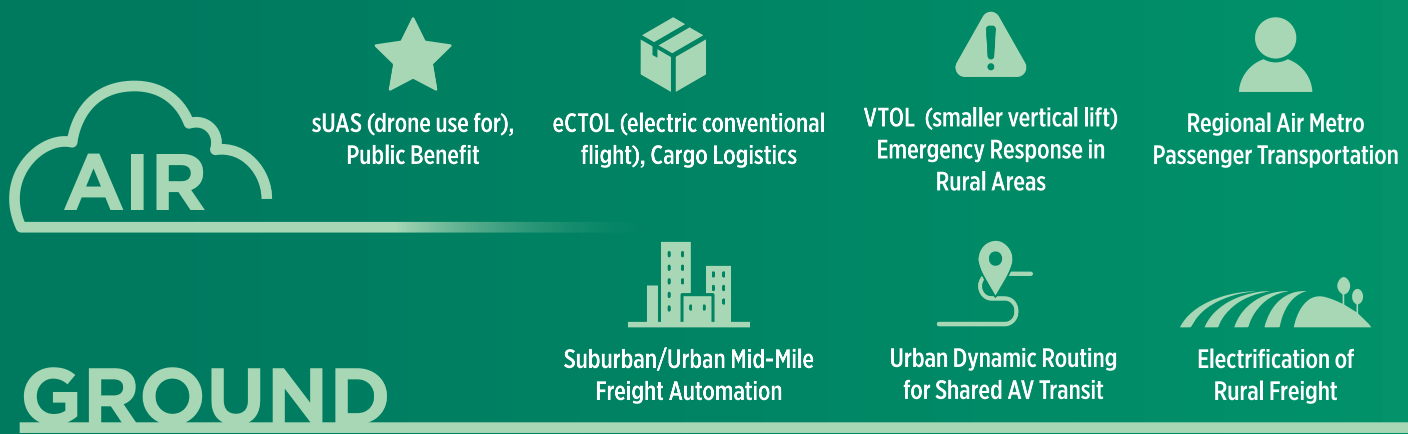
Increased electric grid capacity and resiliency are crucial for enabling advanced mobility technology adoption at scale.

Prioritize investments in advanced testing corridors and **integrate** advanced mobility and infrastructure with existing **multimodal systems**.

USE CASES

From this input, an understanding of the North Carolina culture and strengths, and additional research, several use cases were developed and evaluated for future air and ground applications, as noted in **Exhibit ES-3**.

Exhibit ES-3. Potential Advanced Mobility Technology Use Cases



Unlike in most states, North Carolina's department of transportation maintains most public roads. The state supports local agencies in delivering multimodal transportation options that meet the needs of their communities. The state will continue to support local agencies as their role evolves to include the siting of infrastructure to support ground and advanced air mobility use cases.

LOCAL AGENCY SUPPORT

To support local agencies as they continue to play a key role in advanced mobility use cases, several prompting questions were developed. These questions can be used to help conceive, evaluate, and integrate advanced mobility solutions into their transportation systems. The following contains sample questions from each of the categories addressed in more detail in the full Strategic Plan.

Readiness

What are the viable use cases in terms of technology and policy maturity?

Operations

Is there sufficient local and regional supporting infrastructure?

Utilities

If additional electrical capacity is needed, what is the timeline for implementing it?

Stakeholders

- Is there a champion?
- Will local stakeholders partner?
- Is there a path to community support?

Site & Facility

- What location would provide the greatest opportunity for success?
- Is adequate security possible?

The future of mobility will be realized through better connectivity that will occur at a variety of **mobility hubs**. These will vary based on their urban, suburban, or rural setting and their functionality – whether it be for intermodal connections, distribution centers, central or satellite uses.

ACTION ITEMS

Specific action items included in the full strategic plan support North Carolina's path to an advanced mobility future. The action items are organized around five key success factors, show below, to support the plan's goals of improving quality of life, creating economic opportunity, and being a transportation trailblazer. Under each key success factor is a list of the categories of action items included in greater detail in the plan.

REGULATORY, POLICY, AND PROCESS CONSIDERATIONS

- Implement comprehensive statewide advanced mobility approach
- Create consistent Internal policies
- Identify policies that support integration of AAM technology at airports
- Develop policies that emphasize environmental benefits of advanced mobility technology

WORKFORCE DEVELOPMENT AND GROWING INDUSTRY PRESENCE

- Conduct an advanced air mobility economic impact study
- Develop a cohesive workforce and economic development strategy that attracts industry investment, creates well-paying jobs, and develops, attracts, and retains talent to fill those jobs
- Incentivize internal innovation and ideas

PUBLIC ENGAGEMENT

- Develop and implement a comprehensive public education and engagement strategy

TECHNICAL READINESS

- Monitor progress through the states of technology maturity
- Collaborate with stakeholders, including federal agencies, to help advance the state of the industry
- Identify the key physical and digital infrastructure needed to support advanced mobility technology integration, and if applicable, develop strategic plans to invest and/or upgrade
- Expand data collection and integration capabilities

STRATEGIC FUNDING OPPORTUNITIES

- Leverage existing funding opportunities
- Create new funding opportunities

ADVANCED MOBILITY INTEGRATION PROCESS

Finally, the Advanced Mobility NC Strategic Plan presents a process by which ideas brought by outside stakeholders or internal staff can be tested against the established goals to determine if and how resources should be allocated to support them. If a decision is made to move forward, specific planning, implementation, and performance measurement aspects such as identifying a project champion, obtaining permits and licenses, and capturing lessons learned are noted to help guide the state partner in project development.

1

Introduction

The transportation landscape is changing rapidly, and advanced mobility innovations have the potential to significantly improve transportation system safety, efficiency, resiliency, sustainability, and equity. As a leader in innovation, North Carolina has already laid the groundwork to advance new technologies and ideas for the benefit of our businesses, residents, and visitors.

1.1

Drivers of Change

By 2050, North Carolina is anticipated to grow from 10 million to 14 million people,[1] placing an increasing demand on the transportation system that will require innovation and strategic action. As mobility technologies evolve, new use cases and solutions to real-world challenges emerge. Macro drivers affecting this evolution include the need for increased safety, sustainability, and equity in our transportation ecosystem, as well as technological advances and addressing supply chain volatility (see **Exhibit 1-1**).

Exhibit 1-1. Macro Drivers Affecting Advanced Mobility Technology Development and Availability

Safety

Technology and policy are needed to ensure the integration of automated vehicles (AVs) into the national road network and small uncrewed aircraft (sUAS) and advanced air mobility (AAM) into the National Airspace System (NAS) to maintain the highest level of operational safety.

Sustainability

28% of U.S. greenhouse gas emissions are from transportation, the most of any sector and a key factor driving climate change.

Advanced technologies are needed to provide more sustainable, resilient transportation systems.

Equity

Federal expectations around equity are changing to include a broader, more expansive definition of underserved communities and a focus on delivering benefits for those communities – this is a driver of Federal funding prioritization.

Technology

Rapid advances in air and ground automation, battery technology, artificial intelligence, and overall digital connectivity are enabling numerous innovations and opportunities.

Supply Chain

Redundancy is needed to mitigate disruptions, such as geopolitical unrest and environmental impacts, reduce foreign dependencies, and create jobs.

This will help provide visibility and manage challenges beyond the first tier suppliers.

Sources: National Highway Traffic Safety Administration (NHTSA)[2]; Environmental Protection Agency (EPA)[3]

1.2

What is Advanced Mobility and How Can it Help?

Advanced mobility is the overarching term used for innovative technologies and systems designed to improve safety, efficiency, sustainability, and equity in our transportation systems.

Advanced mobility technologies have the potential to impact the State's extensive and robust transportation network and address some of the State's key transportation challenges.

North Carolina by the Numbers

80K
miles of road
(NC MOVES 2050)[4]

GREATER THAN 80%
of tonnage carried over the road by truck
(NC SMFP 2023)[5]

98
public transit systems
(NCDOT IMD)[6]

72
airports
(NCDOT State of Aviation)[7]

3.5M
NC has 2nd largest rural population in the U.S.
(2020 Census)[8]

56M
airline passengers served/year
(NCDOT 2022 Annual Performance Report)[9]

OVER 50%
of North Carolina's CO_2 emissions are from transportation
(NC Greenhouse Gas Emissions Inventory)[10]

$3.3B
lost in traffic congestion annually
(2015-2019; tripnet.org)[11]

5.4%
zero-car households
(National Equity Atlas)[12]

80%
of commuters use single occupancy vehicles (SOVs)
(NCDOT VMT Reduction Study)[13]

61%
of residents experience transportation insecurity
(ETC Explorer)[14]

Advanced mobility includes innovative aircraft and ground vehicles, supporting physical and digital infrastructure, and alternative power sources, as well as platforms and systems that manage traffic and support transportation in new ways.

These technologies can also create economic opportunities in key industries – farming, logging, and agriculture – by improving transportation access in rural areas. North Carolina has a proven transportation innovation track record, world-class educational institutions, including North Carolina Agricultural and Technical State University (NC A&T) (America's number one public historically black college or university) and industry partners on the cutting edge of the critical research and development that pave the way for the future of transportation.

This Advanced Transportation Mobility (ATM) Strategic Plan is the cornerstone of the **North Carolina Department of Transportation (NCDOT)'s Advance Mobility NC program**,[15] which establishes a strategy for informed decision-making that will support the Department to create and assess technology ideas in the service of transportation programs statewide. It builds on North Carolina's robust statewide plans for ground transportation (NC MOVES 2050) and aviation (Forever First in Flight), which are required for future federally-backed ground and air investment. Understanding community needs is also critical to advancing technological solutions that work for all. Through these efforts, NCDOT is positioning North Carolina as a national leader in transportation innovation and advanced mobility.

1.3

Advanced Mobility Vision and Goals

The following advanced mobility-specific vision and goals were established to focus strategic planning in alignment with NCDOT's overarching goals around safety, reliability, connectivity, and economic growth (see **Exhibit 1-2**).

VISION

Leverage innovative mobility technologies and platforms to provide a safe, sustainable, efficient, resilient, and equitable transportation system that works for all North Carolinians.

Exhibit 1-2. North Carolina's Advanced Mobility Vision and Goals

CHALLENGE	GOAL	APPROACH
North Carolina's residents and businesses deserve a safer, more sustainable, resilient, and equitable transportation system, but traditional infrastructure and technology are not always able to meet those needs efficiently.	Improve Quality of Life	Holistically assess the State's transportation system to identify areas of greatest need and leverage advanced mobility technologies and infrastructure that better meets the needs of North Carolina today and builds the capacity to continue improving the transportation system for years to come.
Many rural areas have underutilized, unique resources and assets that have yet to be leveraged to their full potential in creating new or growing industries and businesses.	Create Economic Opportunity	Foster strategic relationships across sectors to attract innovative companies, upskill the workforce, and encourage investment into novel transportation applications in rural or disadvantaged areas.
Advanced mobility technologies are evolving rapidly, but the existing regulatory, industry, and funding environment is not sufficient to support adoption in many cases.	Be a Transportation Trailblazer	Create a framework for advanced mobility integration that identifies key success factors and actions required by stakeholders to ensure interoperablity and equitable adoption.

1.4

NCDOT Team

This NCDOT effort was initiated by the Deputy Secretary of Multimodal Transportation and led by the Division of Aviation and Integrated Mobility Division (IMD). Together, these divisions will help socialize and operationalize the recommendations put forward in this Strategic Plan.

Division of Aviation

North Carolina's 72 public airports support 330,000 jobs and generate $23 billion in personal income and $3.7 billion in state and local tax revenue.[16] The NCDOT Division of Aviation, with funding from the State of North Carolina and Federal Aviation Administration (FAA), supports local investment in airport development and operations with grants, long-range planning, aviation business development, technical assistance, and airport management training to bolster service and economic growth of this sector.

VISION

To lead innovation in air transportation that connects people and products to markets around the globe.

Division of Aviation
North Carolina Department of Transportation

Integrated Mobility Division

NCDOT's Integrated Mobility Division (IMD) is tasked with administering state and federal funds for public transportation, bicycle, and pedestrian programs and serves as the subject matter expert for multimodal transportation funding, planning, innovation, data, technology, and emerging mobility trends within North Carolina. IMD strives to ensure everyone in North Carolina has equal access to jobs, healthcare, education, and other opportunities by supporting public transit systems, planning bicycle and pedestrian facilities, and preparing for the future of transportation.

Integrated Mobility Division
N.C. Department of Transportation

VISION

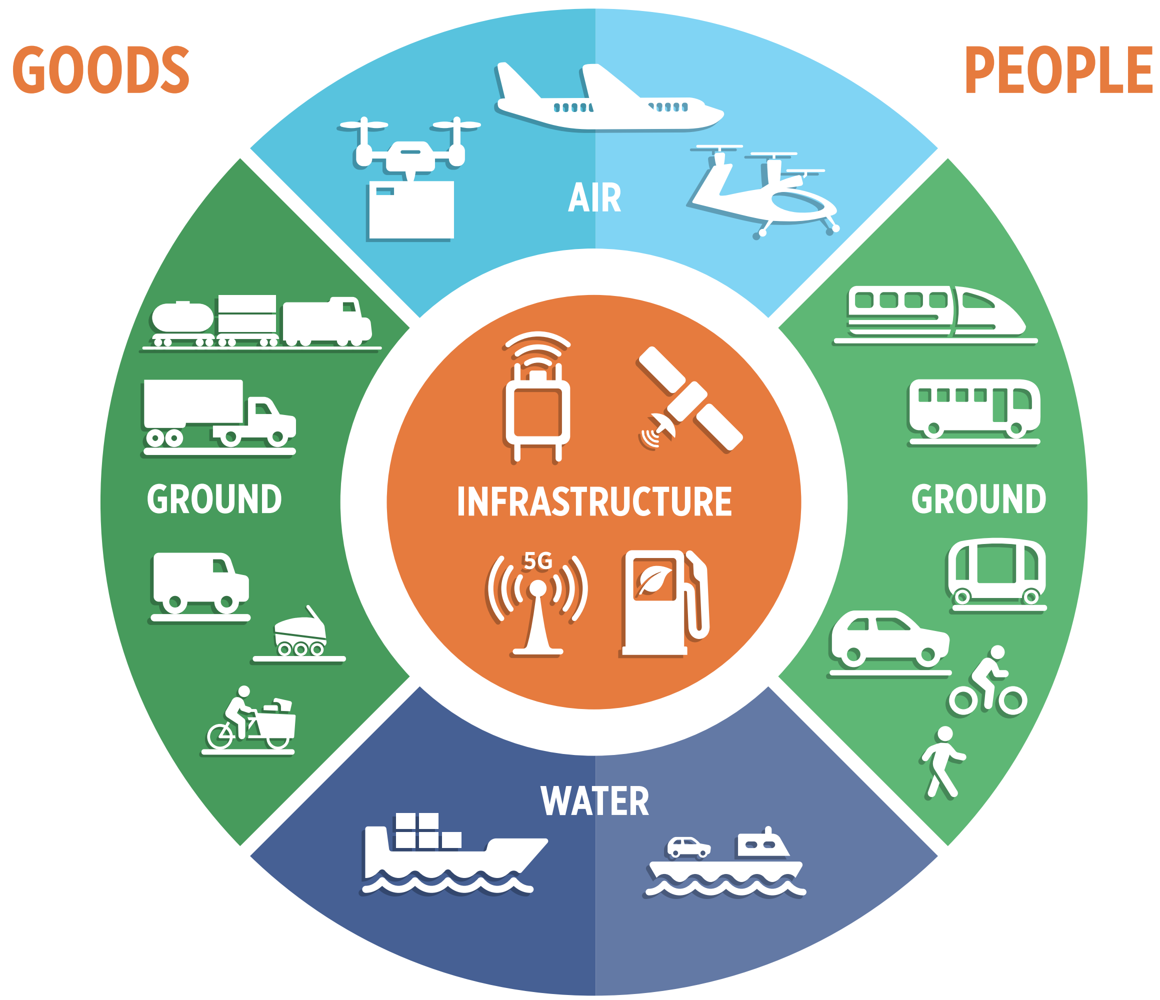
To provide leadership for safe, affordable, and innovative multimodal transportation throughout North Carolina.

1.5

Scope of This Plan

North Carolina has a diverse multimodal mobility ecosystem and many advanced mobility technologies have been demonstrated in the State, including small uncrewed aircraft systems (sUAS), electric vertical takeoff and landing (eVTOL) aircraft, and highly automated circulator shuttles. This Strategic Plan focuses on the advancement of key air and ground mobility technologies that, when integrated into the existing transportation ecosystem and adopted at scale, hold the potential to save lives, improve quality of life, and create access and opportunity for all North Carolinians (see **Exhibit 1-3**).

Exhibit 1-3. North Carolina's Transportation Ecosystem

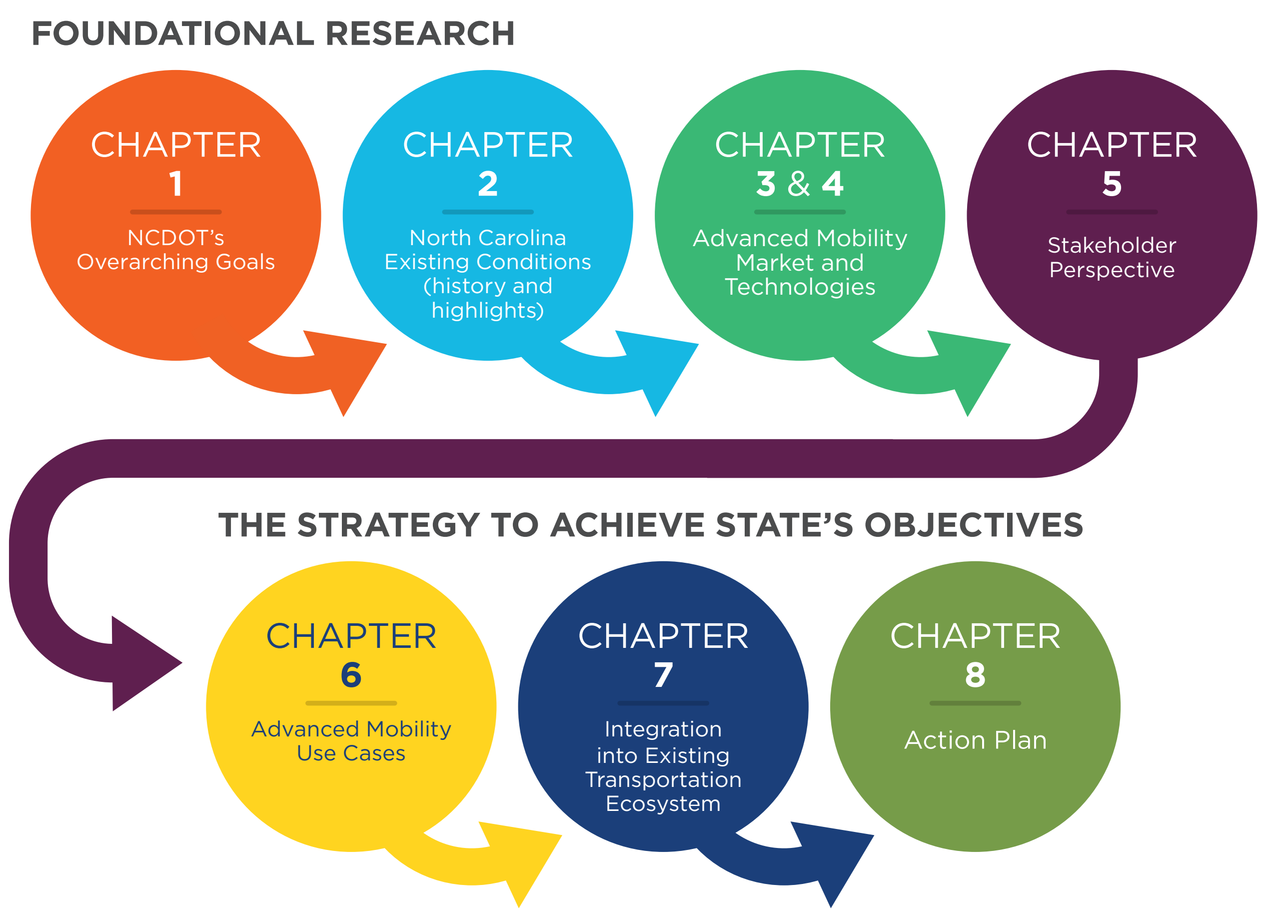


1.6

Plan Development Process

The strategic planning process began with understanding the statewide context, advanced mobility technologies and trends, as well as stakeholder perspectives on existing and anticipated mobility challenges. Next, several air and ground use cases were developed to illustrate how advanced mobility technologies can be used and integrated into the existing transportation ecosystem. Finally, a detailed action plan was developed, including specific strategies and actions needed to accomplish the goals. **Exhibit 1-4** outlines the Strategic Plan's chapters to demonstrate how the plan establishes the foundational goals, research, and context towards a strategy to achieve the State's objectives.

Exhibit 1-4. North Carolina Advanced Mobility Strategic Plan Development Process



1.7

North Carolina's Current Positioning

North Carolina is positioning itself as a leader in advanced mobility, bolstered by its strong track record in research and innovation, a vibrant and skilled workforce, and a wealth of expertise in the sectors of transportation, technology, and manufacturing. Leveraging the strengths and opportunities provided in **Exhibit 1-5**, North Carolina will be able to anticipate and address market forces and trends impacting advanced mobility adoption.

Exhibit 1-5. Strengths and Opportunities – North Carolina's Positioning

STRENGTHS

Top State for Business *CNBC in 2022 & 2023*[17]	**Diversified energy resources, including sustainable, low-cost sources**
#1 Largest Manufacturing Workforce in the Southeast *(EDPNC)*[18]	**250+ unique automotive manufacturing companies** *(EDPNC)*[19]
#3 Competitive Labor Environment *(EDPNC)*[20]	**200+ aerospace, 400+ aerospace supply chain and 174 aircraft maintenance-related companies** *(NCDOT: The State of Aviation)*[21]
31,000+ STEM (Science, Technology, Engineering, Math) Degrees Annually *(EDPNC)*[22]	**Two car battery manufacturing facilities and Toyota's first battery plant under construction**
52 Colleges and Universities *(EDPNC)*[23]	**1st Vietnamese car company, Vinfast, selected NC for 1st North American EV and battery line**
Well-established Research Triangle Park[24]	**Western NC's large lithium deposit reduces dependency on other regions and increases economic opportunity and resilience**
Three Tier 1 Research Universities *(EDPNC)*[25]	**Highest HBCU Enrollment in U.S.** *N.C. A&T State University*[26]

OPPORTUNITIES

Leverage supply chain needs of new manufacturing facilities to: • **Create well-paid, high-quality jobs** • **Reduce current supply chain instability and bottlenecks**	**Increased broadband installation for underserved communities**
Cohesive statewide framework for technology innovation and integration within NCDOT	**Promote NCDOT's established fellowship programs with the State's nationally acclaimed universities to support growing job market**
Leverage increased electricity demand from new technologies to promote sustainable energy and encourage electrical grid upgrades and expansion	**Leverage continued partnerships with public and private partners to maintain NC's position as a leader in advanced mobility**
Scale existing research and development efforts with advanced mobility (e.g., sUAS, autonomous shuttle) to progress towards widespread implementation	**Maximize federal funding and grants to achieve the State's advanced mobility goals**
Advanced manufacturing for alternative fuels in the supply chain	**Culture of acceptance in shift to new transportation modes**

2

North Carolina History and Highlights

North Carolina has a long history of transportation innovation. From the first successful powered airplane flight by the Wright brothers in 1903 through the present day, North Carolina has been consistently forward thinking, putting systems and guidelines in place to facilitate technology adoption that benefits North Carolinians statewide. This chapter briefly summarizes these efforts, program highlights, and partners that have supported these pursuits.

2.1

Air Mobility

North Carolina has leaned into the State's aviation history, becoming a center for many advanced air mobility (AAM) industry firsts. The outcomes of North Carolina's consistent and prolonged focus and extensive collaborations are summarized in **Exhibit 2-1** and **Exhibit 2-2**.

2011

North Carolina UAS Program created to identify potential test sites, prepare for UAS integration into the national airspace, and identify commercial and military use opportunities

2012

NextGen Air Transportation (NGAT) Program was launched by North Carolina State's ITRE under NCDOT Division of Aviation Leadership

2013

First FAA-approved test flight of a commercial use drone

2014

North Carolina Knowledge test and Operator Permit System required by legislature and managed by NCDOT

General Assembly passes legislation to protect resident privacy

2016

North Carolina launched the nation's **first** and only online permitting system for drone operators

Statewide permitting system for commercial and government drone operators lauched and 528 permits issued

2017

NCDOT created UAS standard operating procedures, best practices and guidance for state agencies

NCDOT developed **first** statewide UTM Concept of Operations (ConOps), which was integrated into the FAA's UAS Environment ConOps

2018

NCDOT UAS program launched to increase safety and save tax dollars

FAA selects NCDOT for 3-year UAS Integration Pilot Program

NCDOT enables **first** medical package delivery by drone

First coordinated drone disaster response, for Hurricane Florence, deployed

2019

Supported certification of UPS as nation's **first** fully certified drone air carrier

Launched Nation's **first** paid delivery of medical supplies

Received several national awards including National Association of State Aviation Officials Most Innovative State Program Award

2020

Nations **first** public unmanned air taxi flight demonstration

NCDOT awarded **first**-ever statewide BVLOS Bridge Inspection waiver

NCDOT one of eight teams participating in the FAA's four-year BEYOND program

Walmart pilot project for drone deliveries

2021

Nation's **first** vaccine drone deliveries launched

2022

Long-range drone transportation of medical packages

Nation's **first** tethered drones launched on incident management trucks

2023

BVLOS Drone-in-a-Box Construction Site Inspection waiver

Installation of the state's **first** Level 3 multimodal chargers at Raleigh Exec Jetport in October 2023

Launch of Advance Mobility North Carolina

Exhibit 2-1. Air Mobility Timeline

What is AAM?

AAM is not a single technology, but includes a range of technologies, including short takeoff and landing (STOL), vertical takeoff and landing (VTOL), highly automated or remotely operated aircraft, and electric or alternative fuel aircraft.

Partners

NCDOT has signed teaming agreements with several private sector and academic organizations that provide deeper understanding of the UAS industry's approach. See https://www.ncdot.gov/divisions/aviation/uas/Pages/beyond.aspx for more information.

Exhibit 2-2. Air Mobility Highlights

10 commercial airports

62 general aviation airports

8 military airfields

60M annual airline passengers

1.3M tons of cargo annually

330K attributed jobs in North Carolina annually

$23B annually in personal income

$3.7B annually in tax revenue

There are many facets to developing and sustaining a strong aviation and aerospace ecosystem. A few of these, coordinated through the NCDOT Division of Aviation, are summarized below:

- **K-12 and College Education**
  Ongoing and expanding high school science, technology, engineering, and math (STEM) programming as well as aviation-related bachelor's or master's degrees and pilot training certification in crewed and uncrewed aircraft[27] are training the next generation of professionals.

- **Workforce Training**
  The Division of Aviation offers a 12-course Airport Leadership and Management Program (ALMP) and North Carolina Airport Professional credential programs to airport managers and personnel.

- **Air Cargo**
  Of the 20 airports that provide air cargo activity in the State, Charlotte Douglas International Airport (CLT), Piedmont Triad International Airport (GSO), and Raleigh-Durham International Airport (RDU) comprise over 99% of the total air cargo volume.

- **UAS Permits**
  NCDOT has managed the North Carolina Knowledge Test and Operator Permit system since it became a State legislative requirement in 2014. The Operator Permit is required for both commercial and government operators.

- **Community Engagement**
  NCDOT's focus includes STEM outreach events, and State public agency training events. These efforts are supported through a video education series and social media campaign, focused on drone safety and operator permits.

- **Drone Operations**
  North Carolina uses UAS for surveying and mapping, inspecting roads and bridges, responding to emergencies, assessing damage from dangerous mudslides, spraying for invasive plant species in environmentally sensitive marshes, inspecting job sites, monitoring environmental conditions, managing traffic, and photographing State-owned buildings and historic sites.

- **Business Support Services**
  NCDOT offers existing and potential partners business support services, including: FAA waiver and certification assistance; partner and supplier connections; regulatory navigation; North Carolina operator permits; real estate and site identification; incentives and tax benefit inquiries; drone use training; and workforce solutions.

- **FAA BEYOND Program**
  As one of eight teams participating in the four-year BEYOND program that started in 2020, NCDOT has focused on medical package delivery (Winston-Salem and Kannapolis), transportation infrastructure inspection (statewide), and food and retail delivery (Fayetteville, Durham, Raeford, and Holly Springs). As of 2023, the NCDOT BEYOND program has partnerships with three of the five drone companies with Title 14 Code of Federal Regulations (CFR) Part 135 air carrier certification (Causey Aviation Unmanned, UPS Flight Forward, and Zipline).

2.2

Ground Mobility

Ground mobility covers all ground-based modes of transportation including freight (truck, rail); public transit (traditional fixed route buses, rail, and demand responsive services); automobile-based modes (carsharing, rides on demand, and microtransit); commute-based modes or ridesharing (carpooling and vanpooling); and bicycle and pedestrian modes, including micromobility (bike sharing, scooter sharing). Many of these modes are trending towards the use of alternative fuels. The ferry system, although on water, is also a key complement to NC's ground mobility network and is included here for context.

Last-Mile Freight Mobility

North Carolina is served by a robust multimodal freight network of highway, rail, marine, and air cargo assets. North Carolina's critical freight assets form the backbone of the North Carolina Priority Freight Network (NCPFN). The top industries served by the NCPFN by value are shown in **Exhibit 2-3**.

Exhibit 2-3. Top Industries Served by the NCPFN (by value)

- **10%** Agriculture, Food Processing, and Distribution
- **14%** Aerospace and Aviation
- **16%** Automotive, Truck, and Heavy Equipment
- **20%** Distribution and Logistics for Consumer Goods

With the rapid increase in e-commerce experienced during the pandemic, a focus on last-mile freight mobility has risen as consumer expectation for faster and more visible deliveries has increased. In response, North Carolina has begun to partner with the freight industry and public sector organizations to promote advanced multimodal solutions for middle- and last-mile delivery through strategic initiatives and pilot projects. **Exhibit 2-4** and **Exhibit 2-5** summarize North Carolina's ground mobility timeline, accomplishments, and assets.

Exhibit 2-4. Ground Mobility Timeline

1920s
Private, unofficial ferry routes begin operating along the Outer Banks

1947
First state-owned NC Ferry System route begins operating between Manns Harbor and Roanoke Island

1974
North Carolina is the first state to establish a Bicycle Program

1990
NC by Train, North Carolina's intercity passenger rail, begins service between Charlotte and Raleigh

1992
Bicycle Program expanded to address pedestrian accommodations

2009
NCDOT Board adopts Complete Streets Policy

2016
Published North Carolina Readiness for Connected and Automated Vehicles

2018
Volvo Truck and FedEx platoon three trucks

Published Connecting North Carolinians to Opportunities Public Transportation Strategic Plan

2019
Bicycle and Pedestrian and Public Transportation divisions merge to become the Integrated Mobility Division (IMD)

2020
Connected Autonomous Shuttle Supporting Innovation (CASSI) program completes its first two projects with EasyMile

2021
CASSI program completes its third project with EasyMile in partnership with the National Park Service

N.C. A&T State University partners with Starship Technologies to deploy wheeled sidewalk delivery robots for food delivery

2022
CASSI program partners with Beep for future low-speed, automated shuttle projects

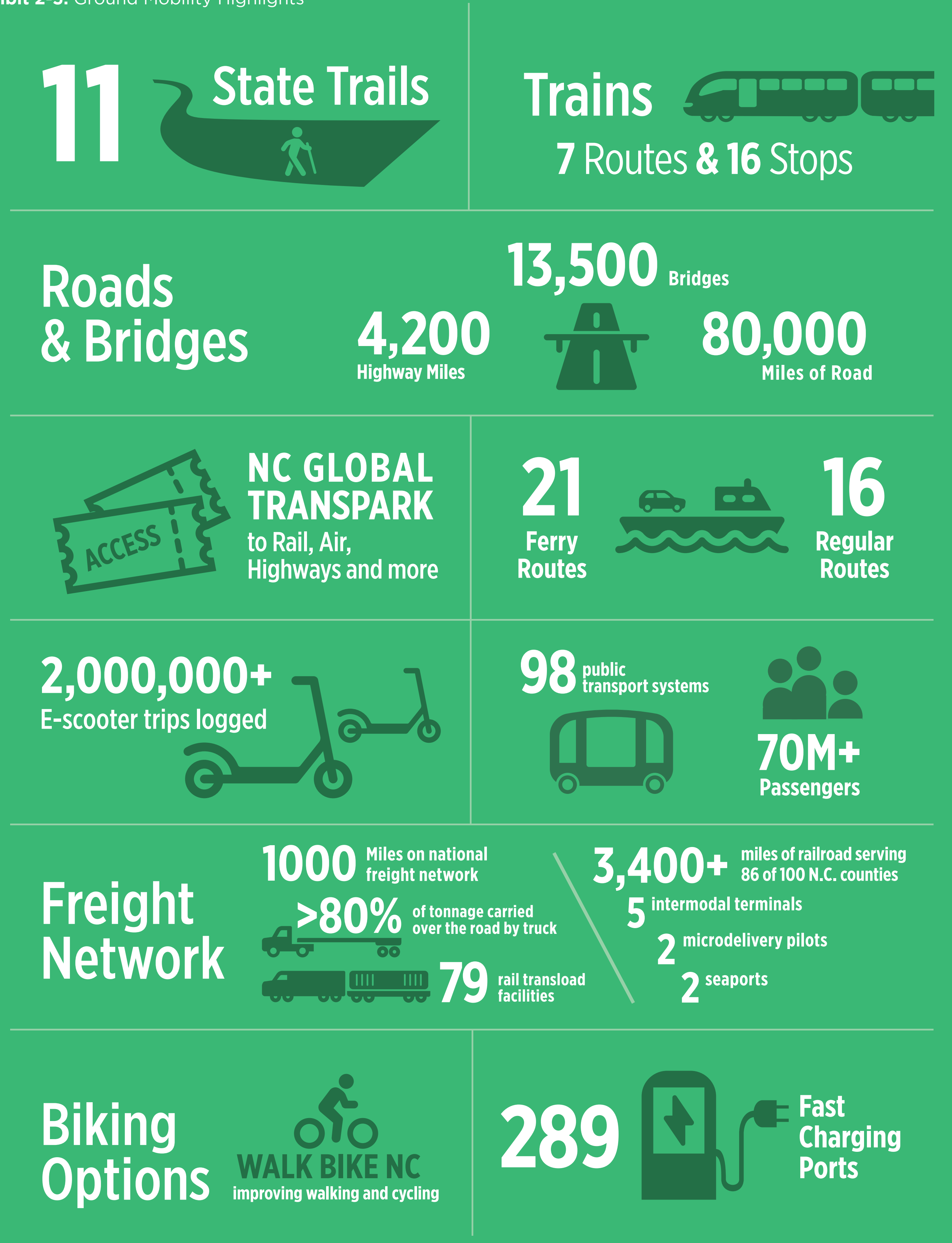
NC by Train experiences record ridership of over 522,000 passengers

NC Ferry System is second largest state-run ferry system in the United States, transporting approximately 1.5 million passengers annually

2023
CASSI program completes two projects with Beep and Navya

East Carolina University and UNC Charlotte partner with Starship Technologies to deploy wheeled sidewalk delivery robots for food delivery

Exhibit 2-5. Ground Mobility Highlights



Connected Autonomous Shuttle Supporting Innovation (CASSI)

NCDOT's CASSI[28] program is designed to show the public what autonomous vehicle technology can do in safe, real-world settings by partnering with communities statewide to test and evaluate connected and automated vehicles in pilots that provide free shared rides to the public. Through the CASSI program, NCDOT is incrementally advancing the complexity of connected and automated vehicle projects while learning from past challenges and building on successes.

EasyMile EZ10 Deployments

- January 8-9, 2020: Two-day demonstration at the N.C. Transportation Summit at the Raleigh Convention Center.
- January 21-February 25, 2020: Three-week deployment at N.C. State University's Centennial Campus.
- April 20-July 16, 2021: 13-week deployment at the Wright Brothers National Memorial in partnership with the National Park Service (NPS) for the first automated shuttle deployment at a recreational public lands site. In operation for 54 days, completed 809 round trips, served 3,380 passengers.

The CASSI program is always evolving to include the latest technological advancements. NCDOT will continue to pilot automated shuttles and is further exploring how automated vehicles can be tested and integrated into high quality, on-demand transit services that address transportation challenges.

Beep and Navya Deployments

- March 6-June 2, 2023: 13-week deployment at Cary's Fred G. Bond Metro Park, the first project to include vehicle-to-infrastructure (V2I) communications.
- July 12-December 22, 2023: 23-week deployment at UNC Charlotte that applied lessons learned from the previous project in Cary to increase the complexity of the V2I communications to four naturalistic traffic signals. The project also featured the longest route and most complex operating environment to date.

2.3

Economic and Workforce Development

North Carolina has a strong manufacturing base, a skilled workforce with engaged university and research partners, and a favorable business climate. The state is also home to many companies that are engaged in advanced mobility.

Workforce Direct Investments

Over the last decade, North Carolina has made significant investments in the advanced mobility sector. These investments have supported the creation of thousands of new jobs and helped position North Carolina as a leader in the advanced mobility industry.

Two key programs the State uses to advance North Carolina's workforce include:

Job Development Investment Grant (JDIG)

Administered through the North Carolina Department of Commerce, the JDIG award is North Carolina's signature economic development incentive and can often be a decisive factor in a company's decision to expand or locate in North Carolina. JDIG is considered in situations where the State is competing with other attractive business locations. Four recent examples are listed in **Exhibit 2-7**.

One North Carolina Fund (OneNC)

The North Carolina Department of Commerce administers OneNC grants on behalf of the Governor. Awards can be deployed relatively quickly and help companies offset the costs associated with creating new jobs in the North Carolina. OneNC grants also underscore the partnership and collaboration between the State and local jurisdictions that benefit companies that do business in North Carolina. OneNC awards require that a local government provide an incentive to match the OneNC funding. Award types include public infrastructure funds, building or site funds, workforce grants, and technology funds.

2019
$220M GRANT
Awarded to Siemens Mobility for new manufacturing facility in Lexington, creating
500 NEW JOBS

2021 & 2022
$435M GRANT
Awarded to Toyota for electric vehicle battery plant in Liberty, creating
1750 NEW JOBS

2022
$130M GRANT
Awarded to Boom Supersonic for supersonic aircraft facility in Greensboro, creating
1760 NEW JOBS

2022
$316M GRANT
Awarded to VinFast for electric vehicle manufacturing facility in Sanford, creating
7500 NEW JOBS

Exhibit 2-6. Key Industry Investments

Indirect Investments

In addition to the direct investments specifically for advanced mobility, the state has also made several indirect investments into research and development, workforce training, and infrastructure. Developing a pipeline for a vibrant skilled workforce both supports the attraction of related companies to North Carolina and the generation of job opportunities for its residents. Key state-level indirect investments include: NC Commerce's Workforce Grants and One North Carolina Small Business Program; the NC Clean Energy Technology Center, which is funded through direct appropriation as well as federal, state, and private research grants and the NC State Engineering Foundation; and The Innovative Education Initiatives Act (SL 2003-277, Senate Bill 656) and the Cooperative Innovative High School Programs statute (§ 115C-238.50-.55).

3

Advanced Mobility Market and Trends

Advanced mobility technologies and services are transforming how people and goods are moved throughout the world.

3.1

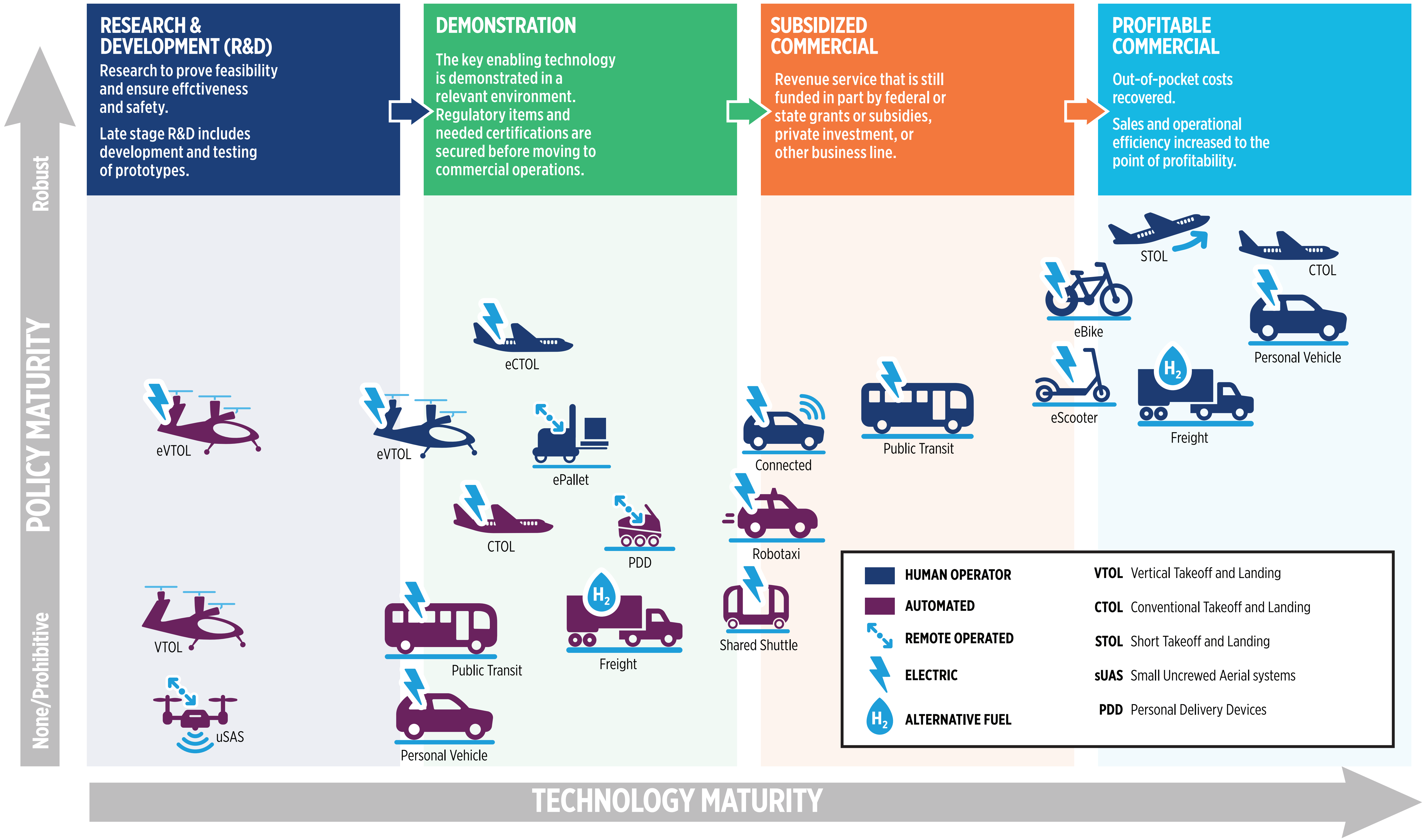
Advanced Mobility Readiness

Advanced mobility technology readiness for wide-scale adoption depends on several factors. While the complexities of the rapidly evolving federal, state, and local technology landscape make generalization difficult, an approximation of key factors such as policy and technology maturity levels for aircraft and ground vehicles is estimated in **Exhibit 3-1**.

Policy maturity indicates how well the level of policy aligns with the needs of advanced mobility and its intended use. Its wide range extends from having no policies or inadvertently prohibitive policies at the advent of the technology to possessing a robust policy environment for well-established technologies. Local government drone policy, for example, demonstrates varying policy levels.

Technology maturity indicates how far a new technology is from commercialization and profitability. Although profits can be generated in earlier stages in military applications, technologies for civilian applications, like those described in this Strategic Plan, move through a predictable cycle from research and development to demonstration to eventual commercial operation. **Exhibit 3-1** characterizes each stage in the technology maturation process.

Exhibit 3-1. Stages of Technology Maturity



3.2

Advanced Mobility Trends

Advanced mobility as it relates to aviation, includes the drone and UAS technologies highlighted in Chapter 2, and key technologies which underpin the movement towards larger and increasingly autonomous advanced air mobility (AAM) aircraft. These advanced aircraft will include novel propulsion methods (e.g., electric, hydrogen) and operate in a variety of modes.

Ground technology continues to advance in the areas of data connections, automation, and alternative fuels. Automated ground vehicle demonstrations have been constrained by technology maturity and focused on smaller vehicles that address last-mile trips for people and goods.

Both AAM and ground technology is rapidly maturing through extensive industry efforts to develop and certify new aircraft, shuttles, and vehicles from passenger cars to full size trucks. Electrification, hydrogen fuel cells, automation, and other innovations are well funded, with billions of dollars in federal, academic, and industry investment in recent years.[29] Currently, air operational capabilities are limited primarily due to obstacles in the regulatory environment, battery capacity, and supporting infrastructure.

The FAA is also actively working to define the regulations that pilots must satisfy to operate aircraft that might have flying characteristics of both helicopters and airplanes. In the future, the AAM market is expected to include larger aircraft, improved performance, and a streamlined regulatory process. Increasing demand for sustainable technologies, multimodal connectivity, and equity in transportation are driving rapid advancement in ground mobility technology, as well. While some innovative mobility solutions are already in use, many are still in the demonstration phase and adoption is fragmented. Scaled operations depend on partnerships for planning and operations, technology maturity, seamless multimodal integration, and sufficient supporting infrastructure.

High-level summaries of air and ground mobility trends are provided in **Exhibit 3-2** and **Exhibit 3-3**.

Exhibit 3-2. Advanced Mobility Trends – Air

AIR	
CURRENT STATE	WHAT TO EXPECT
AAM concepts, including piloted and autonomous electric VTOL (eVTOL) and electric STOL (eSTOL) aircraft, are in the testing phase.	Larger, longer range electric AAM aircraft with increasing levels of automation and remote monitoring capabilities will enter into service.
The regulatory environment for AAM is still in its infancy.	Standardized, performance-based certification pathways will emerge, including maturing operational rules (under 14 CFR Parts 61, 91, 121, and 135), and more automation.
sUAS operate from a small footprint in limited areas. AAM VTOL operations are expected to utilize existing airports/helipads.	There will be a shift to purpose-built vertiports and droneports.
AAM deployments are mostly in the demonstration phase, collecting data for safe operation and scale-up.	Collaboration with ground mobility for integrated mobility-as-a-service (MaaS), including curb management, will become the norm.
The process for sUAS BVLOS certification is cumbersome and limited certificates are issued.	BVLOS operations will expand.
There are critical gaps in lower altitude communications, navigation, surveillance (CNS) and weather systems are purpose-built to support conventional aviation at higher altitudes and existing at aviation facilities.	Traffic management systems for low-altitude, uncrewed aircraft will be developed and expanded.
Charging and alternative fueling infrastructure is limited and is typically for private use.	Electrification and use of alternative fuels will increase. Fueling infrastructure upgrades will enable rapid charging, increasing demand on the grid.

Exhibit 3-3. Advanced Mobility Trends – Ground

GROUND	
CURRENT STATE	WHAT TO EXPECT
Traffic fatalities are increasing, and commercial driver and battery raw materials shortage are worsening.	Increased advanced mobility adoption is expected to reduce traffic fatalities, emissions, traffic congestion, and parking demand through advanced situational awareness provided by onboard sensors.
52% of all U.S. car trips are under five miles.	A shift to micromobility solutions, seen in other parts of the world, will gradually grow in the U.S., shifting away from passenger cars for short trips.
• The fiber backhaul necessary for advanced mobility operations is nearing ubiquity in urban areas. • Deployment of satellite communications, such as Starlink, are becoming commercially viable and gaining adoption in rural areas.	• Faster, reliable, and more comprehensive data availability allow for timely and enhanced artificial intelligence (AI) developments. • Options for satellite communications continue to grow steadily, making data-driven mobility solutions more practical and cost effective. • Investment in broadband availability pushes fiber to deployments in suburban and rural settings.
• Dedicated intelligent transportation system (ITS) bandwidth reduced. • With 5G cell service deployments and original equipment manufacturers (OEMs) including compatible hardware on new vehicles, wireless capabilities are quickly regaining lost progress.	• Absent a federal mandate, future vehicle-to-everything (V2X) communications will be a mix of technologies driven by OEMs and telecommunications providers. • Direct vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications will initially be limited to safety-critical use cases. • Continued advances in connectivity and automation will support enhanced and emerging mobility and safety use cases. • Freight adoption includes the expanded use of existing onboard equipment, such as electronic logging devices (ELD), to serve as connected vehicle (CV) onboard units (OBUs) that display additional information.

GROUND *(continued)*	
CURRENT STATE	WHAT TO EXPECT
• There are a limited number of automated freight (e.g., truck platooning) and transit (e.g., automated shuttles) demonstrations underway. • Advanced Driver Assistance Systems (ADAS) are commonplace; higher levels of automation, known as Automated Driving Systems (ADS), continue to have operational constraints.	• Technology and policy advancements along with public engagement and acceptance will increase prevalence of highly automated vehicles. • ADAS and early-stage ADS technologies will represent most of the AV market through 2030. • Advanced ADS (high driving automation) represent half of the ADAS/ADS market by 2035 (in revenue).[30]
• Federal National Electric Vehicle Infrastructure (NEVI) and OEM funding is dramatically increasing charger accessibility along interstates, U.S. routes, and state routes. • Electric vehicles (EVs) are readily available but charging infrastructure and battery range are often cited barriers to EV adoption.	• Grid upgrades, development of smart grid technologies, and promotion of off-peak charging will increase to meet demand. • Technology advancements will result in electrification of larger, heavier payload and longer-range vehicles. • Hydrogen deployments will advance despite persistent production, transport, and storage challenges through public and private sector partnerships. • The circular economy will advance to better conserve alkali and rare earth metals.

4

Advanced Mobility Technologies

Advanced mobility technologies include innovative aircraft and ground vehicles, related physical and digital infrastructure, and alternative fuels, as well as platforms and systems that manage traffic and support transportation in new ways.

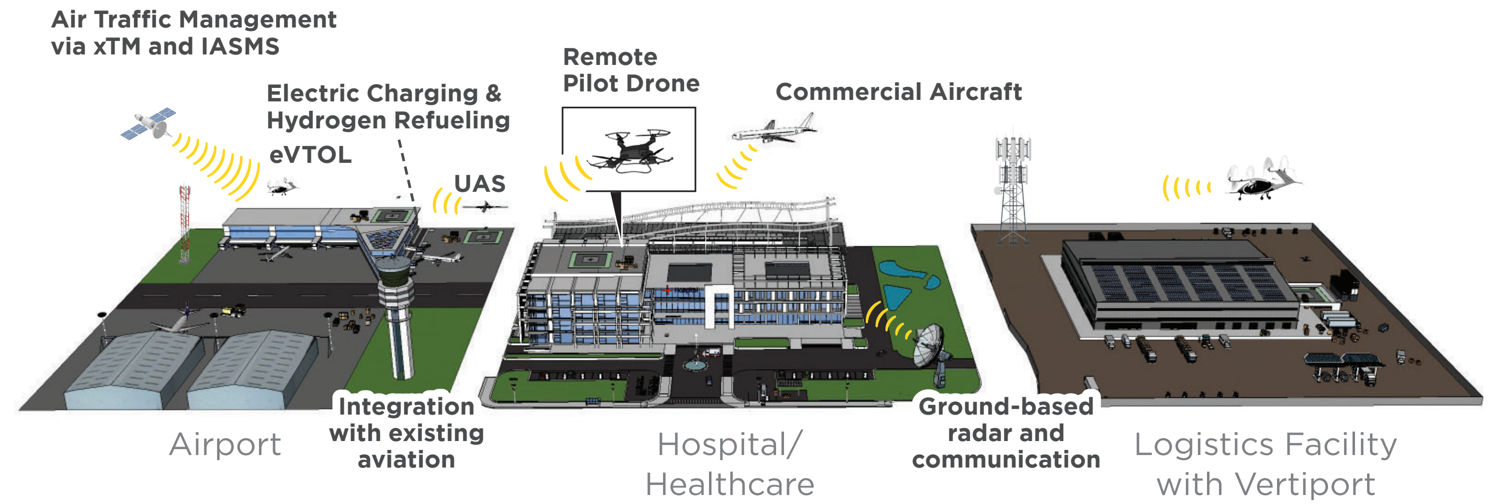
Both aircraft and ground vehicles are becoming increasingly automated, connected, and powered by novel propulsion methods and alternative fuels. For advanced aircraft and ground vehicles to function as intended, various physical infrastructure elements are needed, ranging from fueling stations to complex communications systems. Digital systems and platforms, sometimes referred to as digital infrastructure, are often used to optimize and manage advanced vehicle interactions with other vehicles and physical infrastructure. This involves receiving and interpreting data, then communicating back to a network of other vehicles and devices in real-time.

4.1

Aviation Technologies

AAM technologies vary by takeoff and landing style (CTOL, STOL, or VTOL), level of automation (crewed, remotely piloted, highly automated, or fully autonomous), and fuel type (electric, hybrid-electric, sustainable aircraft fuels (SAFs), hydrogen, and others). Enabling physical and digital infrastructure includes extensible traffic management (xTM), in-time aviation safety management systems (IASMS), airport integration, vertiports and droneports, CNS, and low altitude weather networks. These technologies are shown in **Exhibit 4-1**.

Exhibit 4-1. Advanced Mobility Technologies in the Air Transportation Ecosystem

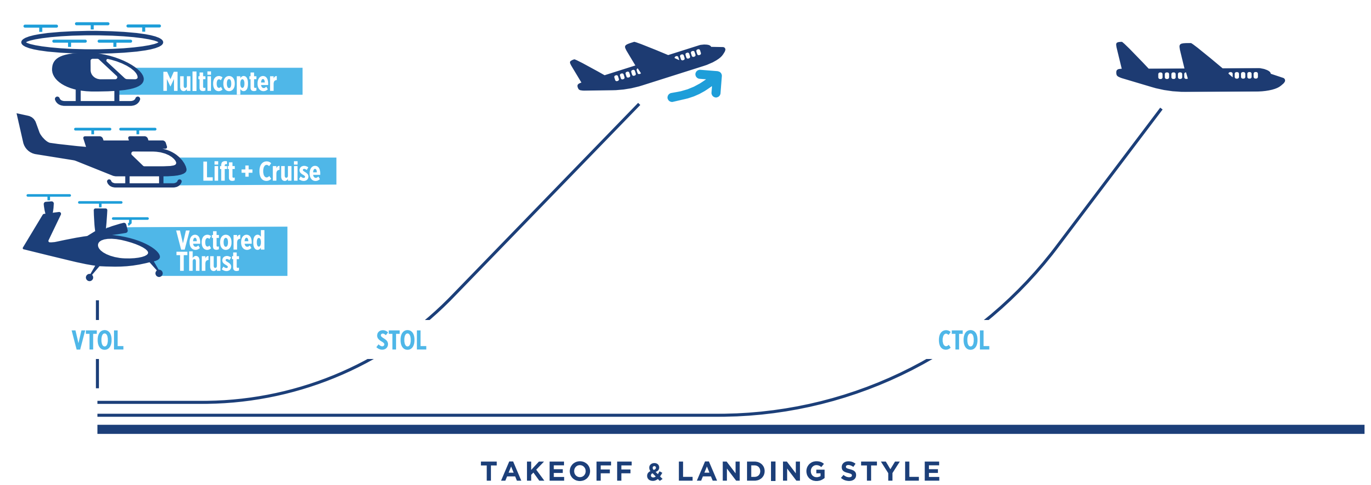


4.1.1

AAM Aircraft Variations

AAM aircraft vary in takeoff and landing method, fuel type, refueling requirements, and degree of autonomy. Additional aircraft design criteria must also be considered, including payload capacity (passenger or cargo), altitude, cruise speed, acoustic footprint, and anticipated costs. The variations in takeoff and landing methods, range, propulsion type, and refueling/charging requirements will influence the type of operations and use cases in a specific location. An overview of advanced mobility aircraft takeoff and landing types is shown in **Exhibit 4-2**.

Exhibit 4-2. Aircraft Takeoff and Landing Types



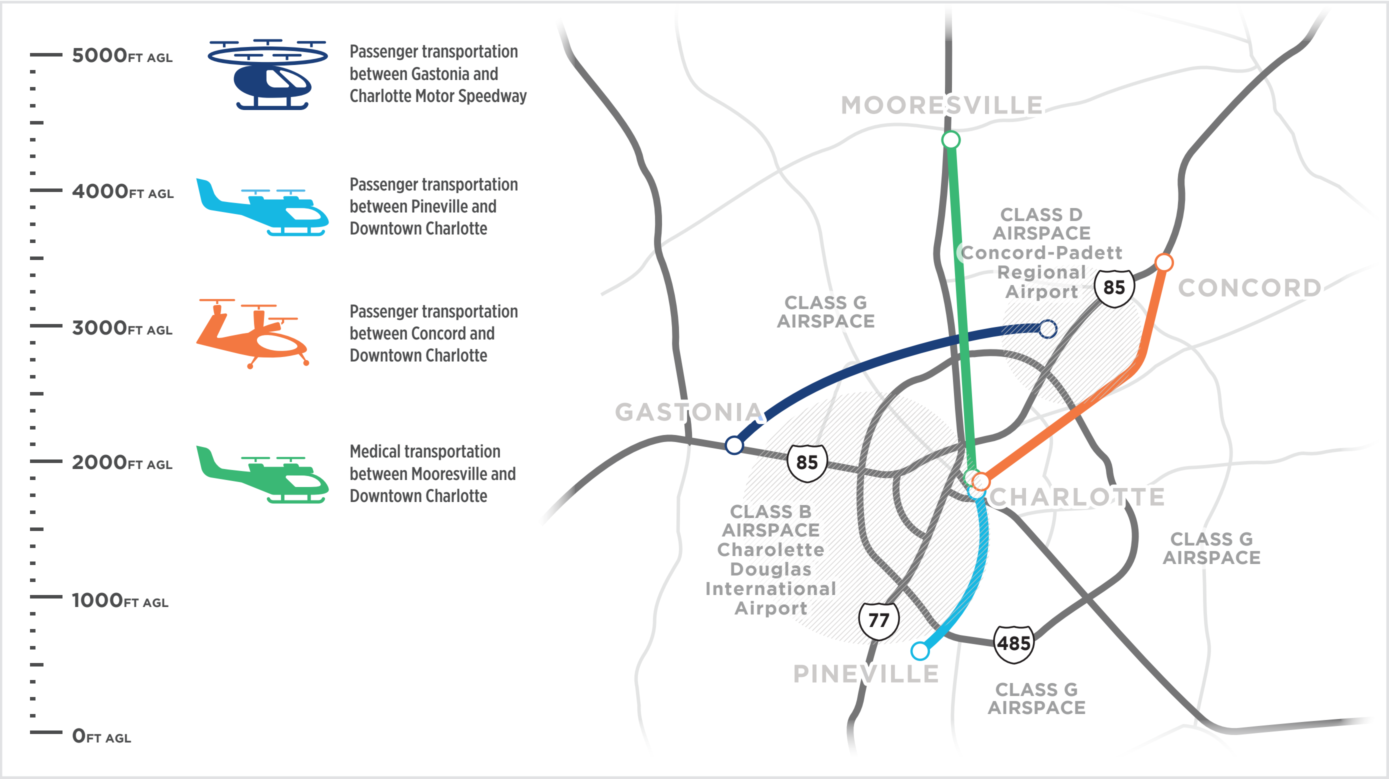
4.1.2

AAM Operations within the National Airspace System

The NAS comprises two types of airspace, controlled and uncontrolled, further distinguished by six classes. Controlled airspace (Classes A, B, C, D and E) typically surrounds busy airports and encompasses higher altitudes frequented by commercial aircraft. Air traffic control services are provided to aircraft flying with use of instrumentation (instrument flight rules, IFR), and, depending on the class of airspace, to aircraft flying via visual references (visual flight rules, VFR). Air traffic services provide safe and efficient management of air traffic and includes active communication, direction, and separation of air traffic by air traffic controllers. In uncontrolled airspace (Class G), pilots are responsible for seeing and avoiding other aircraft, and may not be in communication with ATC.

sUAS and most AAM aircraft promise the movement of goods and people over shorter distances not practical for existing aviation, such as between employment or distribution centers and residential areas. As such, they will operate at lower altitudes, including in both controlled and uncontrolled airspace. **Exhibit 4-3** illustrates the aspirational movement of people and goods using AAM in an urban environment and the interaction between airspace classes.

Exhibit 4-3. AAM Operations within the National Airspace System



Note: Elevations are for illustration purposes. Any of these aircraft can fly at any of these elevations. Altitudes will be based on air traffic priorities, obstructions, and other factors. Class B and Class D are part of the controlled airspace.

4.1.3

Digital Infrastructure

The introduction of AAM technologies dramatically increases the complexity of air traffic management. The FAA is responsible for the development and oversight of air traffic management, including defining the regulatory framework, establishing standards and guidelines, and ensuring the safe integration of AAM aircraft into the NAS. In particular, achieving BVLOS flight requires ensuring awareness of other aircraft and weather conditions to guarantee the highest levels of safety. Reliable high-speed communications will be critical to monitor AAM aircraft operations and facilitate two-way communications. The FAA's Remote ID rule stipulates that aircraft must broadcast their identity, position, speed, altitude, and safety messages (and disseminate real-time weather reporting, if possible). The ability to receive that broadcast will be necessary. Communications networks, such as 5G, will have to be built out to achieve the high-speed communications necessary for AAM to become mainstream, and will also support the real-time reporting of micro-regional and low-altitude weather conditions.

Safe integration of AAM aircraft requires introducing various innovative systems and platforms, such as xTM and IASMS (see **Exhibit 4-4**).

Exhibit 4-4. Digital Infrastructure Platforms/Systems – Air

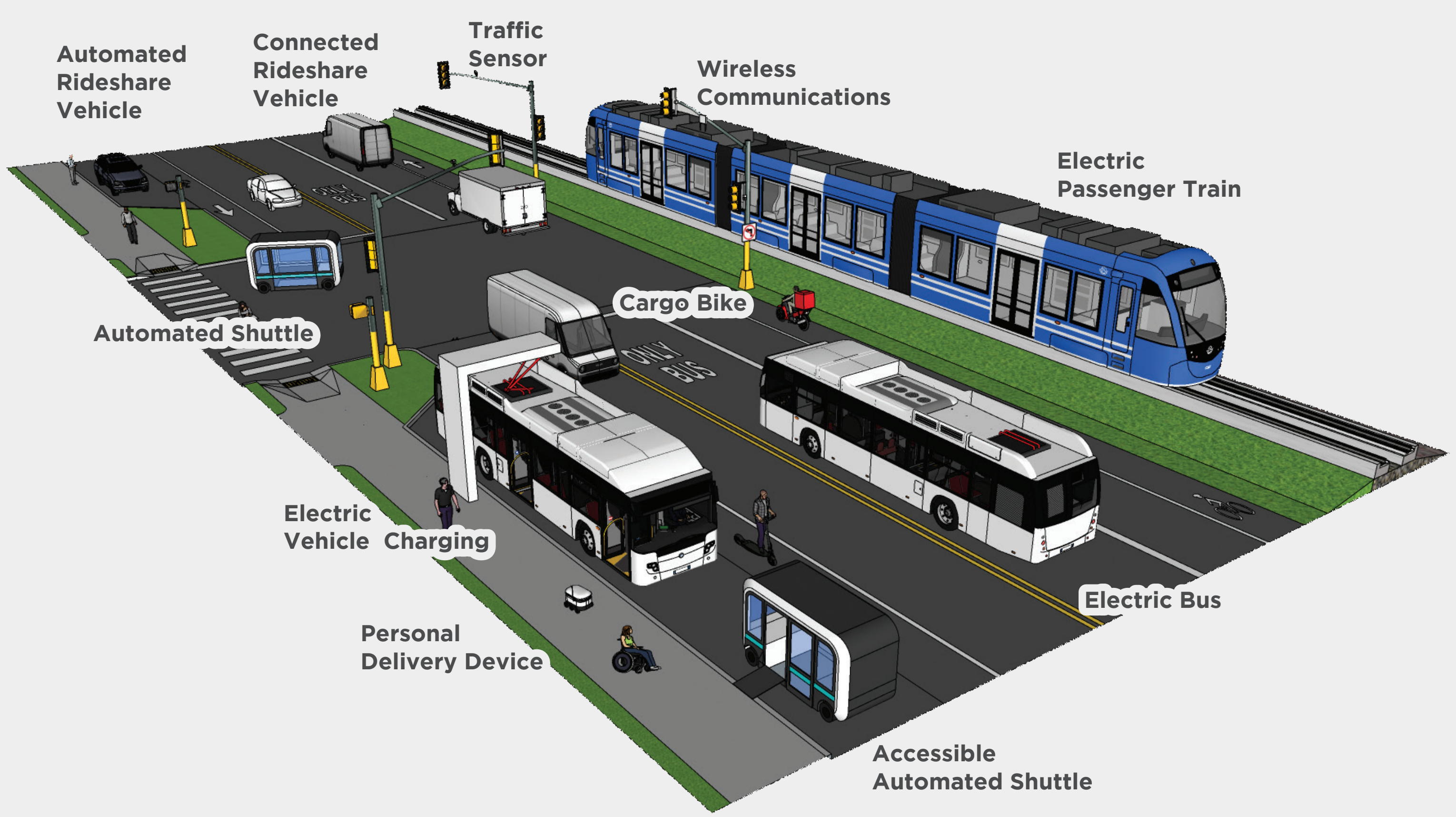
Extensible Traffic Management (xTM)	In-time Aviation Safety Management Systems (IASMS)
UTM: Primarily concerned with managing the airspace below 400 feet AGL for small UAS (< 55 pounds) – UTM will be deployed gradually.	Integrates predictive modeling with proactive analytics to detect hazards. Identifies safety risks exposed by transformation of the NAS with new and increasingly complex operations.
AAM: Lower altitude airspace operations in uncontrolled Class G airspace and in controlled airspace (Class E in cruise; Class D, C, and B near airports).	Improvements to safety provide capabilities for highly automated aircraft operating under novel digital air traffic management systems.

4.2

Ground Technologies

Advanced ground vehicles vary by form factor, size, level of automation, fuel type, and a variety of other features. Enabling digital infrastructure includes CV systems, MaaS, intelligent transportation systems (ITS), and advanced transportation management systems (ATMS). Supporting physical infrastructure includes fueling and charging stations, a variety of sensors and cameras, communication endpoints, and backhaul. These technologies are shown in the ground transportation ecosystem diagram (see **Exhibit 4-5**) and described in the following sections.

Exhibit 4-5. Advanced Mobility Technologies in the Ground Transportation Ecosystem



4.2.1

Levels of Automation

SAE International developed a standard that defines terminology for automated vehicles, including automation levels from Level 0 ("No Driving Automation") to Level 5 ("Full Driving Automation").[31,32] ADAS are typically categorized as SAE Levels 0-2, while hardware and software capable of SAE Levels 3-5 are considered ADS. ADAS help drivers with certain driving tasks to improve safety or reduce the workload on the driver. Examples include lane departure warning, forward collision warning, blind spot warning, Automatic Emergency Braking (AEB), lane keeping or centering, parking assist, and adaptive cruise control.

The human in the driver's seat must constantly supervise the support features and steer, brake, or accelerate as needed to maintain safety. ADS at SAE Levels 3-4 can drive the vehicle under limited conditions and will not operate unless all required conditions are met. For Level 3, the human in the driver's seat must take over driving when the ADS requests. For Level 4, the automated driving features do not require the human in the driver's seat to take over driving. ADS at SAE Level 5 enables full driverless operation everywhere, under all conditions.

There are currently no ADS-equipped vehicles available on the commercial market, but the technology is in the prototyping, testing, and demonstration phases of development.

4.2.2

Vehicle Types

Advanced ground vehicles can be divided into two main types: those carrying goods and those transporting people. Within those categories, vehicles vary by size and form factor, technology, fuel type or electrical charging requirements, connectivity, and level of automation. Other differentiating characteristics include payload or passenger capacity, range (miles a vehicle can operate on a single charge), operational constraints (e.g., speed or weather conditions), and potential costs (e.g., upfront capital required and operational costs). An overview of advanced ground vehicles by type is shown in **Exhibit 4-6**.

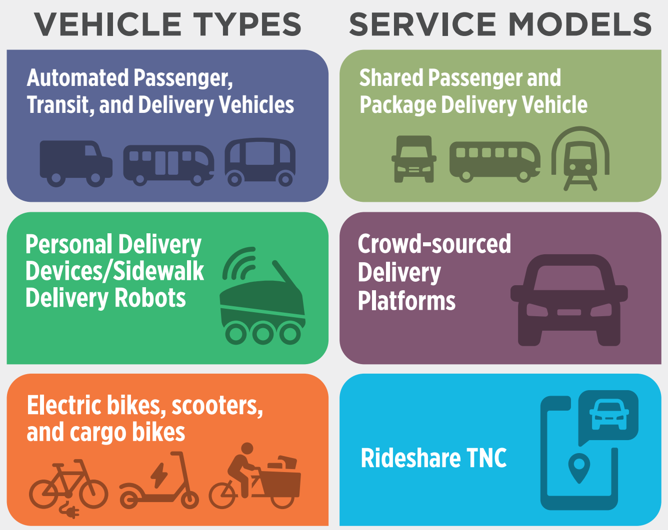


Exhibit 4-6. Ground Vehicle Types and Service Models

Vehicle Types *(CONTINUED)*

Ground freight delivery encompasses a broad spectrum of vehicle types at various stages of development and deployment. Last-mile ground delivery leverages investments in existing infrastructure, paired with new technology to provide scaled solutions that align with the physical environment, such as complete streets, and parcel size. Middle- and last-mile ground freight delivery include traditionally powered vehicles as well as alternative fuels, including battery electric, hybrid electric, hydrogen, and natural gas. The use of electric power assistance in delivery solutions such as electric bikes or palettes has expanded their range and cargo capability beyond what was traditionally limited by the operator's physical capacity.

As technology advances, the world of transportation evolves, particularly in the realm of ground mobility technology for moving people. Highly automated shuttles, electric bikes and scooters, and shared trips from Transportation Network Companies (TNC) have emerged as transformative solutions, reshaping how people move and enhancing the overall transportation experience. These innovative forms of mobility offer reduced congestion, improved sustainability, increased accessibility, and enhanced convenience for commuters and travelers in a dynamic and interconnected transportation ecosystem.

Future scenarios include the mixing of people and goods on trips. On-demand crowd-sourced mobility may include both passengers and goods in rural and suburban locations. Similarly, buses and automated transit vehicles can efficiently move both people and goods between central mobility hubs and satellite hubs.

4.2.3

Connected Vehicles

CV technology includes equipment, applications, and systems that use V2X communications to address safety, system efficiency, and mobility needs in the transportation system. In a CV environment, V2I and V2V technologies are used to exchange critical information on the surrounding environment, including advanced warning that an emergency vehicle is headed through an intersection or that there is another vehicle or vulnerable road user (VRU), such as a pedestrian or bicyclist, outside of a driver's direct line of sight. CV environments are made possible using roadside units (RSUs) and in-vehicle OBUs, including ELDs, roadside infrastructure (RSI), cellular infrastructure, software applications, backhaul and backend systems, and digital roadway information or digital twins.

4.2.4

Data Exchange Platforms

Data exchange platforms are vital to integrating advanced mobility technologies into our transportation systems. They include data server or cloud-based platforms that aggregate data from multiple sources and connect various agency data into a streamlined decision support system, such as computer aided dispatch systems located at transportation management centers.

5

Stakeholder Perspective

To enhance understanding of the industry landscape, outreach was conducted with representatives from industry and academia in early 2023 to discuss their growth plans, opportunities, and challenges within the advanced mobility sector.

During these discussions, technology, intermodal, freight, and workforce considerations were explored with the goal of identifying ways that the State can best support North Carolina's advanced mobility ecosystem. Insights gained from the meetings fall into four categories: policy, infrastructure, technology, and collaborations. **Exhibit 5-1** summarizes key points from the discussions.

Exhibit 5-1. Advance Mobility Stakeholder Feedback

STAKEHOLDER FEEDBACK

POLICY

In the face of ongoing rapid technological change, **standards and guidelines** are needed to **ensure interoperability** and **mitigate the risk of obsolescence**.

True Beyond Visual Line-Of-Sight operations (BVLOS) flight is needed to **unlock the AAM market's significant growth potential**.
Limited BVLOS authorizations and supporting infrastructure is restricting adoption.

NCDOT can **provide guidance to local agencies** on land use and airspace planning, complete streets, and mobility hub integration of air and ground modes and secure buy-in at all levels within the department.

INFRASTRUCTURE

Increased electric grid capacity and resiliency is crucial for enabling advanced mobility technology adoption at scale.

Prioritize investments in advanced testing corridors and **integrate** advanced mobility and vertical infrastructure with existing **multimodal systems**.

TECHNOLOGY

Focus on high-value use cases that can provide tangible results today.

Use technology to **leverage cost-effective and scalable options** for freight movement and last-mile solutions.

COLLABORATIONS

Cross-sector collaboration is key for facilitating innovation, testing and deployments, and workforce development.

Advanced mobility **creates economic opportunity** by attracting new companies to N.C. and creating high-quality jobs.

Encourage apprenticeships and short-term training programs focused on industry needs that **incorporate immediate job placement**.

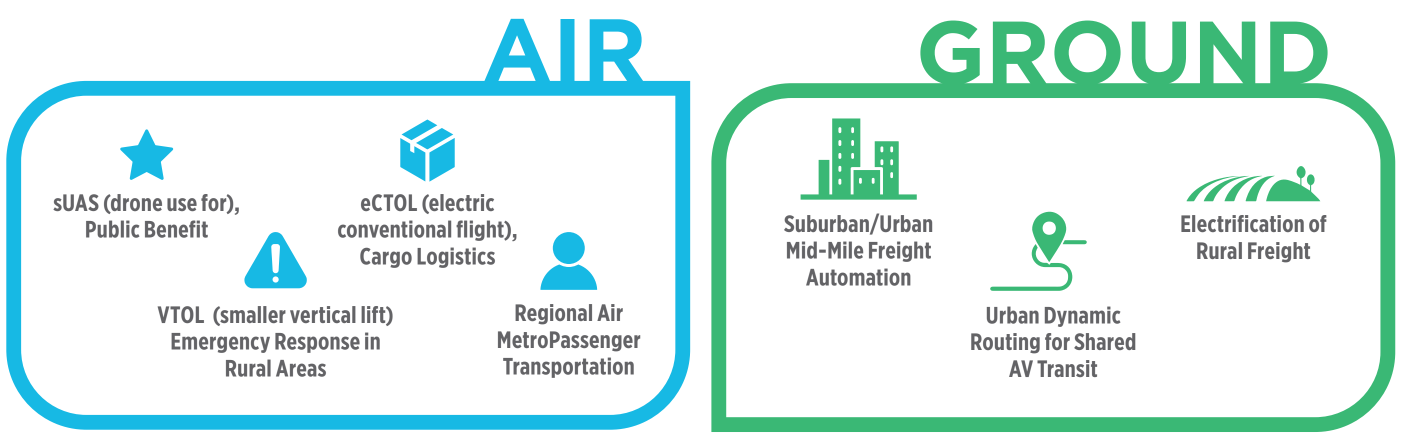
6

Use Cases

Advanced mobility technologies are not one-size-fits-all. Matching the right technology to the right use case is key to unlocking their potential.

Several air and ground use cases were developed to illustrate how these technologies potentially could be deployed to benefit North Carolinians. The use cases are based on an understanding of existing transportation systems, advanced mobility technology current capabilities, and stakeholder feedback (see **Exhibit 6-1**).

Exhibit 6-1. Potential Advanced Mobility Technology Use Cases



6.1

Air Use Cases

AAM aircraft vary in takeoff and landing style, propulsion technology, fuel and energy source, size, and level of automation. As such, the following four air use cases match a particular AAM technology with a suitable application that addresses existing transportation challenges and informs future planning efforts.

Advanced mobility technologies are not one-size-fits-all

Matching the right technology to the right use case is key to unlocking their potential

6.1.1

Air Use Case 1
sUAS Public Benefit Operations

sUAS aircraft have the potential to operate in a variety of public benefit scenarios, including medical supplies transportation, infrastructure inspection (routine and during national disasters), and safety services (crime and crash scene surveillance, search and rescue operations, and rapid field deployments). Many of these services are already in use in North Carolina, but operations can be scaled to serve more regions and amplify benefits. Because these aircraft are small and have VTOL capabilities, sUAS do not require fixed takeoff and landing infrastructure or require a large ground footprint and can be operated from mobile droneports, reducing operating costs while maximizing flexibility. **Exhibit 6-2** shows three illustrative sUAS flight paths that operate similarly but offer different public benefits.

Exhibit 6-2. Air Use Case 1 – sUAS Public Benefit Operations Example

The Washington-Warren region stakeholders shown were not consulted in developing this map. Flight paths are for illustrative purposes only and do not represent actual operations.

An overview of this use case is provided in **Exhibit 6-3**.

OBJECTIVE	Safer, more efficient, more sustainable public benefit operations

Aircraft Type(s)	sUAS	Benefits:	Challenges:
Anticipated Timeframe	Initial deployments underway	Faster travel times and increased flexibility. Lower emissions, operating costs, and noise. Can access hard to reach places (e.g., bridge inspection) and those where ground conditions are unsafe.	Approvals/waivers for BVLOS are needed. sUAS currently have limited payload capacity. UTM services are currently limited.
Route Type	Emergency Response: Flexible Infrastructure Inspection, Package Delivery: Fixed		
Fuel Type	Hybrid-Electric, Electric		
Altitude	Less than 400 feet		

Exhibit 6-3. Air Use Case 1 – sUAS Public Benefit Operations Overview

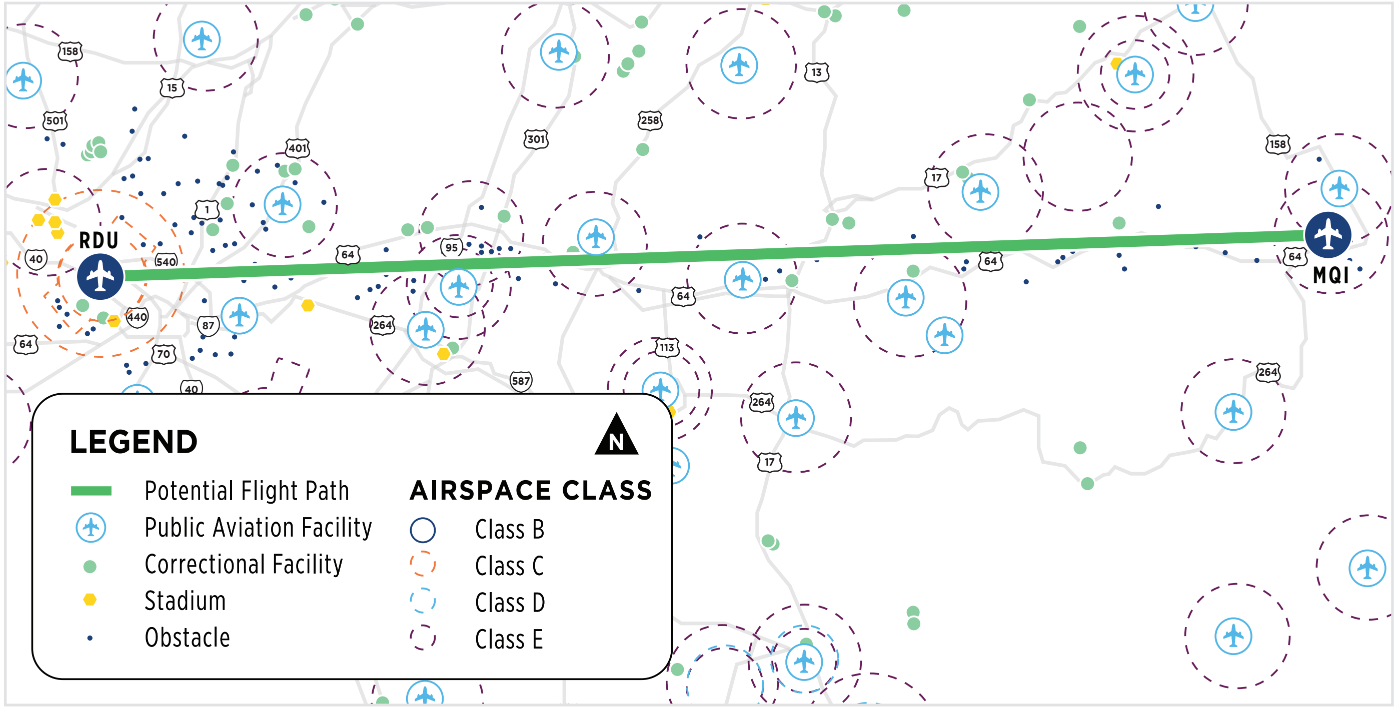
6.1.2

Air Use Case 2 eCTOL Cargo Logistics

In 2021, North Carolina's public use airports efficiently handled over 1.3 million tons of high-value, time-sensitive cargo, supported by a robust ground transportation network. Numerous companies are retrofitting existing CTOL aircraft with electric or hybrid-electric propulsion to reduce emissions, noise, and operations costs. Sufficient charging infrastructure and electrical grid capacity is key not only for enabling CTOL electrification, but it is a primary driver for future uncrewed systems. This means that, in addition to the direct benefits of electrification, electric CTOL (eCTOL) aircraft adoption is a key mechanism for enabling AAM technologies more generally, because many other AAM technologies are also electric-powered.

Integrated cargo carriers have expressed interest in incorporating electric aircraft into their fleet for feeder operations, and the use of existing airframes has the potential to accelerate the FAA certification of an electric or hybrid-electric cargo feeder aircraft. Similar to sUAS activity in North Carolina, the adoption of eCTOL aircraft for cargo movement will help pave the way for wider AAM implementation, including the eventual integration of eVTOL aircraft as payload capacity improvements appeal to cargo feeder needs. In **Exhibit 6-4**, an existing cargo feeder operation using a small turboprop or piston engine aircraft is replicated with use of a piloted, electric Cessna 208B cargo aircraft with increasingly autonomous controls.

Exhibit 6-4. Air Use Case 2 – eCTOL Cargo Logistics Example



OBJECTIVE | **Reduce emissions, noise, and costs while paving the way for other AAM**

Aircraft Type(s)	eCTOL	Benefits:	Challenges:
Anticipated Timeframe	3-5 years	Uses existing airport infrastructure. Less noise, emissions, and operations costs than traditional CTOL. Encourages charging infrastructure development that can support various AAM technologies.	Requires sufficient electric charging infrastructure for widespread adoption. Requires more mature technology to be deployed at scale. Battery advancement is needed to increase range.
Route Type	Fixed		
Fuel Type	Hybrid-Electric, Electric		
Altitude	3,000-10,000 feet MSL		

Exhibit 6-5. Air Use Case 2 – eCTOL Cargo Logistics Overview

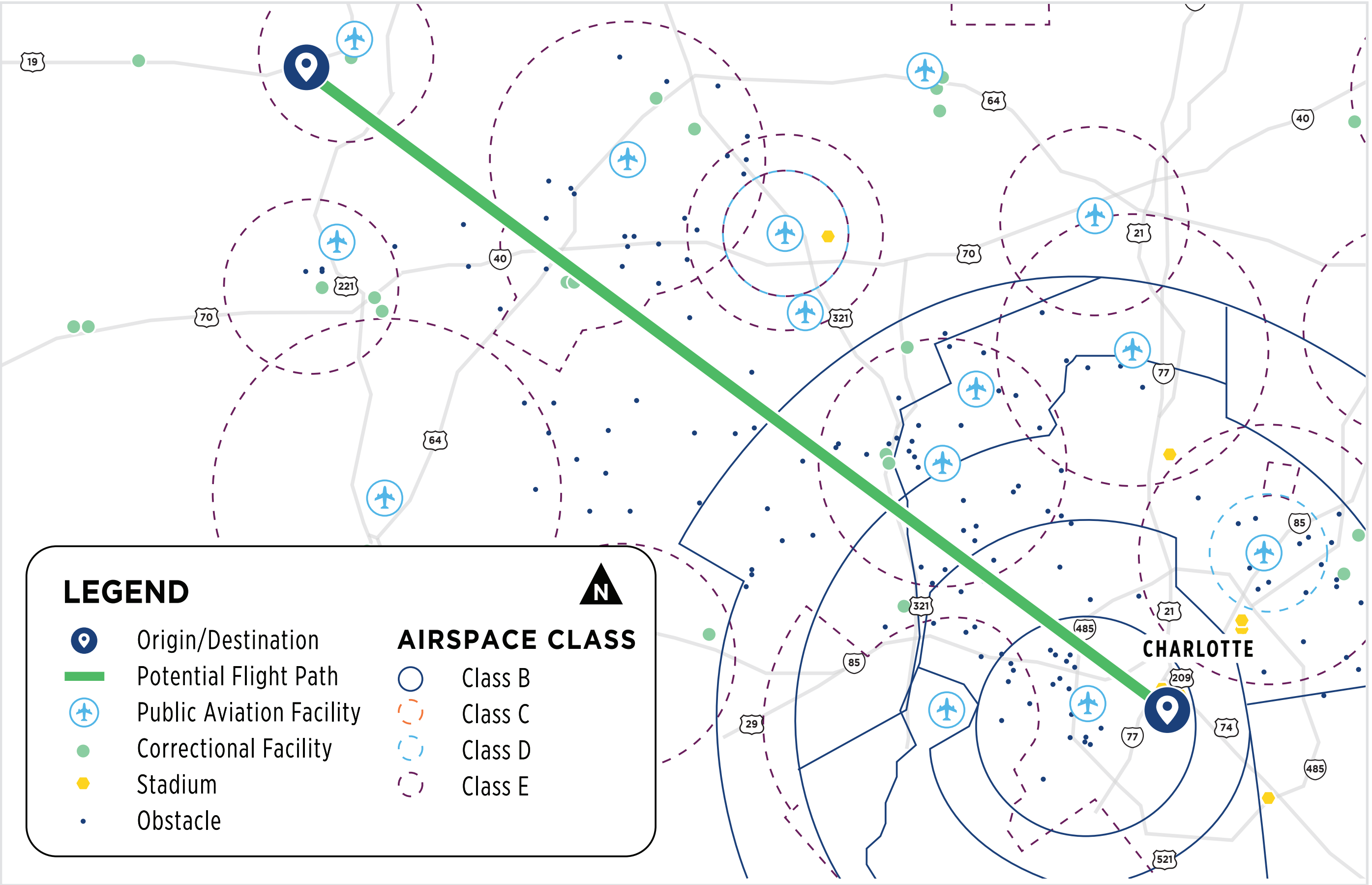
6.1.3

Air Use Case 3
VTOL Emergency Response in Rural Areas

Emergency response efforts in rural areas can be costly and time consuming since the population is more spread out than in densely populated areas. It can also be challenging for ground vehicles to access remote locations or rugged terrain. VTOL aircraft offer an efficient and effective solution for transporting medical supplies, equipment, and personnel to rural areas, potentially transporting patients from remote locations to medical centers or delivering organs for transplant. Emergency responders can also utilize VTOL aircraft for crime and crash scene surveillance, rescue operations, and rapid field deployments, such as those to natural disaster sites. Some of these benefits are already being realized by NCDOT partners, but scale across rural areas would improve emergency response effectiveness statewide.

The example in **Exhibit 6-6** shows a potential flight path that would result in expedited transport of someone needing immediate medical care from a remote rural location to a hospital center in Charlotte, a drive that would typically take over two hours. This use case demonstrates the potential benefit of utilizing larger eVTOL aircraft for emergency response efforts, expanding on the successful implementation of sUAS use cases that already provide significant public benefit in North Carolina.

Exhibit 6-6. Air Use Case 3 – VTOL Emergency Response in Rural Areas Example



OBJECTIVE	Improve emergency response capabilities in rural areas

Aircraft Type(s)	VTOL	Benefits:	Challenges:
Anticipated Timeframe	5 years	Improves response time and reduces operations costs. Does not necessarily require specialized landing infrastructure (similar to helicopters). Supports a wide range of emergency response services. Can access regions cut off from other transportation modes.	Some applications requiring a higher payload (e.g., aerial firefighting) may require purpose-built aircraft that may not be cost effective until battery and charging technology mature further. Requires retrofit or purpose-built ground support infrastructure, including for charging and maintenance.
Route Type	Flexible		
Fuel Type	Hybrid-Electric, Electric		
Altitude	Varies; route shown is at 5,000 feet		

Exhibit 6-7. Air Use Case 3 – VTOL Emergency Response in Rural Areas Overview

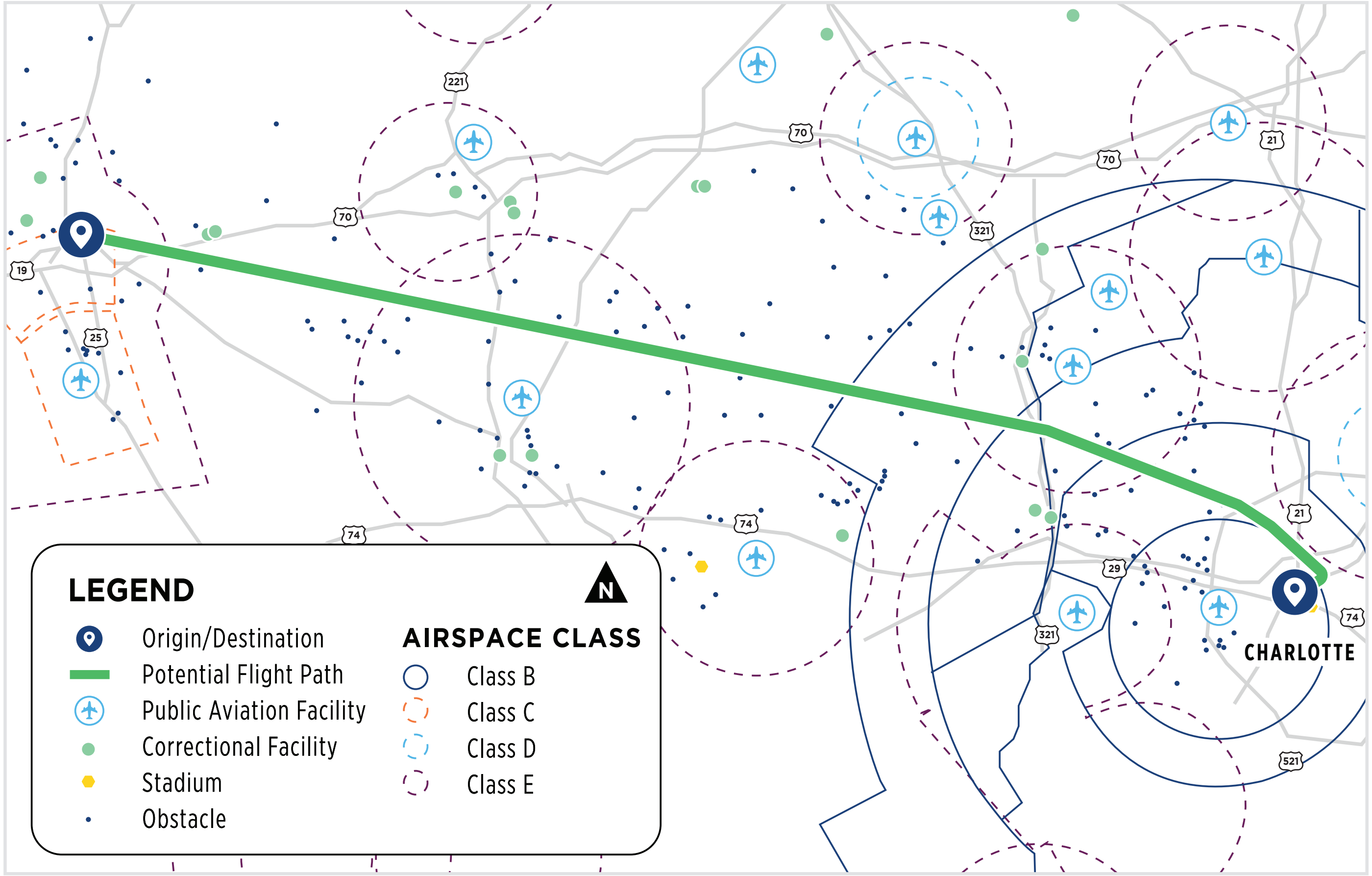
6.1.4

Air Use Case 4
Regional Air Metro Passenger Transportation

Utilizing AAM in regional air transport for passengers can reduce travel times, bypass congested roadways, and provide access to hard-to-reach destinations. Fixed routes between high-traffic destinations can reduce travel time and increase connectedness from city-to-city or between urban and rural locations in a given region.

Exhibit 6-8 shows an example of a potential regional air transportation route connecting Downtown Asheville (a tourist destination attracting 10 million visitors annually) with Charlotte Gateway Station (a future multimodal transit hub site), which then will connect to other transportation modes, including the Charlotte Area Transit System (CATS) bus lines, the Lynx Silver Line light rail, Amtrak intercity trains, and Greyhound intercity buses. Potential benefits and challenges are presented in **Exhibit 6-8**.

Exhibit 6-8. Air Use Case 4 – Regional Air Metro Passenger Transportation Example



OBJECTIVE | **Increase passenger mobility in an urban and regional market**

Aircraft Type(s)	VTOL, STOL	Benefits:	Challenges:
Anticipated Timeframe	10-20 years	Significantly reduces travel times between high traffic destinations.	Requires purpose-built infrastructure (vertiports).
Route Type	Fixed	Route planning for fixed routes is less complex than dynamic routing.	Movement of passengers will require a high degree of public confidence in the safety of vehicles before moving passengers.
Fuel Type	Hybrid-Electric, Electric	Improves efficiency and potentially creates economic opportunity.	The range of potential vertiport locations and new overflights could introduce community concerns around privacy, equity, and the environment (e.g., noise pollution).
Altitude	Variable; 1,000 feet to 5,000 feet	Connects to multi-modal transit facilities, improving access to jobs, services, entertainment, and tourism destinations.	

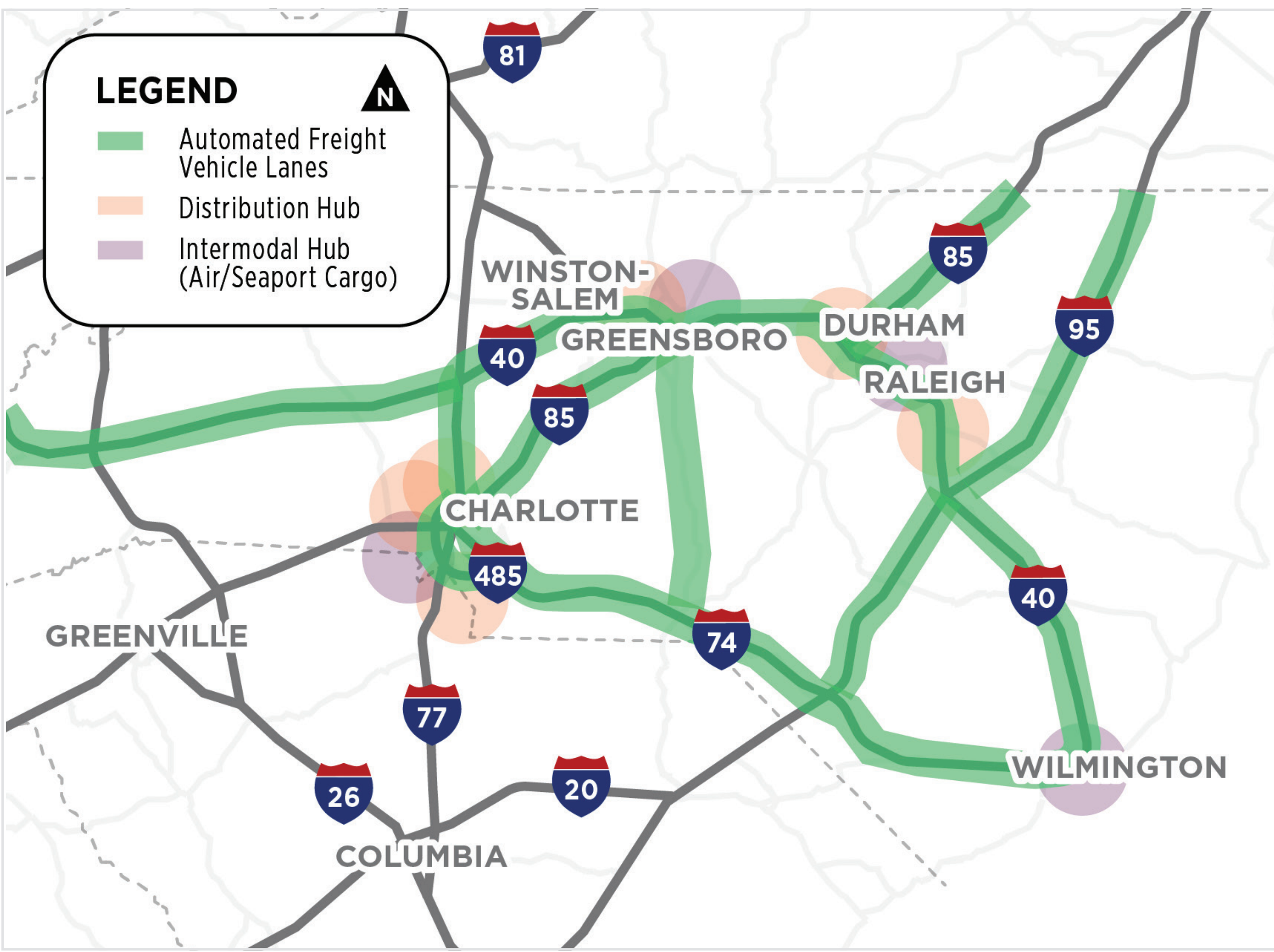
Exhibit 6-9. Air Use Case 4 – Regional Air Metro Passenger Transportation Overview

6.2

Ground Use Cases

Advanced mobility technologies for ground vehicles vary widely, from long-haul trucking automation to last-mile transit and micromobility. The following three use cases match a particular ground technology with a suitable application to address existing transportation challenges and inform future planning efforts.

Exhibit 6-10. Ground Use Case 1 – Urban/Suburban Mid-Mile Freight Automation Example



6.2.1

Ground Use Case 1
Urban/Suburban Middle-Mile Freight Automation

Movement of goods between major intermodal and freight distribution hubs offers an opportunity to leverage emerging technologies that enhance efficiency, increase safety, and reduce emissions when alternative fuels are used. This type of goods movement generally occurs outside the urban core and consists of major trips along limited access facilities (roadway designated for through traffic) with final connections currently occurring on signalized arterial networks using human-driven vehicles. Common or routine routes serving major freight destinations are ideal for dedicated freight AV lanes as they increase efficiency and safety through automation and greater speed harmonization.

OBJECTIVE | **More efficiently move freight from warehouse to distribution centers or mobility hubs**

Vehicle Type(s)	Large AVs (tractor-trailers)	Benefits:	Challenges:
Anticipated Timeframe	3-5 years	Addresses the existing driver shortage. A shift to alternative fuels reduces noise, vibration, and emissions. Once fully automated, the technology can extend operations beyond driver hours-of-service constraints. A hub network approach for AV truck movement allows for the downloading of data from the trip and systems checks before the next trip. Less impact on vehicles with less than full loads or empty backhaul.	Current platforms are functioning only on limited access facilities. Infrastructure readiness criteria for full AV deployment has not yet been developed. Standard communication protocols needed for freight signal priority and with private sector facilities (gates, etc.) do not yet exist.
Fuel Type	Varies by model		
Operational Speeds	Can operate at posted speed limits		

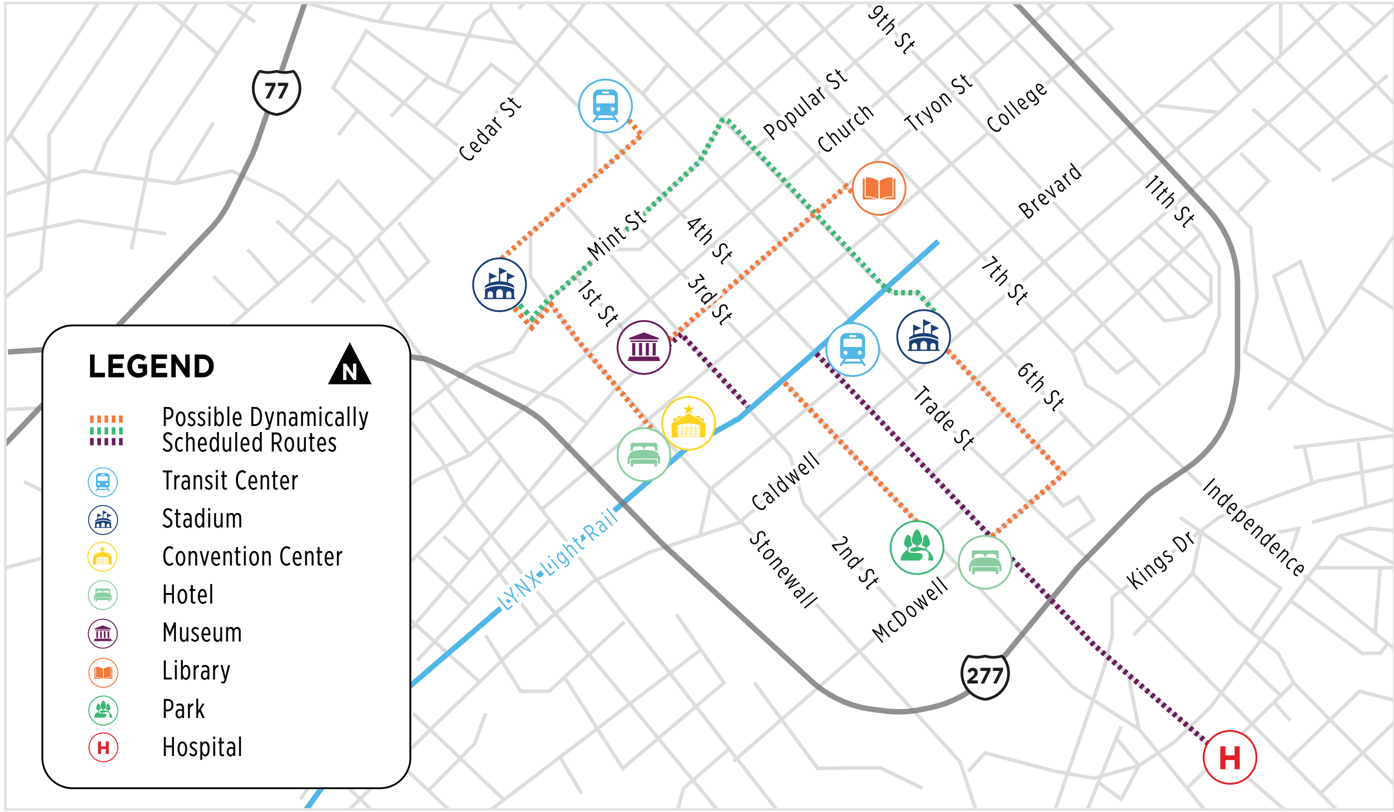
Exhibit 6-11. Ground Use Case 1 – Urban/Suburban Mid-Mile Freight Automation Overview

6.2.2

Ground Use Case 2
Urban Dynamic Routing for Shared AV Transit

Large capacity transit vehicles, such as buses, require high population density to be cost effective and typically operate on indirect fixed routes, taking passengers longer to reach their destination than traveling by passenger car would. Owning a personal vehicle, however, is cost prohibitive for many and reliance on single occupancy vehicles contributes to traffic congestion and increased emissions in the overall transportation network. Smaller and medium-sized AV transit vehicles can serve as a middle ground, providing access to public transit through dynamic routing. Dynamic routing can result in more direct routes and less miles driven by changing the stop order or skipping stops based on demand. **Exhibit 6-12** is an example of how AVs with dynamic routing can be deployed to move groups of individuals directly between various highly-visited areas, such as employment centers, hotels, shopping centers, sports and entertainment venues, and transit centers, reducing the number of single occupancy vehicles while reducing travel times.

Exhibit 6-12. Ground Use Case 2 – Urban Dynamic Routing for Shared AV Transit Example



OBJECTIVE	Increase efficiency for transit riders and providers through dynamic routing

Vehicle Type(s)	Shared AVs	Benefits:	Challenges:
Anticipated Timeframe	3-5 years	Extends current last-mile use cases to have broader reach (i.e., more areas served).	Navigating signalized and four-way intersections is challenging.
Fuel Type	Varies by model	Replaces or augments low-utilization fixed-route service with flexible, on-demand service.	Navigating permissive left turns when the behavior of approaching vehicles cannot be predicted by the AV is challenging.
No. of Passengers	Up to 8	May increase transit utilization by offering high-demand routes. Optimizes the use of shared AV assets.	Full accessibility of vehicles and services to serve people with disabilities can be difficult without an operator on board.
Operational Speeds	Up to 25 MPH currently; expect to be greater in 3-5 years		Sufficient public confidence in AVs is needed to encourage ridership. Technical capabilities and capacity need to be developed to support multiple routes and on-demand service. Technology and policy are not yet mature enough to operate AVs without a driver. The business case for sustainability still needs to be made.

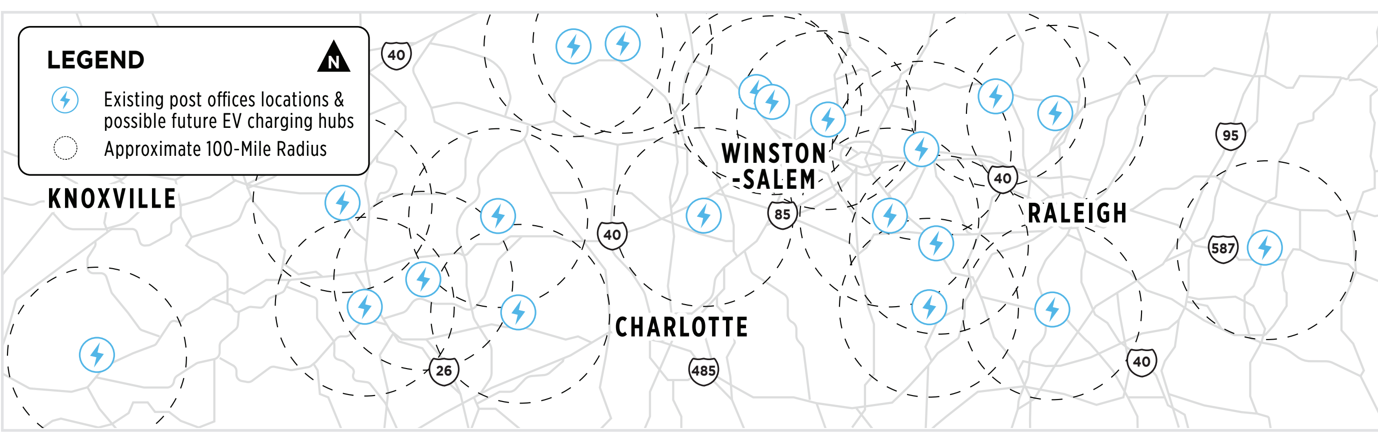
Exhibit 6-13. Ground Use Case 2 – Urban Dynamic Routing for Shared AV Transit Overview

6.2.3

Ground Use Case 3
Electrification of Rural Freight

Rural goods mobility presents a unique opportunity to leverage emerging technologies to meet NCDOT's mission of connecting people, products, and places safely and efficiently. In areas with less dense populations, delivery drivers make longer trips to deliver fewer parcels, which increases vehicle miles traveled and emissions when using conventionally powered vehicles. Incorporation of charging at established distribution locations and destinations can support the adoption of alternative fueled vehicles that reduce emissions and noise, preserving the quality of the environment. Relying on existing post office locations, for example, as centralized EV charging points can serve as an initial starting point for rural freight electrification. These locations can also serve as rural satellite hubs for goods mobility, as shown in **Exhibit 6-4**.

Exhibit 6-14. Ground Use Case 3 – Electrification of Rural Freight Example



OBJECTIVE | **Increase sustainability of freight movement in rural areas through electrification**

Vehicle Type(s)	Box trucks, personal vehicles, UAS	Benefits:	Challenges:
Anticipated Timeframe	Initial deployments underway	Reduces emissions and noise. Leveraging personal vehicles through crowd sourced applications may reduce the number of trips in rural areas.	Current battery technology limits range, payload, and vehicle size. Grid capacity in rural areas is often insufficient for the fast charging needed for freight operations. Adoption by smaller fleets may not be economically feasible until the technology matures.
Fuel Type	Varies; for EVs, some models can travel up to 300 miles on a single charge		
Cargo Size/ Weight	Smaller parcels and packages for final delivery		
Operational Speeds	Posted speed limits		

Exhibit 6-15. Ground Use Case 3 – Electrification of Rural Freight Overview

7

Advanced Mobility Integration

For advanced mobility technologies to operate successfully, they must be integrated into existing transportation systems in efficient, user-friendly ways. Mobility-as-a-Service (MaaS) and Complete Streets are complementary strategies that, when combined with mobility hubs, create a powerful synergy that makes non-driving modes as easy to use as driving modes.

Together, these strategies are a powerful tool for realizing benefits of advanced mobility technologies, as they enable efficient freight and passenger movement, promote sustainable travel choices, enhance accessibility and equity in transportation, and contribute to the overall quality of life in urban, suburban, and rural areas.

An overview of these three strategies is provided in **Exhibit 7-1**.

Exhibit 7-1. Advanced Mobility Integration Strategies

STRATEGY	KEY CHARACTERISTICS	BENEFITS
Mobility Hubs	• Facilitates the movement of goods and/or people, depending on local needs and constraints. • Ranges in size from bus stops and bike sharing stations to major air and ground passenger and freight hubs. • Transfer occurs between modes and/or between larger vehicles and shuttle, shared use, and micromobility solutions.	• Can integrate many forms of mobility providing options to passengers (AAM, TNC, EV, scooter, walking) and customers (pick-up or receive last-mile delivery). • Can include recharging solutions for multiple modes (e.g., air, bike, truck, etc.). • Supports the aggregation of people and goods at scalable locations to optimize individual movements.
MaaS (Mobility-as-a-Service)	• Integrates diverse modes and related services into a unified and on-demand mobility platform. • Provides a single application for planning, booking, and paying for trips.	• Streamlines the user experience across modes. • Increases transportation system efficiency and sustainability by leveraging a single trip to move both people and goods. • Increases accessibility and convenience of mobility hubs. • Improves quality of life.
Complete Streets	• Transportation networks that accommodate all users. • Prioritizes safety and accessibility for pedestrians, cyclists, transit users, and vehicles. • Actively engages the community throughout the planning and construction process.	• Seamlessly integrates with mobility hubs. • Incorporates bike lanes, bus stops, sidewalks, and multi-use paths. • Creates inclusive, vibrant public spaces. • Inclusion of on-demand services and goods mobility maximizes curb usage and management.

7.1

Mobility Hubs Overview

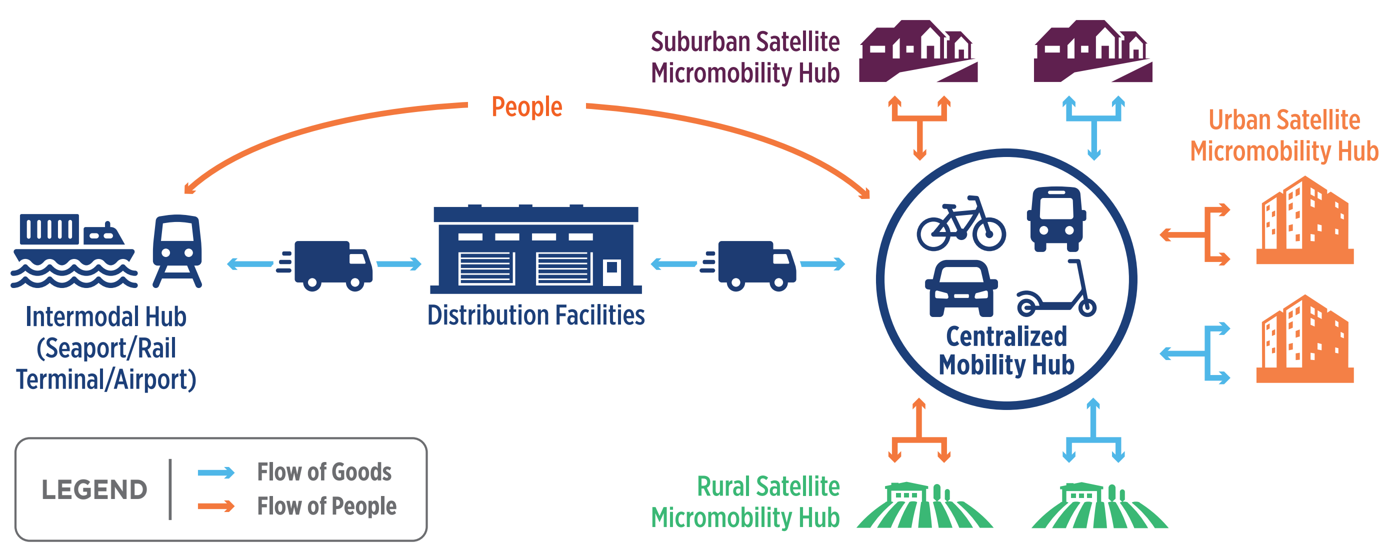
The mobility hubs concept aims to improve transportation efficiency, reduce congestion, enhance connectivity, and promote sustainable mobility options. By creating designated facilities for the transloading of passengers and freight across different modes, mobility hubs enhance the overall transportation experience and contribute to building more resilient, accessible, and environmentally friendly transportation systems. Mobility hubs fall into two broad categories: middle-mile and last-mile hubs.

The middle-mile is a crucial link between the initial leg of a journey and the final destination, serving as important nodes where goods are efficiently consolidated, processed, and redistributed between different modes, such as from large cargo ships to trucks or from trains to delivery vans. They also serve as hubs for major movements of people between population centers both domestically and internationally and include intermodal hubs and distribution facilities.

Last-mile mobility hubs, such as centralized or satellite hubs, serve as key nodes in the transportation network, providing central locations where various modes of transportation converge, facilitating the transfer of people and goods between larger and smaller vehicles. This concept has emerged as a strategic approach to enhance transportation efficiency and connectivity by creating designated facilities within existing supply chains and transit networks. These facilities enable the seamless transfer of both freight and passengers from larger transportation vehicles, such as semi-trucks and buses, to smaller mobility solutions, including electric vehicles, shuttles, box trucks and micro-mobility devices.

Mobility hubs can be dedicated to either goods or people movement, or a combination of both, depending on the needs of the specific area. **Exhibit 7-2** shows how middle- and last-mile mobility hubs relate to one another.

Exhibit 7-2. Mobility Hub Concept Flow Diagram



7.2

Middle-Mile Intermodal Hubs

Intermodal hubs represent major freight and passenger terminals that include North Carolina's existing public deep-water seaports, airports, public and private rail terminals, and intermodal logistics centers, playing a vital role in facilitating the movement of people and goods during the middle-mile phase. In many regions, these facilities already exist, but their coordination and compatibility with advanced mobility technology are essential to ensure integration throughout the mobility ecosystem. An example intermodal hub is shown in **Exhibit 7-3**.

Diagrams of each mobility hub type are shown in the following. They are for illustrative purposes only; actual configurations will vary by location.

GROUND Transportation and Technology

AIR Transportation and Technology

MODES IN/OUT

- AAM
- Buses
- Maritime
- Rail
- Semi-trucks

Exhibit 7-3. Example Maritime Intermodal Hub

7.3

Middle-Mile Distribution Facilities

Distribution facilities play a pivotal role in the supply chain as key hubs for the consolidation and distribution of goods. These centers are typically large-scale logistics facilities strategically located in areas that facilitate efficient transportation and connectivity.

They serve as crucial middle-mile nodes where goods from various sources are received, processed, and prepared for further distribution, including for last-mile delivery. They serve as central points of coordination, synchronization, and optimization, ensuring that products are efficiently transported from manufacturers to end consumers.

In addition to consolidation, distribution facilities may also serve other functions within the supply chain. They can act as shipping hubs, where goods are sorted, categorized, and packaged for transportation to various destinations. They may also incorporate transloading capabilities, allowing for the transfer of goods between different modes of transportation, such as from trains to trucks. Some distribution centers may include manufacturing facilities, where additional value-added processes or customization can take place before the final products are distributed.

Distribution facilities are often equipped with advanced technologies, such as inventory management systems, automation, and robotics, to enhance efficiency and accuracy in handling large volumes of goods. These technologies enable streamlined operations, accurate order fulfillment, real-time tracking of inventory, and seamless integration with transportation networks.

Advanced mobility technologies allow for distribution facilities to serve an important role: verification of systems and downloading of data. Expansion of automated vehicles will require systems checks to validate function and staffing with qualified technicians, so integration at these hubs can also generate data for critical safety evaluation of advanced vehicle technology.

While focused primarily on the movement of goods, distribution facilities should also consider the movement of people, as distribution hubs provide significant workforce opportunities. Considerations for transit services to move people, especially at pre-defined shift changes, is a key opportunity to enhance transportation efficiency and equity.

An example distribution facility is shown in **Exhibit 7-4**.

Exhibit 7-4. Example Distribution Facility

Mobility hubs can create a powerful synergy that makes non-driving modes as easy to use as driving modes

7.4

Last-Mile Centralized Mobility Hubs

Centralized mobility hubs integrate different modes of transportation in lower population density or high transportation demand locations, relative to other locations in the same region or planning area, whether suburban or rural. They serve as key transfer points where passengers switch between single occupancy vehicles or bicycles to larger capacity buses, trains, or trucks. Additionally, these hubs provide facilities for transloading freight from larger vehicles to smaller vehicles, such as from trucks to electric vans, for efficient and sustainable logistics. An example centralized mobility hub is illustrated in **Exhibit 7-5**.

Exhibit 7-5. Example Centralized Mobility Hub

GROUND Transportation and Technology

AIR Transportation and Technology

MODES IN/OUT

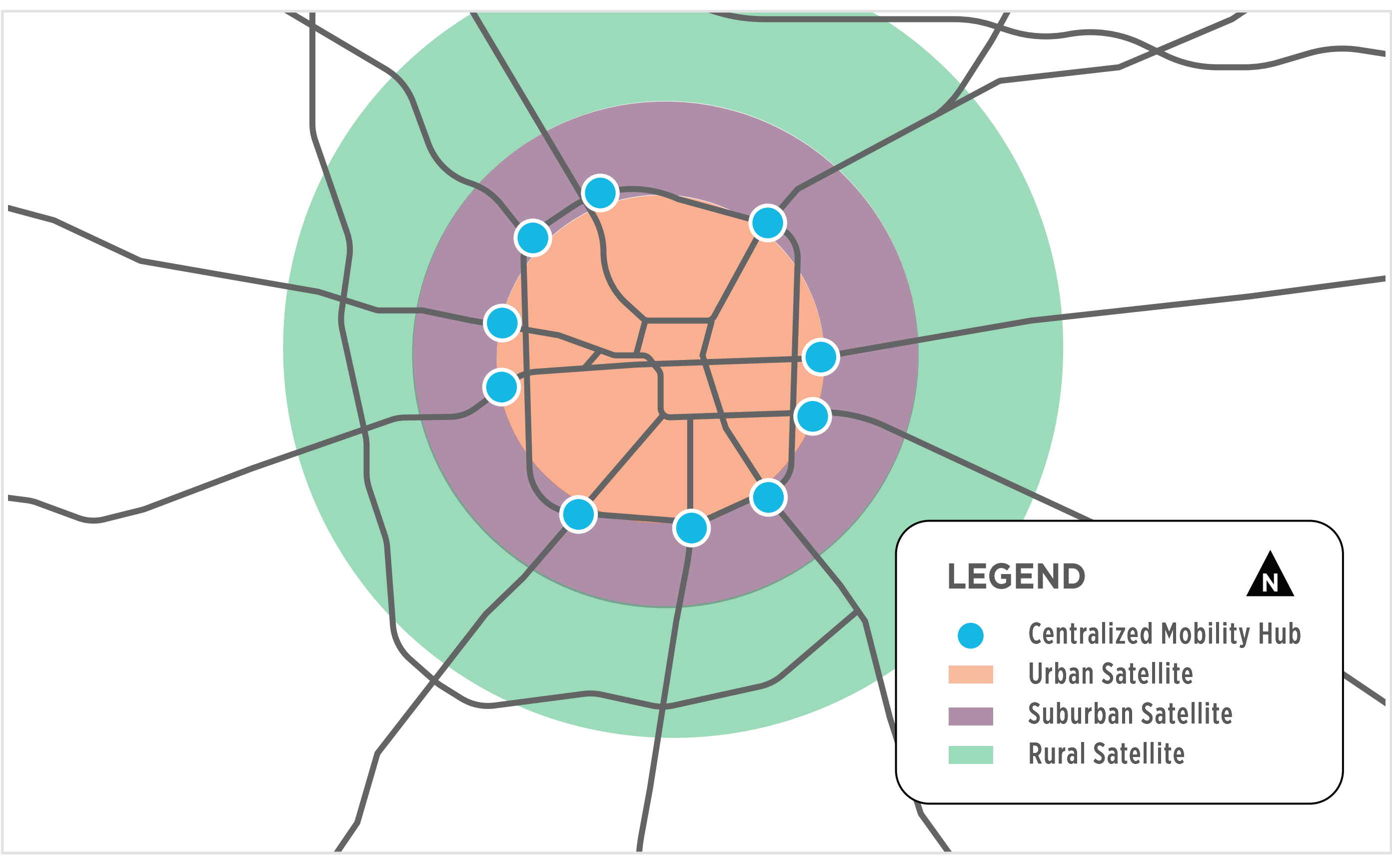
- AAM
- AV/EV buses
- AV shuttles
- Box trucks
- Cargo bikes
- Delivery vans
- Personal delivery devices
- Shared delivery
- Shared mobility
- Micromobility (scooters, EV bikes, etc.)
- UAS

7.5

Last-Mile Satellite Hubs

Satellite hubs with micromobility solutions serve as smaller-scale facilities in various neighborhoods or specific regions that provide localized access points for transportation services, allowing for convenient access for passengers and freight to and from the larger mobility network, supporting efficient and equitable last-mile transportation. They can be strategically located around a centralized mobility hub to facilitate transportation to and from rural or suburban population centers. The various satellite hub types and their relation to centralized mobility hubs and each other are illustrated in **Exhibit 7-6**.

Exhibit 7-6. Satellite Hub Types



Urban

- Closest to the centralized mobility hub.
- Located in densely populated or high transportation demand areas.
- Relatively small footprint due to space constraints in densely populated areas.
- Easily accessible to residents, businesses, and other key stakeholders.
- Typically focused on transit facilities that go to/from micromobility modes (bikes, sidewalk delivery robots, etc.) to larger modes (shuttles, trains, box trucks, etc.).
- Size varies by location and volume of passengers and goods.

Suburban

- Located farther out than urban satellite hubs in surrounding areas with significant population and transportation demand.
- Typically have a larger footprint than urban satellites due to less intense competition for space and the need for parking.
- Accessible to residential neighborhoods, commercial centers, and other key destinations.
- Often include park and ride facilities.
- Size varies by location and volume of passengers and goods.

Rural

- More remote than suburban satellites.
- Serves more dispersed populations.
- Typically have a larger footprint than suburban satellite hubs would have for the same traffic volumes due to increased space availability.
- Similar to suburban satellite hubs, but initially may function more like an on-demand transit stop.
- Size varies by location and volume of passengers and goods.
- Can be used as locations for final delivery of goods via UAS.

Several examples illustrating possible satellite hub configurations are provided in **Exhibit 7-7** through **Exhibit 7-10**.

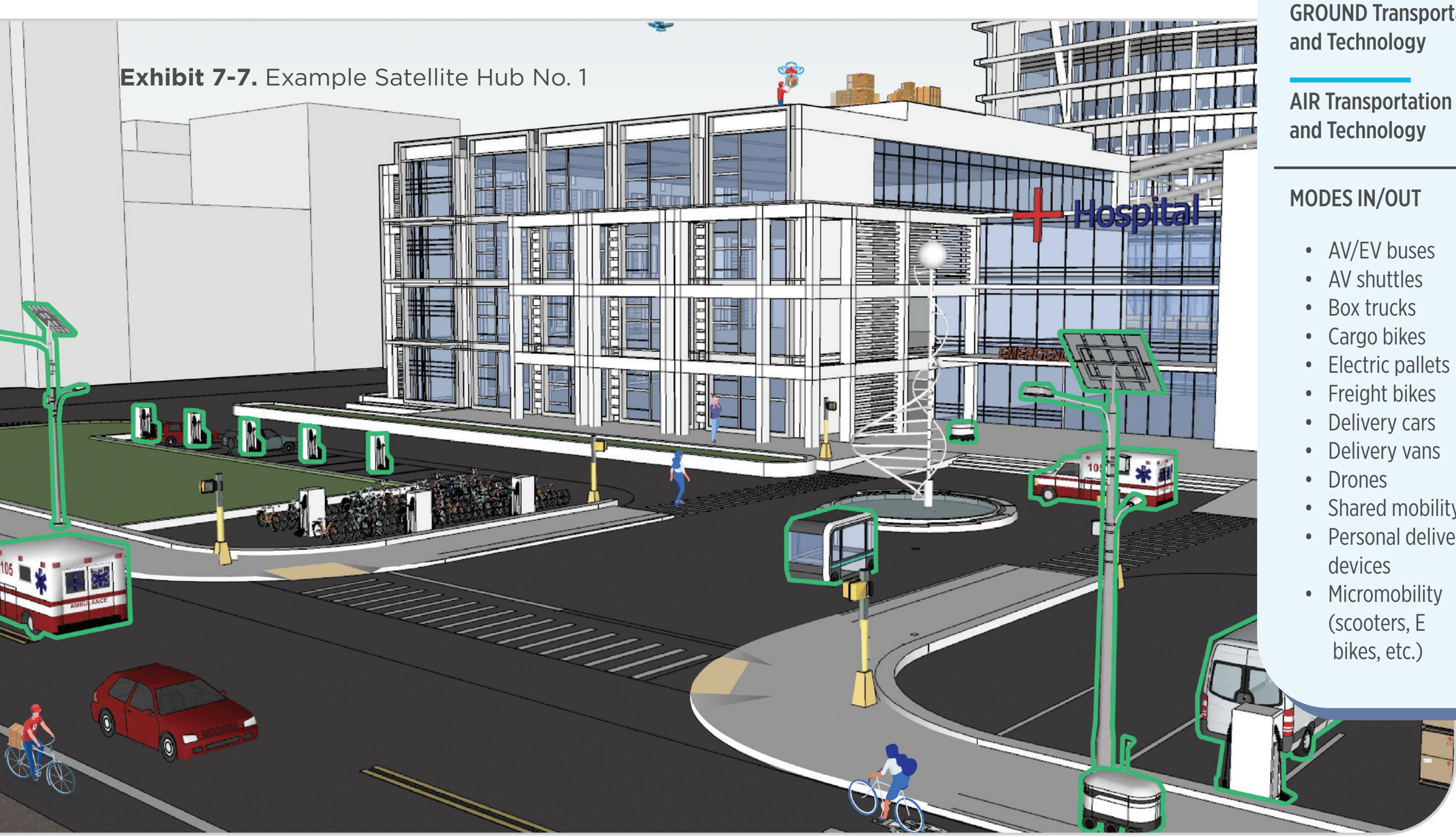


Exhibit 7-7. Example Satellite Hub No. 1

GROUND Transportation and Technology

AIR Transportation and Technology

MODES IN/OUT

- AV/EV buses
- AV shuttles
- Box trucks
- Cargo bikes
- Electric pallets
- Freight bikes
- Delivery cars
- Delivery vans
- Drones
- Shared mobility
- Personal delivery devices
- Micromobility (scooters, E bikes, etc.)

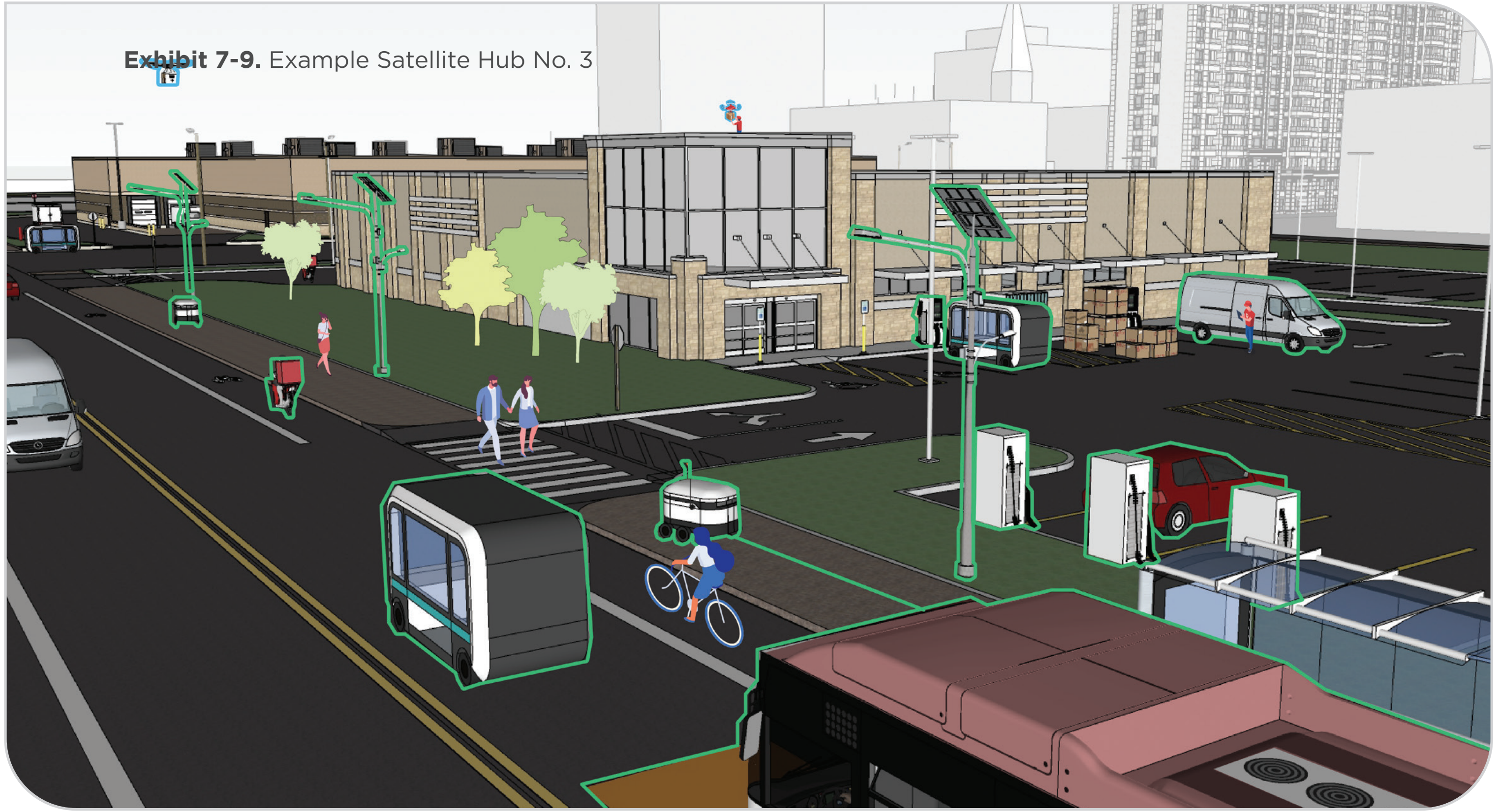


Exhibit 7-9. Example Satellite Hub No. 3

Exhibit 7-8. Example Satellite Hub No. 2

Exhibit 7-10. Example Satellite Hub No. 4

8

Action Plan

NCDOT has developed the following action plan to realize its three advanced mobility strategic goals – improve quality of life, create economic opportunity, and be a transportation trailblazer – fully leveraging advanced mobility technologies for the benefit of North Carolinians.

This action plan identifies and analyzes five key factors for successfully leveraging advanced mobility technologies, outlines the future actions needed from various stakeholders, and provides a decision-making process for integrating advanced mobility technologies into the statewide transportation system.

8.1

Future Actions by Stakeholders

To facilitate a smooth transition to advanced mobility, NCDOT is committed to continuing to work with federal and local governments, Metropolitan Planning Organizations (MPOs), Rural Planning Organizations (RPOs), academia, and industry. This joint effort will position the State well as advanced mobility scales. The following is a summary of recommended actions these stakeholders can take in support of NCDOT's advanced mobility goals.

8.1.1

State Action by Key Success Factors

Actions identified in this section have been organized around the following five key success factors identified by NCDOT's Division of Aviation and Integrated Mobility Division as areas important to the past and continued growth of North Carolina's advanced mobility ecosystem:

- Regulatory, Policy, and Process Considerations
- Technical Readiness
- Public Engagement
- Workforce and Economic Development
- Strategic Funding Opportunities

Given the rapid rate of change in industry, the action items are focused on the next five years. In some cases, they are prioritized further as "Immediate," items recommended for the next year, and "Short Term," items to address in 2 to 5 years.

8.1.1.1

Regulatory, Policy & Process Considerations

North Carolina has a favorable regulatory environment for advanced freight mobility, AAM, and shared automated mobility solutions, as outlined below.

Shared Autonomy and Freight: In 2017, North Carolina incorporated the operation of fully autonomous vehicles on roadways under General Statute (G.S.) 20-401, Regulation of Fully Autonomous Vehicles, if certain requirements were satisfied. Extending to last-mile delivery, North Carolina adopted Senate Bill 739 which includes personal delivery devices for transporting cargo with automated driving technology under G.S. 20-175.16, Personal delivery devices authorized; operation, equipment. These legislative changes allowed for many pilot deployments to test the technology in North Carolina.

Advanced Air Mobility: AAM regulation has three levels of authority – the FAA, the State, and the local jurisdiction. The FAA is responsible for the safe integration of all UAS and AAM aircraft into the National Airspace System. The State will play a key role in identifying where AAM aircraft will fly, and can support key ground infrastructure, as well as ensuring a favorable legislative and regulatory environment. Local jurisdictions can regulate land use through zoning laws, which can affect the location of a heliport or vertiport.

In North Carolina, Senate Bill 744 passed in 2014, establishing requirements for drone operators, including pilot permitting, educational certification, and the delineation of appropriate no-fly zones. These requirements are vital to ensure safe and responsible drone operation, protect individual privacy by preventing surveillance at private residences, and address potential misuse of drones.

To continue to maintain a favorable regulatory environment, the State can further develop state-level regulations, promote understanding, and support opportunities at the local level for mobility advancement and economic development growth. Action items to consider in this regard are addressed in Exhibit 8-1.

The following action items can be integrated into NCDOT's processes, in collaboration with other federal, state, and local agencies, the state legislature, academic partners, and industry partners.

Exhibit 8-1. NCDOT Regulatory, Policy, and Process Action Items

Implement comprehensive statewide advanced mobility approach

Immediate *(1 year)*

- Streamline and consolidate procedures related to innovation exploration, implementation, and institutionalization (e.g., SOPs for vendor meetings, requests for information (RFIs), and requests for proposal (RFPs).)
- Encourage and prioritize complete streets approaches that are context-sensitive to emerging last-mile goods movements (e.g., sidewalk widths to accommodate personal delivery devices (PDD), bike lane widths for cargo bikes, access management to mobility hubs with right-in, right-out movements, and curb management strategies for last-mile delivery and shared use).
- Convene team(s) to address interoperability, direct access to supporting infrastructure, cybersecurity (in coordination with NCDIT), and right-sizing solutions.
- Create a zoning framework for land use related to advanced mobility (e.g., heliports and vertiports, direct access ramps to industrial complexes, etc.)
- Leverage and expand NCDOT Division of Aviation's existing UAS Program Office to serve as NCDOT AAM expertise, including by attracting and retaining strong industry leadership.
- Document best practices from pilots and determine future evaluation and technology maturity.
- Develop Key Performance Indicators (KPI) for initial and long term applications.

Short Term *(2-5 years)*

- Develop educational materials to aid local decision-makers in understanding the potential benefits and limitations around advanced mobility technologies and infrastructure.
- Develop operations and maintenance strategies for ongoing use after initial deployment of advanced mobility technologies.
- Evaluate existing laws that have the potential to restrict AAM operations to ensure none are subject to Federal preemption and that NC maintains a favorable regulatory environment.
- Collaborate with industry partners, government entities, and infrastructure owner operators (IOOs) to understand and inform guidelines, standards, certification, and policies related to advanced mobility technologies and infrastructure.

Create consistent internal policies

Immediate *(1 year)*

- Establish an Advance Mobility Steering Committee, led by NCDOT's multi-modal leadership, with participation from public, private and academic partners.
- Utilize process discussed in Chapter 8.2 to integrate advanced mobility technologies into existing infrastructure projects for efficiency and futureproofing.
- Review existing state policies for alignment with Federal priorities, such as multimodal, justice/equity, innovation, broadband expansion, and resilience.
- Use KPIs and consider including the indicators in planning, design, and construction.
- Facilitate mainstreaming integration of new technologies and innovation through the Advanced Mobility Steering Committee.
- Establish and update the resources needed by industry to work within the State.

Short Term *(2-5 years)*

- Report progress and outcomes of Advanced Mobility Steering Committee to related committees within the Board of Transportation.
- Regularly review and make changes to policies, as needed, to deconflict with Federal priorities.
- Assess and align existing cybersecurity and privacy policies to identify vulnerabilities and opportunities for advanced mobility program.
- Coordinate with NCDIT on strategies that mitigate risk of cybersecurity breaches.
- Ensure Advanced Mobility NC programs have standardization of data management, retention and sharing, include security provisions and privacy protection of personally identifiable information (PII) and company trade secrets, in coordination with other state (NCDIT) and federal initiatives.

Identify policies that support integration of AAM technology at airports

Immediate *(1 year)*

- Continue to support NCDOT partners' deployments of sUAS in NC and continue to promote the use of sUAS within State agencies.
- Promote the use of sUAS applications (aerial photography, runway inspections, security) at public use airports.
- Consider integrating potential vertiport considerations into the NCDOT Helicopter Landing Area Permit process to encourage near-term growth in AAM operations.
- Leverage NCDOT's thorough understanding of the state of the industry and airports' challenges and opportunities around AAM to identify policy changes that may be needed.
- Develop clear guidance on how State airports can plan for advanced mobility, including identification of applicable use cases, on-airport vertiport development, and maintaining airspace protection.
- Assist State airports in understanding the overlapping needs for the electrification of ground support equipment, rental car fleets, and AAM aircraft.

Short Term *(2-5 years)*

- Work with public-use airports to develop a strategy for addressing policies that inhibit AAM adoption.
- Assist airports in educating local decision-makers on ensuring that future off-airport vertiport development does not conflict with the safe operation of existing aircraft through airspace protection and zoning and land use compatibility.
- Promote industry attraction by identifying potential fixed ground infrastructure and use cases that address NCDOT's goals and provide notable public benefit.

Develop policies that emphasize environmental benefits of advanced mobility technology

- Collaborate with NCDEQ and federal agencies on the quantification of advanced mobility technologies' benefits over conventional technologies (emissions, noise pollution, etc.).
- Pursue innovative and time-saving approaches to Federal environmental reviews, such as programmatic National Environmental Policy Act (NEPA) reviews, that will reduce delay in the timing of potential operations.

8.1.1.2

Technical Readiness

NCDOT has a strong track record of scaling up transportation technologies and is aligning its organization around opportunities to expand these efforts. The strengths shown previously in **Exhibit 1-4** highlight North Carolina's technical readiness for advanced mobility adoption. Advancing the action items identified in **Exhibit 8-2** will sustain that forward momentum. These action items will involve stakeholder coordination with a wide range of stakeholders including the federal government, other state agencies, industry, academia, and others.

Exhibit 8-2. NCDOT Technical Readiness Action Items

Monitor progress through the states of technology maturity

Immediate *(1 year)*

- Track advanced mobility technology progress through the stages of technology maturity.
- Make informed projections for when each technology will enter the next stage of maturity.
- Engage industry stakeholders to better understand their plans for fleet modernization and timeframe for incorporation of emerging technologies.
- Identify actions across key success factors needed to facilitate progress from one stage to the next.

Short Term *(2-5 years)*

- Update technology maturity, progress, and timelines based on latest information.
- Track advanced mobility trends and incorporate new concepts/technologies into technology maturity tracking efforts.
- Follow through on actions identified across key success factors to help progress technologies from one stage to the next.
- Iterate on short- and middle-term tasks until all technologies are scaled up and reach the profitable commercialization stage.

Collaborate with stakeholders, including federal agencies, to help advance the state of the industry

- Continue to coordinate with Commercial Vehicle Safety Alliance's (CVSA) Enforcement and Industry Modernization Committee on autonomous trucking at hubs and participate in federally-sponsored opportunities such as the FAA's BEYOND Program and the USDOT Freight Logistics Optimization Works (FLOW) program.
- Leverage State resources, infrastructure, and academic and industry partnerships to identify, participate in, and, if appropriate, lead federally-sponsored research, demonstrations, and deployments of advanced mobility technologies and supporting infrastructure.
- Support the creation and updating of advanced mobility technology guidance and certification processes, including participation in working groups/steering committees as established by standards development organizations.
- Position NCDOT to serve as a statewide information clearinghouse, such as through a statewide Advanced Mobility Steering Committee, to share industry, technology, and policy updates as well as data and lessons learned.
- Encourage industry participation in the State's research and development, demonstration, and deployment efforts by federal, state, and local governments to demonstrate technical readiness and inform supporting infrastructure investments.

Identify the key physical and digital infrastructure needed to support advanced mobility technology integration, and, if applicable, develop strategic plans to invest and/or upgrade

Immediate *(1 year)*

- Identify key infrastructure needed by industry to achieve entry-into-service or scale existing operations, such as electrical availability and data connectivity, and undertake a gap analysis of existing resources.
- Conduct a readiness review of state highway infrastructure for advanced ground mobility.
- Assess the potential impacts, barriers, and return on investment by infrastructure type and environment.
- Inventory State-owned sites with existing physical space and characteristics needed to support infrastructure and operations, or that could support advanced mobility technologies with minimal modification, emphasizing underrepresented areas and multimodal integration opportunities.
- Collaborate with industry, utilities, and telecommunications to conduct a preliminary analysis of the demands placed on the electrical grid, broadband, and 5G networks by infrastructure, aircraft, and vehicles.

Short Term *(2-5 years)*

- Continue iterative data collection and analysis to inform decision-making.
- Deploy targeted infrastructure upgrades and collect data to validate accuracy of initial assessments.
- Leverage data collected to develop an infrastructure upgrade strategy for scale-up.
- Establish a central data management platform connecting NCDOT, local agencies, mobility service providers, and end users and supporting integrated trip planning, a mobility wallet, MaaS, and digital platforms.
- Partner with universities to leverage data sources and develop use cases.
- Develop data architecture and digital twins to facilitate integration and planning.
- Establish a video data streaming platform that can connect local municipalities.
- Continue working with industry stakeholders including utilities and telecommunications to develop a strategy for upgrading the electrical grid, broadband, and 5G capacity as advanced mobility technologies scale.
- Support local agencies in developing strategic plans for infrastructure and hub siting, incorporating Complete Streets, MaaS, and alternative fuels.

Expand data collection and integration capabilities

Immediate *(1 year)*

- Engage with last-mile delivery service providers to complete a feasibility study that evaluates how their video data feeds can be centralized alongside operational data from air, seaports, and rail terminals.
- Work with the Division of Motor Vehicles (DMV) to develop process for capturing AV registration data, similar to codes used for EV registration.

Short Term *(2-5 years)*

- Continue to support the accuracy of mobility applications, such as Google maps and Waze, by collaborating to develop and maintain data availability.

8.1.1.3

Public Engagement

Public engagement for advanced mobility technologies is critical to the successful integration of these technologies into North Carolina's transportation system. To build awareness and engagement, support from airports, physical and digital infrastructure providers, manufacturers and operators, local government, university partners, nonprofits, and legislators will be key. Specific actions are suggested in **Exhibit 8-3**.

Exhibit 8-3. NCDOT Public Engagement Action Items

Develop and implement a comprehensive public education and engagement strategy

Immediate *(1 year)*

- Continue to promote the successful testing and deployment of advanced mobility technologies by NCDOT (e.g., CASSI, use of sUAS for disaster recovery, etc.) and statewide partners.
- Craft standard messaging that conveys the public good and safety benefits advanced mobility technologies offer.
- Establish a Statewide Task Force for information sharing across stakeholders.
- Continue to leverage existing platforms for stakeholder engagement (e.g., Annual Transportation Summit, North Carolina Airports Association Annual Conference, etc.).
- Develop robust social media campaigns promoting both air and ground advanced mobility technologies (e.g., via LinkedIn).
- Develop narratives showcasing research related to air and ground advanced mobility technologies
- Develop messaging that helps communicate about technology in non-technical language to reach a broader audience.
- Outreach to industry providers to develop strong pilot concepts (see Strategic Funding Opportunities on page 87).

Short Term *(2-5 years)*

- Create a partnership program educating local governments on advanced mobility's importance for mobility and economic development and include concrete steps to support industry growth.
- Create a marketing campaign highlighting the new technology and innovation work NCDOT is investing in and promoting.
- Incorporate new advanced mobility technologies in outreach and engagement efforts, as technology evolves.
- Continue outreach and engagement activities to stay up to date on business and community needs.
- Encourage industry partners to participate in and provide feedback on demonstrations and deployments that familiarize stakeholders with advanced mobility technologies. Feedback solicited should be used to support evaluation outcomes.

8.1.1.4

Workforce Development and Growing Industry Presence

North Carolina has benefited from a history of strong public support for innovation. Research Triangle Park is the largest planned research center in the U.S., created in 1959 by hundreds of scientists, politicians, and business leaders. Having a workforce prepared for the next generation of jobs continues to be a priority.

The State has many economic development and workforce development incentives to attract employers and train employees and a robust pipeline of dedicated programming, including K-12, higher education, and continuing education. With broad investment opportunities, job creation is also a critical metric. The State has many tools and strategies to help attract more advanced mobility related business, research, testing, and service deployment leading to job creation.

Collaborating with industry stakeholders, such as Duke Power, Dominion NC Power, ElectriCities, NC Electric Membership Corporations, other public agencies, academic institutions, advanced mobility industry manufacturers, operators and service stations, as well as dealerships, destinations, and community leaders will continue to be critical in building out a sustainable advanced mobility ecosystem.

Exhibit 8-4 proposes action items to grow NC's workforce and industry presence that can be undertaken in collaboration with stakeholders such as NC Commerce, Economic Development Organizations (EDOs), university partners, NCDPI, State college and technical schools, infrastructure site hosts, OEMs, charging equipment vendors and dealers, utilities, permitting agencies, incentive programs, and funding providers.

Exhibit 8-4. NCDOT Workforce Development and Growing Industry Presence Action Items

Conduct an advanced air mobility economic impact study

Immediate *(1 year)*

- Estimate the change in economic activity from focused growth in the advanced mobility sector over the next 20 years.
- Quantify job creation, tax revenues, and GDP growth opportunities in North Carolina.
- Identify and prioritize public investment that is needed to catalyze private sector ventures.

Short Term *(2-5 years)*

- Share results of the economic impact analysis, track trends identified, and start to measure progress towards goals.

Develop a cohesive workforce and economic development strategy that attracts industry investment, creates well-paying jobs, and develops, attracts, and retains talent to fill those jobs

Immediate *(1 year)*

- Support EDOs and local leaders by strengthening the supply chain needed for product development and service enhancement.
- Support locally based startup business opportunities in mobility that create high-quality jobs within the state.
- Coordinate and support matchmaking of stakeholders involved in the advanced mobility and electric vehicles space.
- Provide opportunities for North Carolinians to foster a variety of skill sets.
- Build upon existing success with Aviation Career Education (ACE) Academies Grant Program for middle and high school students.

Short Term *(2-5 years)*

- Track technology evolution to anticipate new/different skillsets that will be needed in the future and work with educators to proactively develop programming to develop those skillsets.
- Leverage advanced manufacturing to create workforce opportunities.
- Develop overarching emerging mobility workforce development and upskilling strategies, such as an Advanced Mobility Workforce Development Handbook, establishing a strategy for development of NC talent from elementary school to adult workers and an outline for an internship program for students at the State's public use airports.
- Prioritize innovative technology companies when funding projects with Airport Economic Development Funds (AEDF).

Incentivize internal innovation and ideas

Immediate *(1 year)*

- Offer awards and acknowledgments within NCDOT.
- Ensure the Process for Integrating New Transportation Technologies is well publicized throughout NCDOT.
- Increase participation with North Carolina Transportation Centers of Excellence to support retaining students with innovation backgrounds.

Short Term *(2-5 years)*

- Consider incentives and support for NCDOT to proactively pursue reskilling and upskilling for its staff.

Develop guidance and resources that prepare North Carolina's workforce for new advanced mobility opportunities

Immediate *(1 year)*

- Develop playbooks for implementing advanced mobility use cases that emphasize transparency and collaboration.
- Leverage the State's clean energy youth apprenticeship programs emphasizing education institutions serving underrepresented communities.
- Continue to support the inclusion of advanced mobility technology in NCDOT programs (e.g., Aviation Career Education (ACE) Academy Grant Program, Airport Leadership and Management Program, and North Carolina Airport Professional credential program).
- Encourage participation from the State's colleges and universities in the Advanced Mobility Steering Committee.

Short Term *(2-5 years)*

- Work with other agencies and education partners to develop a statewide curriculum for mobility industry jobs.
- Offer direct placement and internship programs in advanced mobility that invest in North Carolinians and retain talent.
- Work with industry partners to create on-the-job training opportunities and curriculum to prepare future workers.

8.1.1.5

Strategic Funding Opportunities

North Carolina benefits from a history of recurring designated funding bolstered by a proactive collaborative grant strategy and foreign direct investment (FDI) capital. **Exhibit 8-5** outlines action that can be taken to advance this position.

Exhibit 8-5. NCDOT Strategic Funding Opportunities Action Items

Leverage funding opportunities

- Identify and share information on existing funding sources, such as the $25M pilot program passed under the Advanced Aviation Infrastructure Modernization Act and the USDOT SMART Program, to improve visibility and utilization by stakeholders.
- Develop a proactive grant pursuit strategy that identifies and prioritizes projects early so a pipeline of projects is ready when funding becomes available.
- Communicate funding opportunities to industry partners.
- Develop a shared resource document on grant approach, including best practices and lessons learned, and establish coordination across all grant projects.
- Work with private sector and educational institutions to encourage investment and create funding opportunities.

8.1.2

MPOs and RPOs

MPOs and RPOs are key to the advancement of transportation mobility programs as they convene, educate, and generally support local stakeholders. Each MPO and RPO is at a different point in its evolution. The following are several actions they can progress as they elevate the advanced mobility portfolios of their member organizations.

Key Success Factor	Possible Action Items
Regulatory, Policy & Process Considerations	• Review local permitting requirements, State guidance for emerging mobility consistency (i.e. EV, curb management, etc.), and state-level clean transportation planning and collaborate across agencies. • Create guidance documents that help MPOs/RPOs quantify impacts and support long range planning. • Coordinate with state agencies and other MPOs/RPOs to identify and address existing legislation that may inhibit accomplishing advanced mobility goals. • In support of regional transportation planning studies, conduct tabletop exercises to identify advanced mobility use cases that consider aligning community needs with potential use cases and applications. • Establish a working group, committee, or task force to investigate advanced mobility technologies for consideration and incorporation in strategic planning. • Informed by State case studies, local understanding, and coordination with regional partners, develop code and zoning amendments that enable advanced mobility technologies. • Incorporate advanced mobility integration strategies into long-term planning, leveraging a case study approach to guidance documents building on previous pilots.
Technical Readiness	• Match advanced mobility solutions with prioritized local needs. • Continue to maintain updated quantification of regional greenhouse gas impacts as the shift to alternative fuels continues and better data becomes available. • Continue to work with state and local agencies to facilitate coordinated strategic planning that promotes interoperability and connectedness.

Exhibit 8-6. MPO and RPO Action Item Recommendations

Key Success Factor	Possible Action Items
Public Education and Engagement	• Leverage content produced by State and Federal governments to develop materials that educate local/regional decision-makers, industry, and community stakeholders. • Conduct and publicize targeted demonstrations to familiarize the public with various advanced mobility technologies. • Amplify messaging of member agencies around advanced mobility, especially when focused on safety, efficiency, emissions, and equity outcomes that could improve quality of life.
Economic and Workforce Development	• Identify broadband gaps and opportunities to ensure sufficient connectivity for education, workforce development, and industry investment and innovation. • Monitor and identify areas of limited workforce accessibility and strategically invest in accessibility for vulnerable workforce groups in markets with advanced mobility workforce demand.
Strategic Funding Opportunities	• Identify champions and funding opportunities for proposed advanced mobility solutions. • Collaborate with partners early to strategize about the top grant priorities. • Determine ways to assemble multiple funding opportunities to best advance the collective investment in advanced mobility opportunities.

8.1.3

Local Agencies

Local agencies interact closely with the public and play a key role in managing local ordinances and translating advanced mobility strategies to the local context. Whether planning to attract advanced mobility activities or responding to interest from an operator or vendor, there are several specific planning considerations that local agencies, including airports, can consider to ensure they are prepared.

Exhibit 8-7. Advanced Mobility Planning Considerations

READINESS

- What are the viable use cases in terms of technology and policy maturity?
- Is sufficient demand expected?
- How does advanced mobility fit into the larger regional strategy or other zoning?
- Have airspace limitations been identified?
- What funding or financing is available?

UTILITIES

- Can the local utility provider deliver sufficient power for operations, charging, and maintenance?
- Will electricity be provided through existing infrastructure, or will new facilities need to be constructed?
- Do the electric needs of operations conflict with other electrification efforts (e.g., ground service equipment, vehicle charging, etc.)?
- Is there a sufficient supply chain for delivering and safely storing materials such as hydrogen?

OPERATIONS

- Are new operations compatible with existing operations?
- Is separation between operations needed?
- Is there sufficient local and regional supporting infrastructure (e.g., weather data, CCTV, radar, etc.) to support operations?

STAKEHOLDERS

- Have benefits and impacts been discussed with local, State, and Federal elected officials?
- How can we build community support and mitigate environmental, safety, and other concerns?
- How will the introduction of new technology impact existing residents, businesses, or airport tenants?
- Are local stakeholders willing to partner? Is there a champion for the project?

SITE & FACILITY

- Where should advanced mobility sites and facilities go? Is there the space?
- Should space be repurposed? How will this impact to operations or revenue?
- How will vehicles (e.g., delivery, emergency, passenger, operations, etc.) access the site?
- Can deployments be supported by existing infrastructure (e.g., CTOL vs. eVTOL)?
- Can environmental impacts (e.g., noise, visual pollution, air quality, etc.) be quantified?
- Is there space for expansion?
- What requirements does the operator have (e.g., EV charging, battery storage, security, etc.)?
- How will passenger connectivity work?
- Is adequate security possible?

More specifically, the following are actions that agencies can take to integrate advanced mobility into their planning and programming, so their communities are well positioned when these technologies scale.

Exhibit 8-8. Local Agency Action Item Recommendations

Key Success Factor	Possible Action Items
Technical Readiness	• Review items listed in **Exhibit 8-8**, identify which actions are needed, and prioritize which to complete first. Revisit at a regular cadence. • Develop a strategic plan for infrastructure and hub siting, incorporating Complete Streets, MaaS, and alternative fueling.
Public Engagement and Acceptance	• Participate in state or MPO/RPO demonstrations and marketing campaigns and/or replicate demonstrations to familiarize the public with advanced mobility technologies. • Leverage materials from federal, state, and MPO/RPO organizations to educate stakeholders and constituents. • Publicize advanced mobility accomplishments.
Economic and Workforce Development	• Identify broadband gaps and pursue funding to close these gaps. • Explore opportunities to connect vulnerable workforce groups to areas with workforce demand using advanced mobility solutions.
Strategic Funding Opportunities	• Work with state and regional agencies to secure funding for advanced mobility technologies and supporting infrastructure.
Regulatory, Policy & Process Considerations	• Align cybersecurity and privacy protocols to state-level protocols to provide continuity to transportation system users.

8.2

Advanced Mobility Integration Process

Pilots or demonstrations, such as those included in the CASSI program, provide value to NCDOT in many ways. They allow NCDOT to test innovative technologies in small-scale, low-risk environments, so incremental progress can be made to move solutions towards unsubsidized commercial operations. North Carolina consistently invests in advanced mobility vehicles, systems, and infrastructure through funding, financing, providing expertise, or granting access to equipment or space to operate and evaluate solutions.

As the rate of change increases, NCDOT is developing a robust process to evaluate multi-modal transportation technologies before investing towards demonstrations and deployments. **Exhibit 8-10** presents a performance standard for evaluating and developing transportation technology investment ideas, in five phases:

+ Ideas

All ideas, internal or external, public, private, or academic, are welcome and can be submitted to NCDOT via the Innovation Use Case Review Form. The Innovation Use Case Review Form should note how the use case aligns with NCDOT's mission, vision, and values. Preliminary identification of potential funding sources, resources, staff, and equipment needed should also be included.

+ Vision Alignment

NCDOT has developed a standard review process for potential use cases related to innovative technologies. As part of this step all pilots/use cases will be reviewed by the NCDOT team for alignment with the Advanced Mobility NC vision and goals.

+ Plan

Following approval, the use case plan should be documented using the Innovation Use Case Work Plan Form. The form should document a schedule for planning, launch, implementation, and close out. At this stage, the necessary staff time, equipment, and funding should be documented. Developing a risk register is also recommended.

+ Implement

Implementation includes preparation, which is more detailed project development activities such as creation of a detailed schedule, as well as outreach to stakeholders, and development of performance objectives. This also involves refinement of the team, negotiating the terms and conditions, and contracting. As the project moves into implementation, permits may need to be obtained prior to installation and testing. The system then must be operated and maintained for the contracted period.

+ Measure Performance

Throughout the operations and maintenance period, each innovation use case is tracked and reported to help publicize successes and identify lessons learned. Sharing the results in a dashboard will allow other staff and stakeholders to be aware of ideas in various stages of evaluation, planning, or implementation.

The goal of this process is to foster a culture of innovation that is well-planned, well-documented, and well-executed. Collaboration within teams, across the Department, and with other partners should be at the core of each innovation use case explored to ensure its success. The process will also help industry partners and other external stakeholders understand NCDOT's priorities in the exploration of use cases. This process will also help communicate the resources and incentives that are available to partners and stakeholders to test and evaluate emerging technologies.

8.3

Onward

While safety, sustainability, equity, technology, and supply chain drivers shape our mobility future, North Carolina will continue to leverage innovative technologies and platforms to provide systems that work for all North Carolinians, residents and visitors alike.

As the action items and focus on innovation are further integrated into NCDOT's culture, it will be important to capture and report on successes, especially as they relate to the goals of improving the quality of life, creating economic opportunity, and being a transportation trailblazer.

This will allow North Carolina to set the stage for a modern, safe, sustainable, efficient, resilient, and equitable transportation system.

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