GREATER NASHVILLE REGIONAL COUNCIL

REGIONAL SMART MOBILITY ASSESSMENT

AUGUST 2019

GREATER NASHVILLE REGIONAL COUNCIL

Stantec

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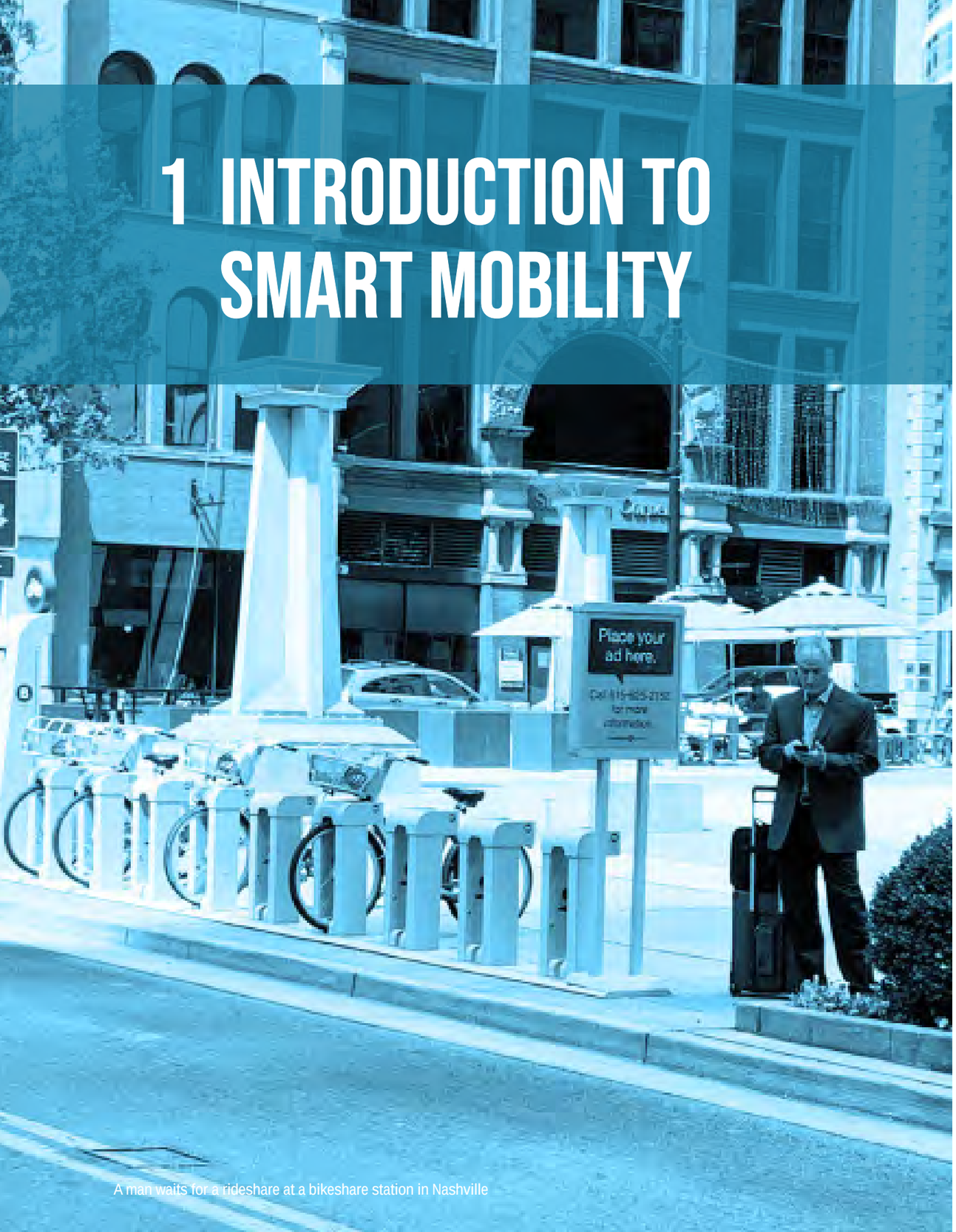
This document was prepared by Stantec on behalf of the Greater Nashville Regional Council and contains deliverables 3, 5 and 6 of the GNRC Regional Smart Mobility Assessment: Synthesis of Findings in Related Materials and Plans; Summary and Analysis of Inventory/ Existing Conditions and Trends; and Technology Briefing Paper on Best Practices and Toolbox of Strategies.

1 INTRODUCTION TO SMART MOBILITY



A man waits for a rideshare at a bikeshare station in Nashville

OVERVIEW

A MOBILITY REVOLUTION IS UPON US.

The rapid rise of digitally-connected mobility services has brought new flexible offerings to millions of Americans and hundreds of thousands across Middle Tennessee. A host of emerging technologies are revolutionizing travel and bringing **more services to the fingertips of Tennessee's** citizens. People can now easily travel without their own car, using just a cell phone to access shared cars, bikes and even scooters; smarter signals and roadside communications are helping manage travel flows, controlling congestion and responding to incidents faster; electric motors and batteries have revolutionized vehicles and opened new opportunities to reduce greenhouse gas emissions; and automation is already beginning to operate vehicle safety features for us, with mundane tasks like finding parking soon to become obsolete as cars park themselves. For Middle Tennessee, this revolution could not come at a better time.

Greater Nashville is among the fastest growing regions in North America, and its popularity has drawn more people, more trips, and more congestion. While major investments in high-capacity transit systems are the essential topic of past, present, and future transportation system dialogues, Smart Mobility has emerged **as an immediate opportunity to get more out of the region's existing transportation networks.** In lock-step with the Smart Cities movement that has brought improved public services, better data management, and greater information to citizens, Smart Mobility offers Greater Nashville the opportunity to add safety, efficiency, and even capacity to existing roadways, bikeways, walkways, and transitways.

Fortunately, regional and local governments are already identifying growing core mobility needs and common themes across the region: we need more travel opportunities by more modes; we need safe and efficient operation of our existing corridors; we need collaboration across jurisdictional lines; we need to bring new mobility services to those most in need; and we must protect our communications systems and ensure the privacy of our data.

Fortunately, the region is already a national leader **in developing the backbone of necessary Smart** Mobility infrastructure, with many jurisdictions operating state-of-the art networks and facilities, but much more needs to be done to leverage all that emerging technologies have to offer to the traveling public. **The number one outstanding issue in this region remains the development of consistent standards, technologies, and data-sharing agreements to maximize the efficient operations of shared mobility services, emerging traveler information platforms, and roadway management systems.** While most jurisdictions have heard of Smart Mobility, only a few are ready to collaborate across municipal lines and develop the necessary partnerships to move the region more efficiently, safely and equitably.

The GNRC has an opportunity through this regional Smart Mobility Assessment to help chart a coordinated approach to several key corridors which span the region. Already this assessment has developed a database of compatible Smart Mobility infrastructure which could be leveraged to work along entire corridors. This assessment also includes best practices from peer cities who have overcome similar barriers and charted new approaches to how they manage their infrastructure, fund new technologies, and build public-private partnerships. These valuable lessons can serve as a guide for Middle Tennessee, enabling faster adoption of technologies.

This document summarizes the first Phase of the regional Smart Mobility Assessment. Building upon its conclusions, GNRC will work with regional stakeholders in Phase 2 to structure a regional vision for integrating Smart Mobility.

FREQUENTLY ASKED QUESTIONS

WHAT IS SMART MOBILITY?

Smart Mobility refers to the interconnection between people, vehicles, and infrastructure through enhanced technology improvements that optimize the performance of multimodal transportation services, create a more efficient, sustainable system, and enhance the user experience. The value added to the transportation system can result in increased convenience, safety, and efficiency of operation, including strategies that reduce the use of single occupant vehicle trips.

HOW DOES SMART MOBILITY RELATE TO SMART CITIES?

Many cities and regions are exploring how advancements in technology can improve the quality of life and the delivery of government services. Efforts generally center around easier access to information, more efficient use of resources, and better mobility access. Some jurisdictions in the Nashville region have already begun exploring how their communities might employ smart cities strategies to improve their service to citizens. By focusing on mobility, GNRC can craft a vision for how neighboring communities can work together to improve the performance of the corridors shared by all.

WHY TECHNOLOGY & SMART MOBILITY?

The Greater Nashville region is growing rapidly and adding lanes along our roadways is cost prohibitive and seldom decreases congestion. Technology enhancements can alleviate congestion, improve safety and travel time reliability, and provide information for users to make better travel decisions. Technology enhancements optimize the efficiency of the existing transportation network and can improve the functionality of our built environment and public rights of way to accommodate more users, modes, and activities.

WHAT ARE SOME EXAMPLES OF EMERGING TRANSPORTATION TECHNOLOGIES?

Technologies deployed to improve mobility can include infrastructure such as traffic signals (see page 10 for more info), dynamic message boards, and sensors and cameras that gather a variety of data, including speed, number of and type of vehicles, pavement conditions, incident detection, and other safety and performance information. It also includes vehicles that are connected through tools such as Automatic Vehicle Location devices, Bluetooth, and dedicated short range communication. Connected Vehicles provide additional safety features and share data to improve the travel experience.

WHAT MAKES THESE TECHNOLOGIES SMART?

Smart Mobility technologies include physical devices that detect what is happening, the software that processes what is happening, and the communications infrastructure that shares this information in real time. The ability to make adjustments based on real time data is a key component of a smart system.

WHAT IS THE PURPOSE OF THE REGIONAL SMART MOBILITY ASSESSMENT?

This assessment is intended to help define how the transportation system in the Greater Nashville region should prepare for and thrive in an environment offering all modes of transportation with vehicles that are connected, shared, and even autonomous. The assessment will examine the physical infrastructure (devices, software, communications) as well as the policies needed to accommodate the growing number of connected vehicles and sensors, and the data they produce.

WHAT ELEMENTS ARE CONTAINED IN THIS SPECIFIC DOCUMENT?

This document contains a synthesis of findings of what technology is currently deployed or planned within the Greater Nashville region. These findings are based on meetings and interviews with stakeholders from jurisdictions within the region, as well as a review of various planning documents and policies guiding technology and mobility investments. Also included is an inventory of Smart Mobility assets located along several corridors which interconnect the region. An overview of best practices provides a summary of how leading cities and regions are utilizing smart mobility strategies and investments to improve their transportation systems.

HOW DOES EMERGING TRANSPORTATION TECHNOLOGY AFFECT THE DISCUSSIONS ABOUT REGIONAL MASS TRANSIT?

GNRC recognizes that emerging transportation technologies are already changing how we think about mobility. Since the first conversations around a regional transportation network began over 10 years ago, the advancements in mobility have been significant. In recent years, technology improvements have brought us bikeshare systems, carshare programs, rideshare and trip planning apps, dockless scooters and bicycles, and soon, autonomous vehicles. This new era of shared mobility brings a tremendous opportunity to improve accessibility for many users. During the 2018 referendum on a transit plan in Nashville, some questioned whether emerging technologies might replace the need to invest in transit. However, as our region continues to grow, the original form of shared mobility – mass transit – will remain a critical need.

Mass transit, whether light rail or bus rapid transit, will continue to be the most efficient way to move people along a corridor. Single passenger vehicles – even autonomous vehicles – will move <2,000 people per hour in a lane, while dedicated transit lanes will move up to 8,000 people/hour. Our restricted right of ways require inclusion of a robust mass transit system with sufficient capacity to move the residents of Middle Tennessee.

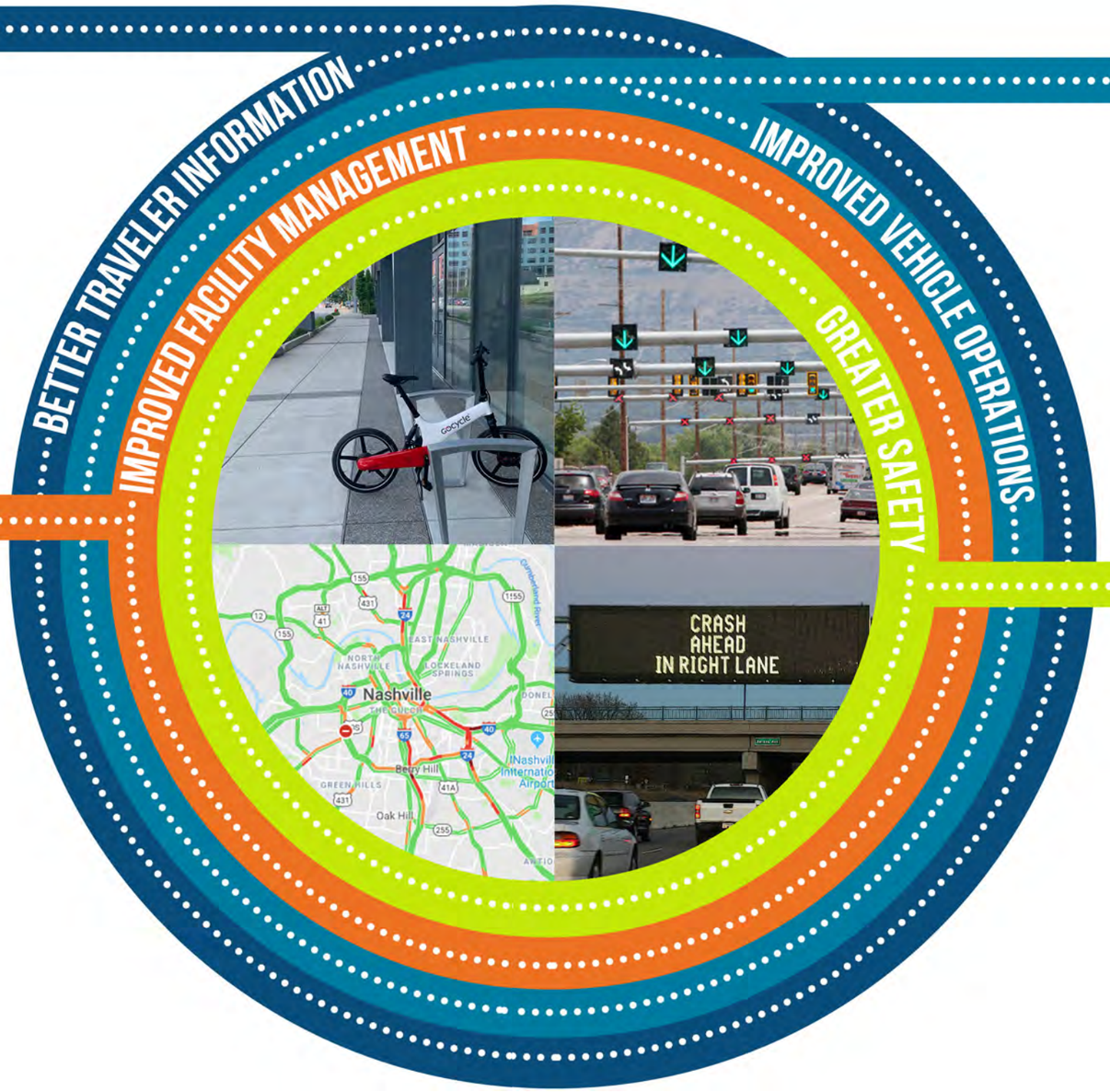
As our regional dialogue around mass transit continues, the role of all emerging transportation technologies will be carefully evaluated, and we expect many of them will play a critical role. This assessment will help identify how these emerging technologies can ensure our investments in transportation are deliberate, comprehensive, and future-ready.

BENEFITS OF SMART MOBILITY

SOME OF WHAT SMART MOBILITY CAN OFFER

- Active carpool, rideshare and micro-transit scheduling
- Real-time incident reporting
- Parking space, bike share, and scooter availability
- Dynamic route planning

- Real-time transit vehicle locations and arrival times
- Onboard occupancy and capacity loading
- Early mechanical failure warning and prevention systems
- Automated speed control and lane guidance



- Congestion relief with smart signals and reversible lanes
- Comfortable walking with leading pedestrian intervals and crosswalk beacons
- Faster transit service with queue jump lanes and offboard payment
- Easier biking with dedicated signals, protected lanes, and smart bike parking

- Immediate emergency responder dispatching
- Passive pedestrian and cyclist detection and notification
- Advanced incidcent aboidance notification
- Automated and blind-spot detection and braking

TECHNOLOGY OF SMART MOBILITY

TECHNOLOGIES YOU INTERACT WITH

RIGHT-OF-WAY MANAGEMENT

TRAFFIC CAMERAS
Linked to Traffic Operations Center for adaptive signal control

RAMP METERS
Access control to preserve regional road capacity

SMART SIGNALS
Communicating and adapting to real-time traffic conditions

QUEUE JUMPS
Reducing transit delays and improving reliability

SIGNAL PRIORITY
Extending green time when transit vehicles approach

REVERSIBLE LANES
Time-of-day delay management to increase capacity

TRAVELER INFORMATION

DYNAMIC MESSAGE SIGNS
Real-time conditions reports to motorists

CONGESTION AHEAD
SLOW DOWN

RIDEMATCHING BOARDS AND APPLICATIONS
Customer-friendly coordination of carpools

RIDESHARING APPLICATIONS
Real-time access to TNC rides

MICROMOBILITY APPLICATIONS
Real-time availability and location of bikes, shared vehicles and docking locations

TRIP PLANNING APPLICATIONS
Routing, cost and time across modes

COMMON PAYMENT SYSTEM
Universal access across multiple forms of shared transportation

SOME OF THE COMMON FEATURES IN USE TODAY

TECHNOLOGIES YOU INTERACT WITH

SAFETY AND COMMUNICATIONS

FIBER AND 4G WIRELESS
Interconnected signals, corridors and safety systems

IN-CAR SAFETY MESSAGES
Advanced detection of on-board faults and failures

SIGNAL PRE-EMPTION
Clearing signal queues to speed emergency responders

VARIABLE SPEED LIMIT SIGNS
Adjustable speed limits to accommodate various road conditions

MAXIMUM
?
mph

AUTOMATED INCIDENT DETECTION
Immediate dispatch of emergency responders

VEHICLE OPERATIONS

OFF-BOARD PAYMENT
Cash-less, all-door bus boarding to reduce delays

AUTOMATED BRAKING
Remote sensing and communication with connected vehicles and signals

ADAPTIVE CRUISE CONTROL
Predictive flow control to maximize safety and efficiency

PLATOONING
Vehicle to vehicle communication and collaboration to increase capacity

AUTOMATED LANE FOLLOWING
Onboard and roadside guidance to reduce incidents and increase capacity

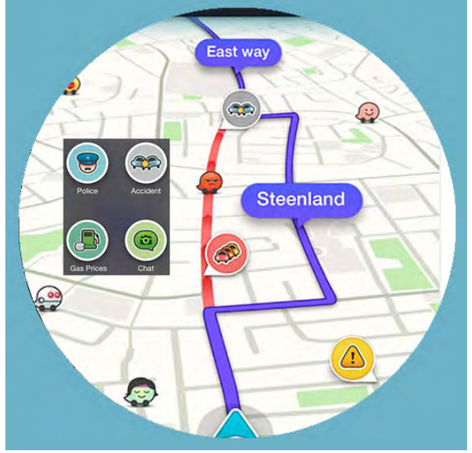
TECHNOLOGIES THAT ARE SUPPORTING US

SUPPORTING TECHNOLOGIES (BACK-END)

RIGHT-OF-WAY MANAGEMENT

- Traffic Operations Centers
- Traffic camera feeds
- Wireless queue detectors
- Transportation data ITS software
- Active traffic management

TRAVELER INFORMATION



- Parking occupancy sensors
- Dynamic routing applications
- Real-time transit locations
- Highway advisory radio/CB interrupter
- DSRC/5G infotainment

THE DATA FOUNDATIONS OF SMART MOBILITY

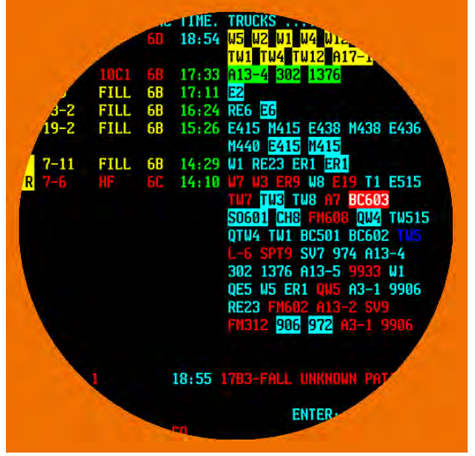
OPEN DATA ANAD SECURITY

- Data server protection
- Disaster recovery protocols
- Encryption protocols
- Smart locks on ITS and traffic signal cabinets
- Licensing standards
- Data-sharing agreements
- Privacy standards and protection
- API/handshake standards
- Cloud security
- Change default passwords on networking equipment

TECHNOLOGIES THAT ARE SUPPORTING US

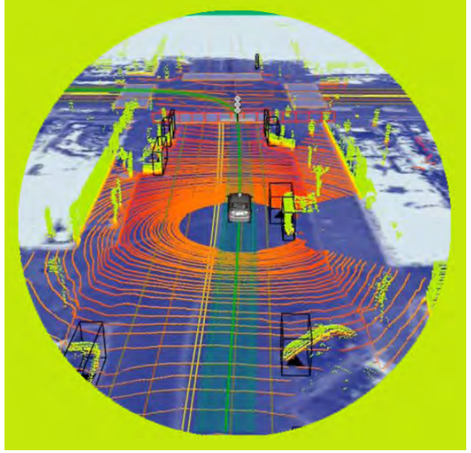
SUPPORTING TECHNOLOGIES (BACK-END)

SAFETY AND COMMUNICATIONS



- Dedicated fiber connections
- Automated emergency dispatch systems (CAD)
- Wireless 5G data
- Roadside communications (DSRC/5G)

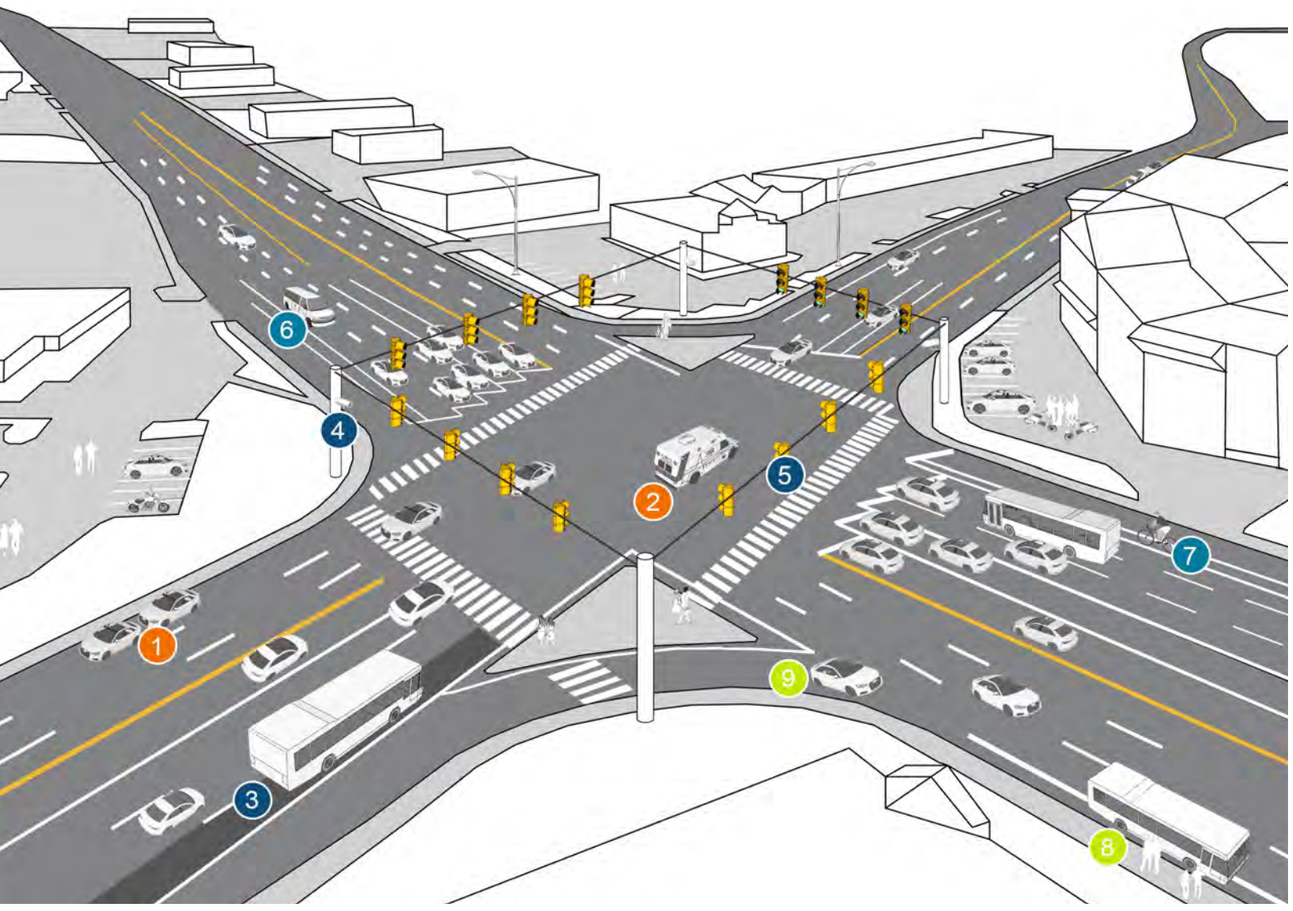
VEHICLE OPERATIONS



- Automated vehicle location (AVL) systems
- Vehicle/power train monitoring chips
- Light Detection and Ranging (LIDAR)
- Radar/infrared cameras
- Automated passenger counters

Additional details about each of the technologies in this section can be found in the Smart Technology Glossary in Appendix B

FEATURES SEEN ON ROADS NEAR YOU



1. AUTOMATED CRASH DETECTION

2. SIGNAL PREEMPTION

3. QUEUE JUMPS

4. TRAFFIC CAMERAS

5. SMART SIGNALS

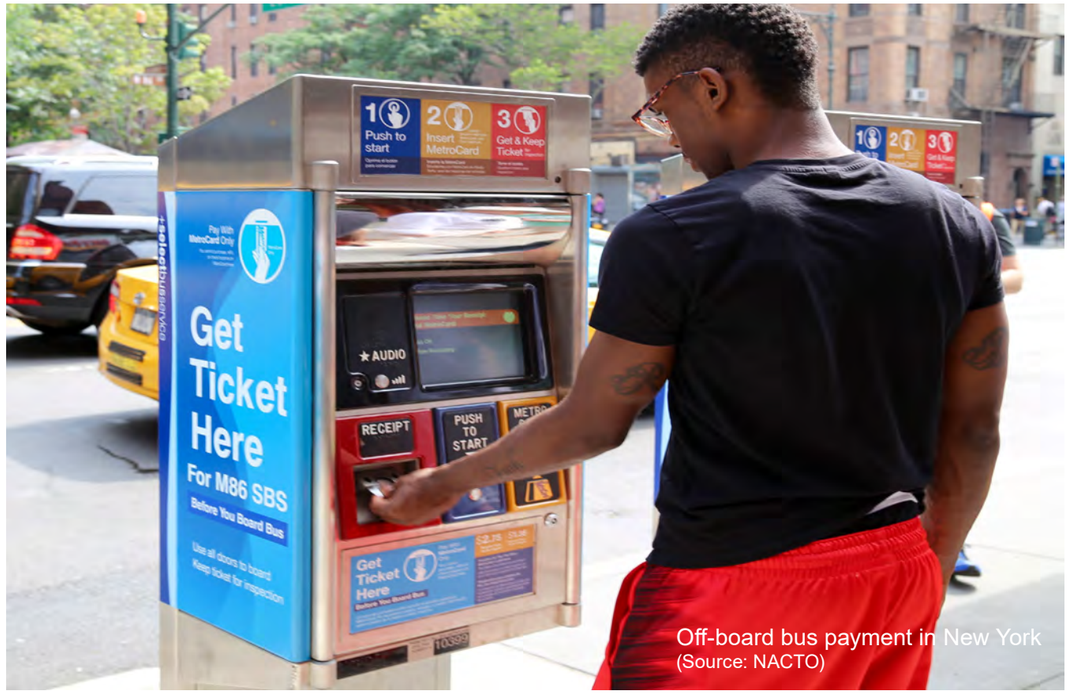
6. RIDEMATCHING APPLICATIONS

7. BIKESHARE APPLICATIONS

8. OFF-BOARD PAYMENT

9. AUTOMATED LANE FOLLOWING

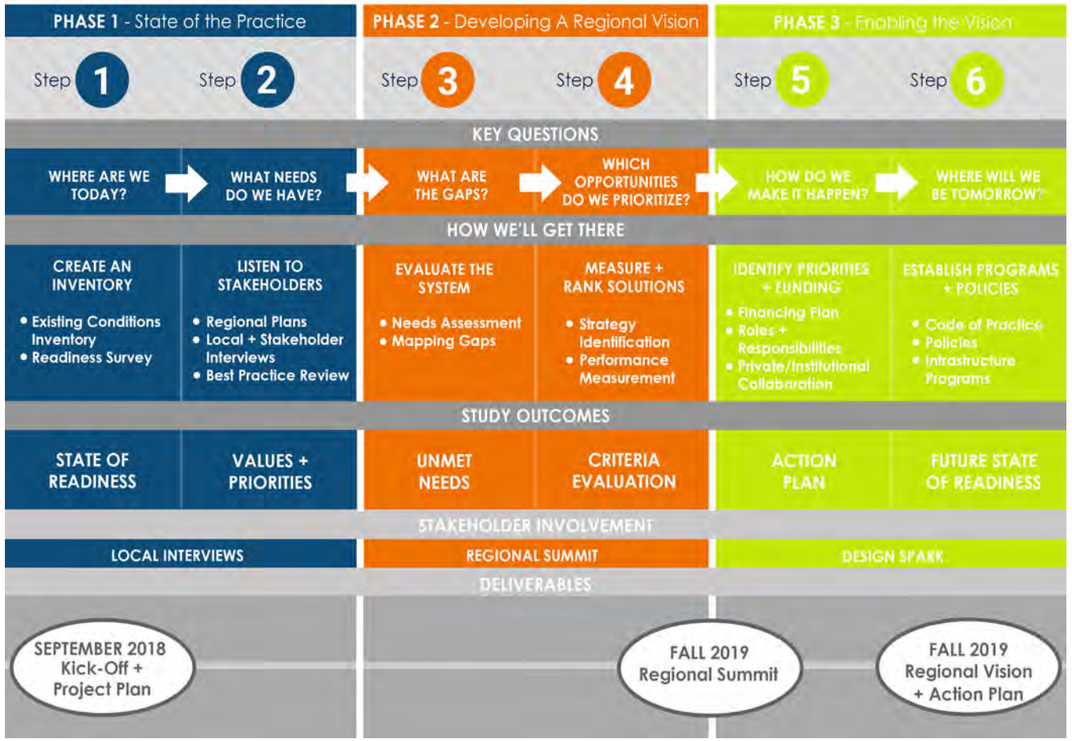
Nashville Bcycle app
(Source:Bcycle)



Off-board bus payment in New York
(Source: NACTO)

WHAT'S IN THE SMART MOBILITY ASSESSMENT?

REGIONAL SMART MOBILITY ASSESSMENT PROCESS



ASSESSMENT STEPS

The Assessment will be conducted in three sequential phases. First, a **"State of the Practice"** inventory of regional smart mobility infrastructure, programs and plans identifies what Middle Tennessee provides today and where it stands next to national peers. This is the subject of this first report. It will be followed by the development of a **"Regional Vision for Smart Mobility"** produced with the input of the region's stakeholders and intended to address the needs and opportunities which new technologies can address. The final phase will develop a roadmap for how to **"Enable the Vision"** with new technologies, including a tool to evaluate and rank smart mobility initiatives against the region's needs as they evolve over time.

1 STATE OF THE PRACTICE (FALL-WINTER 2018)

This document outlines the region's first inventory of smart mobility assets, programs and plans. It draws from State, regional and local data sets and reports as well as interviews with public stakeholders in all seven counties and many cities within the region. It includes the location and type of hard assets, such as fiber communications networks and roadside technologies, as well as other communication networks and information technology systems that can be utilized by smart mobility technologies.

As part of collecting smart mobility information, planning and policy documents produced for the region and by many municipalities also were reviewed to identify any smart mobility related efforts. As summarized in this report, these documents provide evaluations of mobility needs in the region—many of which can be addressed with smart mobility. A more detailed needs evaluation will occur during the visioning process in the second phase of this Assessment.

Additional needs and priorities were identified during stakeholder interviews across the region, which are also summarized in this report. Stakeholders have been highly valuable for identifying existing and planned smart mobility assets, many of which reside in information technology departments in addition to traditional transportation-related departments.

Finally, the state of the practice includes an evaluation of best practices in smart mobility from around the United States to help benchmark progress in the region and identify strategies that may aid the development of a regional vision for smart mobility in middle Tennessee.

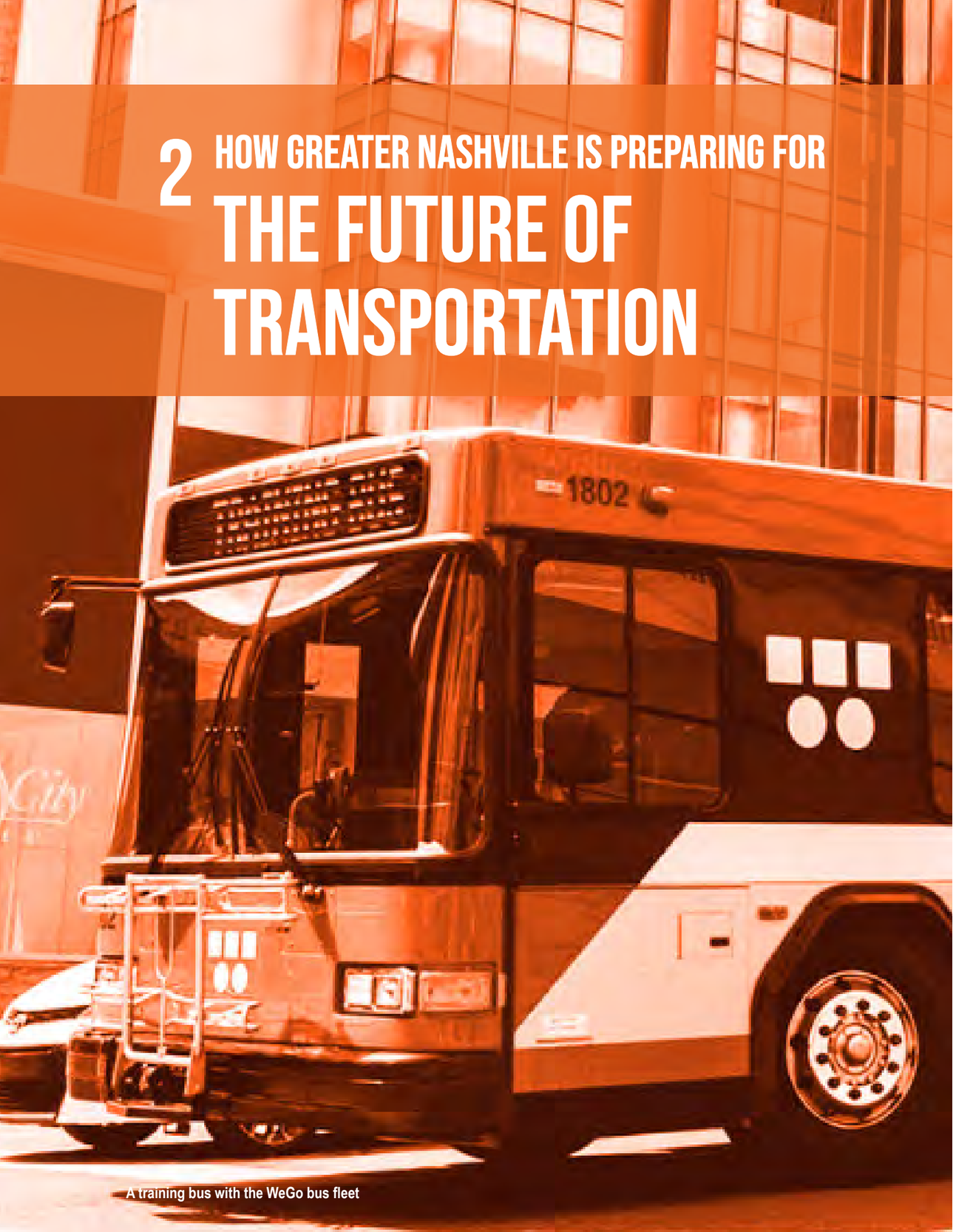
2 REGIONAL SMART MOBILITY VISION (FALL 2019)

To guide how the region's smart mobility infrastructure, programs and policies may evolve, a regional vision will be developed which draws from the input of leaders, planners, employers, operators, and technologists in government, private business and non-profit institutions across Middle Tennessee. Empowered with assessments of existing smart mobility assets, summaries of identified mobility needs, and an understanding of what emerging technologies are capable of providing, a collaborative Regional Summit will be held to establish a clear vision for integration existing and future technologies into the transportation system. The goal of the summit will be to ensure that every mobility need that technology can aid is addressed by the regional vision.

3 ENABLING THE VISION (FALL-WINTER 2019)

An action plan for achieving the regional vision will be developed. This is expected to include clear objectives and a series of infrastructure, policy and programming initiatives for implementation over the next several years. To help prioritize the most critical efforts for achieving the vision, a "design spark" will be held with regional stakeholders who understand the technologies and impacts of smart mobility. This single-day collaborative work session will help define initiatives and their intended outcomes. The final product of the Assessment will be a framework for implementing emerging technologies in a sustainable manner which meets Middle Tennessee's needs for improved mobility.

2 HOW GREATER NASHVILLE IS PREPARING FOR THE FUTURE OF TRANSPORTATION



A training bus with the WeGo bus fleet

REGIONAL AND LOCAL PLANNING

To begin the assessment, a review of recent local and regional planning efforts was conducted to identify plans, programs and policies which support or could support smart mobility. Many studies have been completed over the last three years to address mobility challenges facing Middle Tennessee's vehicular, transit, walking and biking networks.

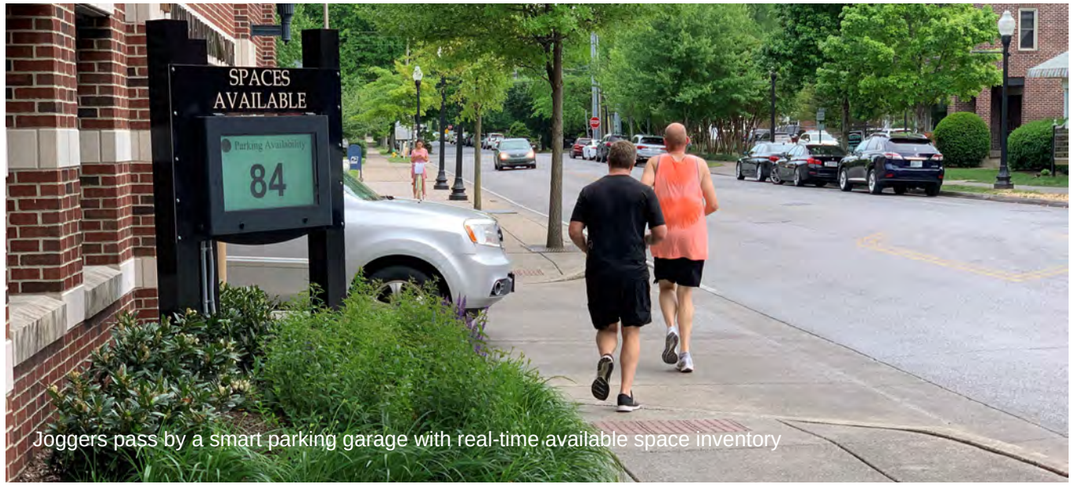
Regional Reports & Plans Reviewed	Date of Publication
MTA's nMotion	12/2016
TDOT I-24 Smart Corridor	05/2017
Regional Transportation Plan (2016-2040)	02/2016
Smart City Minimum Technical Standards (CN Appendix 1)	04/2016
Connected Nashville	04/2018
Gear Up 2020	07/2016
Nashville Area Metropolitan Planning Organization Parking Smarter in Middle Tennessee	2017
Moving Forward	2017
USDOT: Smart City Challenge Nashville Connected: Music City's Smart Transportation Vision	02/2016

Local Reports & Plans Reviewed	Date of Publication
Spring Hill Rising 2040	2015
Connect Columbia	2018
Connect Columbia Transportation and Land Use Plan (Columbia's Framework Plan)	2018
Murfreesboro Comprehensive Plan	Mobility chapter under development
Smyrna Comprehensive Plan 2007	Currently updating
Fairview Comprehensive Plan Update	Currently updating
Envision Franklin	2017
Shared Urban Mobility Devices Policy	2018
Let's Move Nashville: Transit Improvement Program	2017
Nashville Next (Access Nashville 2040)	2016
Franklin Parking Study	2017
Nolensville Comprehensive Plan	2017
Brentwood Connectivity Study	2018
Connect Franklin	2016
Lebanon 1984 Comprehensive Plan and 2006 Transportation Plan	Stantec currently updating
Mt Juliet Future Land Use and Transportation Plan	2016
Mt Juliet Greenway, Bicycle & Pedestrian Master Plan Update	2016
Gallatin on the Move 2020	2009

KEY THEMES IN OUR REGION

A review of recent planning efforts reveals multiple smart mobility needs and opportunities across many topic areas; however, several consistent themes emerged across multiple documents, identified by regional strategies and local comprehensive plans alike. In order for Middle Tennessee to begin defining how smart mobility might address travel challenges, it will be important to focus on these themes and their underlying needs, as described below.

As part of this assessment, an initial evaluation of Middle Tennessee's state of readiness to address these needs reveals that much work remains to be done. While **we are national leaders** in planning and preparing for emerging transportation technologies, more will need to be done to fully prepare and adapt to the changes which smart mobility will gradually make to transportation accessibility, network efficiency, and data sharing. Needs associated with the following themes are described in the forthcoming pages, along with a level of readiness that is based on feedback received from local jurisdictions. Vanderbilt University (VU) is currently developing a smart mobility scorecard of their own that will assess progress towards goals and guide public investments.

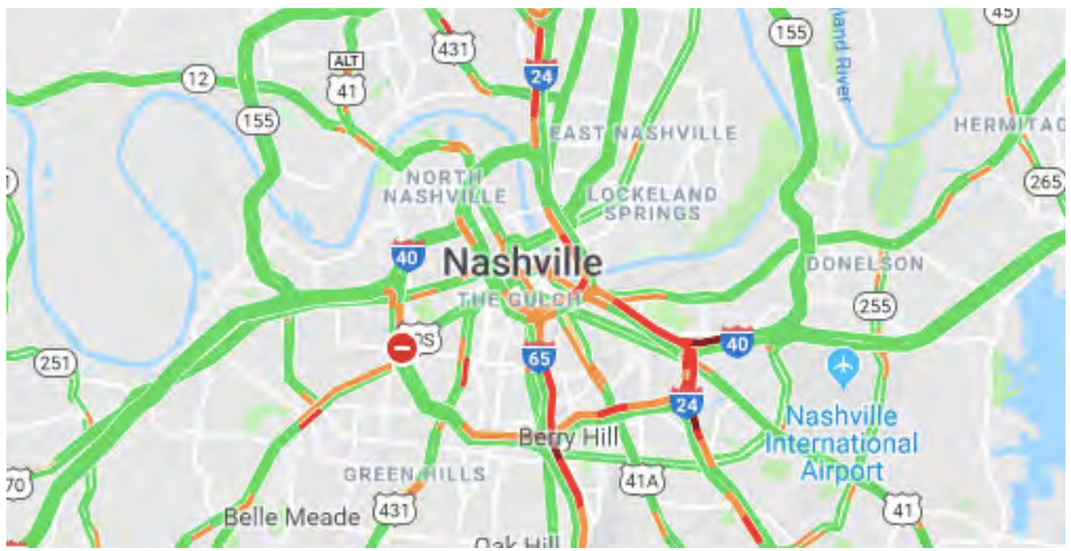


Joggers pass by a smart parking garage with real-time available space inventory

1. Equity and safety
2. Managing demand and accessing traveler information
3. Efficiency of roads / infrastructure to move people
4. Data sharing and privacy
5. Interoperability/communication between modal networks
6. Smart planning tools

A man waits for a WeGo bus

Screenshot of live traffic data on the TDOT Smartways app



EQUITY AND SAFETY

Get everyone “on board”

NEEDS

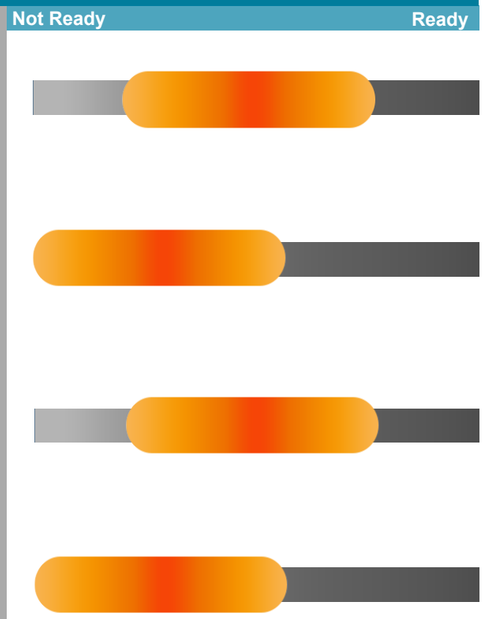
MULTI-MODAL PROGRAMS
Transportation providers should offer more equitable access to shared multi-modal mobility programs in areas that are currently underserved by public transit options.

TECH-ENHANCED TRANSIT AMENITIES
The region severely needs new buses and passenger waiting shelters equipped with on-board and in-station Wi-Fi so riders can access real-time arrival information.

PEDESTRIAN SAFETY IMPROVEMENTS
Several dangerous intersections require traffic signal updates, improved synchronization, and pedestrian safety improvements to improve safety and traffic flow.

RELIABLE, EFFICIENT SERVICE
Smart mobility and paratransit services need to be improved for people with disabilities and access issues. This includes flexible vehicles and cash-payment options.

LEVEL OF READINESS



MANAGING DEMAND AND ACCESSING TRAVELER INFORMATION

Get modes to meet in the middle

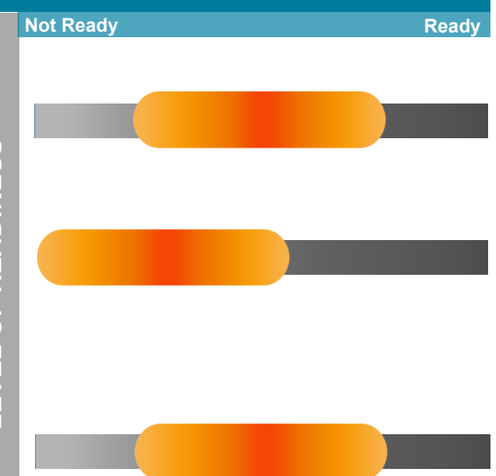
NEEDS

TRAVEL INFORMATION
The region needs to develop better travel information software platforms.

MULTI-MODAL HUBS
More accommodations for new travel modes are needed, including rideshare loading/ unloading locations, shared mobility stations, and transit mobility hubs.

MOBILE DATA TERMINALS
Upgrades to mobile data terminals for AccessRide paratransit service should be made to better display real-time information. Web and mobile apps are needed to promote initiatives like the WeGo easy-ride commuter program.

LEVEL OF READINESS



Traffic along the I-24 corridor (Source: TDOT)

Data centers like this one house important data and boost cybersecurity

EFFICIENCY OF ROADS/INFRASTRUCTURE TO MOVE PEOPLE

Staying up to speed

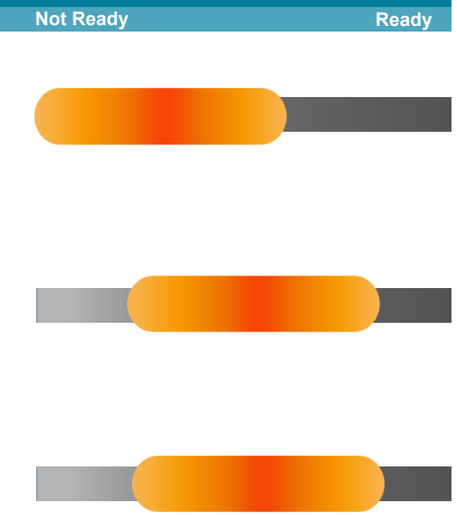
NEEDS

TRANSIT LANES
Specific cooridors such as I-24 East, I-65 South, and Ellington Parkway/Route 386 have the potential to better manage their current infrastructure by sharing lanes to accommodate Freeway BRT and Express Buses.

REAL-TIME INFORMATION
There is need to upgrade publicly-available transit vehicles (including public buses and shared mobility fleets) to be able to transmit their locations and schedules in real-time.

COORDINATED SIGNAL MANAGEMENT
There is a regional need to expand traffic signal timing and management systems to include more key travel corridors and secondary streets, particularly since traffic volumes and travel times are increasing.

LEVEL OF READINESS



DATA SHARING AND PRIVACY

Creating a data backbone

NEEDS

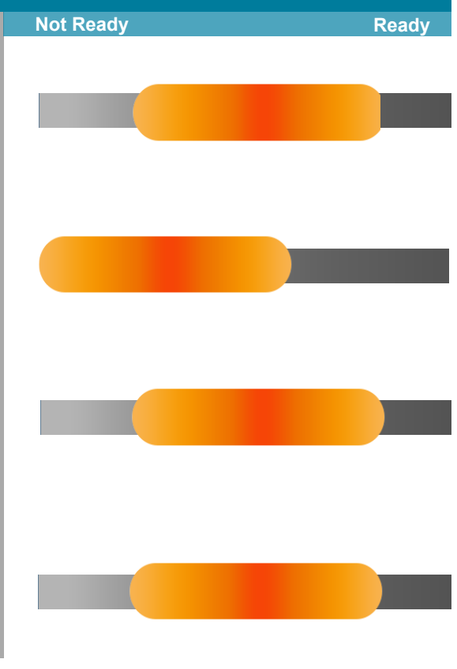
INCREASE DATA SHARING
There is need for focus on increased transparency, coordination with regional planning organizations, and priorotization of providing real-time data.

SENSORS AND DATA
New smart technologies should support adaptable monitoring and traffic control devices/ sensors, and other real-time resources should align with regional plans/policies.

REAL-TIME INFORMATION
New regional policies should emphasize sharing bus arrival times, parking space availability, location of shared mobility vehicles, and requires data from SUMD system operators.

C**YBERSECURITY**
Better anticipation of software vulnerabilities is needed, requiring implementing risk assessment processes that clearly document potential security concerns.

LEVEL OF READINESS



Digital transit wayfinding in New York (Source: NACTO)

Ebikes make short tripes efficient. (Source: Gocycle)

INTEROPERABILITY / COMMUNICATION BETWEEN MODAL NETWORKS

Connecting all forms of travel

NEEDS

SMART TRANSIT
Partnerships are needed between WeGo/ RTA and Transportation Network Company Services (TNCs) to integrate smart mobility capabilities into their services.

STANDARDIZED SYSTEMS
Regional planning efforts recognize the anticipated growth/expansion of smart infrastructure and transportation technology. Future opportunities include:

- Ensure compliance with national and international technology standards
- Enhance digital wayfinding signage
- Provide reliable first/last mile services
- Standardize data formats and syntax to facilitate communication between different software
- Develop apps for access to rideshare services

LEVEL OF READINESS

Not Ready — Ready

SMART PLANNING TOOLS

Working together for success

NEEDS

EXPANDING TRANSPORTATION DEMAND MANAGEMENT (TDM)
Regional planning emphasizes need for more progressive TDM policies and practices that promote smart technology improvements and greater investment in multi-modal transportation networks.

COORDINATED PLANNING
Overall smart planning/TDM efforts must be synthesized and coordinated. This requires facilitation of open-data agreements, recruitment of experienced smart city partners and data management staff, and a technical advisory committee of municipal/state officials and agencies to discuss transit improvements

PARTNERSHIP FUNDING
Transportation initiatives need to be better allocated and sourced, and policies such as the IMPROVE ACT should be utilized to fund public transport and infrastructure.

LEVEL OF READINESS

Not Ready — Ready

STATE OF SMART MOBILITY READINESS

INTERVIEW SUMMARIES

50% of respondents don't share or receive traffic information with other jurisdictions or agencies.

62% of respondents don't have a formal plan or document which identifies their intentions for expanding ITS infrastructure or transportation technology.

50% of respondents don't have transportation data sharing agreements/MOUs with other jurisdictions or agencies.

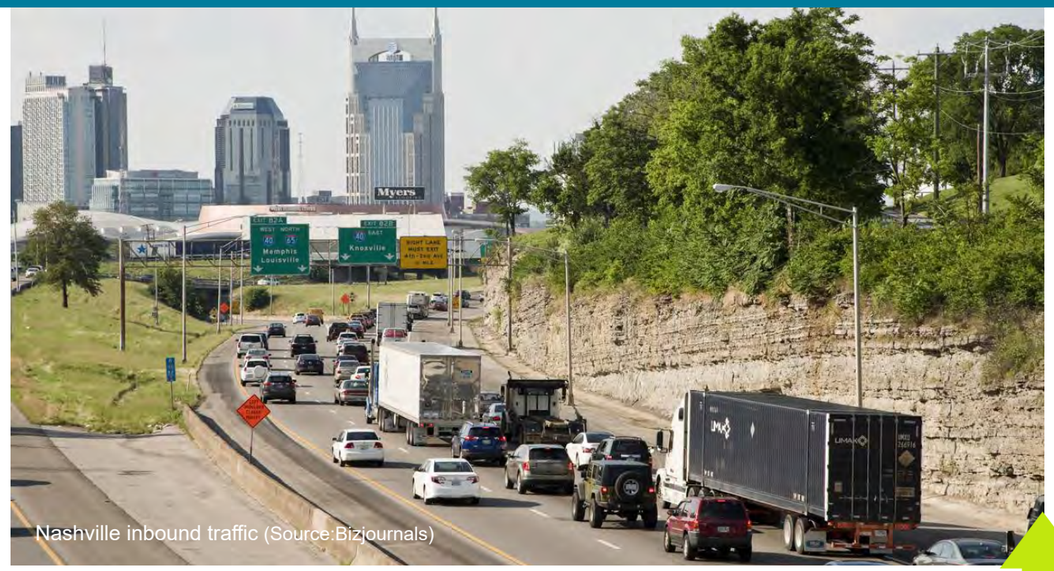
Given pressing challenges in the region, a series of meetings were held during the Fall of 2018 in most jurisdications within each county of Middle Tennessee to discuss local technology strategies and future plans for addressing local mobility challenges. A survey was also distributed to the stakeholders allowing them to self-evaluate where their community was on the smart mobility spectrum and how they compared themselves to peer communities. These interviews and survey results help frame the challenges of integrating smart mobility into the region's transportation systems. Top among these challenges include:

- The **availability of funding,** staffing, education, and clear guidance on next steps is limited, making the right investment decisions difficult.
- Multi-modal mobility as service systems may be a challenge in **areas that are entirely auto-centric.**
- There is great uncertainty in **how quickly the broader population will adapt** to new mobility services.
- Community government, business and civic association leadership need to **improve** and expand their **conversations** around emerging technology and its benefits.
- **Standards and policies** regarding privacy and the collection, sharing and personal data retention **aren't in place**.
- Connected Automated Vehicle (CAV) technologies are met with some interest, but their **immediate benefits** and impact are unclear.
- **Interjurisdictional operability** of smart mobility technologies **is limited** and prioritization along multi-jurisdiction corridors needs better coordination.
- **Collaborative groups** such as Traffic Signal Controllers and the IT Directors Roundtable **may provide great benefits** to the region.

Few local plans included specific recommendations related to smart mobility. Instead, many are focused on increasing options for people who walk and bike, managing development smartly, and improving regional transit. Many local initiatives are looking to expand transportation options beyond the private vehicle, with a focus on "efficient" options.

- The city of Gallatin is one of the few places that includes initiatives related to smart signal technology as well as innovative transit service through something like a "flex bus." Other communities that mention traffic signal coordination include Brentwood, Hendersonville and Nashville.
- Nashville and Franklin were the only cities with plans mentioning expanding electric vehicle (EV) charging infrastructure.
- Nashville's plans are the most advanced local plans related to smart technology, with a focus on managing traffic congestion through ITS as well as flexible travel lanes for private vehicles and transit.
- There is a clear focus on data standards and sharing, not only for regional coordination but to expand travel information to the public through apps, real-time information, and signage. This also includes safety and security regarding this data.
- There is a regional focus to reconsider roadway space and how adaptable lanes and technologies could support efficiencies for inserting modes other than the private vehicle.
- Parking also emerged as an area of focus for using technology to improve efficiency.

Discussions with local jurisdictions revealed a number of potential opportunities for improvements and collaboration around Smart Mobility.



Nashville inbound traffic (Source:Bizjournals)

COMMUNICATION

The Greater Nashville Region already has vast amounts of **fiber optic communication** in place along with some pockets of cellular communication.

Communication is key in communities preparing for Smart Mobility. Communication is required for real-time information processing and, subsequently, reliable traveler information. Furthermore, fiber optic communication, specifically, will become more and more important as **bandwidth needs increase** due to larger amounts of data acquisition along with the increased number data collection devices deployed.

Where deployment of fiber optic communications is cost-prohibitive, **fiber-sharing agreements** should be explored with telecoms and public utilities. **Right-of-way policies** could require a specific number of fiber optic buffer tubes be provided to the local transportation department with the permitting of new cable by a private utility in public rights-of-way.

RIGHT-OF-WAY MANAGEMENT

As the population and traffic continues to grow in the Greater Nashville Region, the number of traffic signals continues to grow. With the growth of the traffic signal systems, many communities have begun investing in **Advanced Traffic Management System (ATMS) software**. With a common platform being utilized in much of the region, there is opportunity for sharing data and system status with neighboring communities.

The deployment of ATMS software and expansion of connected traffic signals has enable a number of communities to implement a **Traffic Operations Center** to be able to more-efficiently adjust signal timings, monitor traffic conditions, and provide traveler information to motorists.

Upgraded traffic signal controllers and detection systems are also providing more flexibility to Traffic Engineers when timing corridors, improving overall system operations.


Traffic Operations Center in Knoxville (Source: TDOT)

ROADSIDE DEVICES

Roadside devices are of growing interest in the Greater Nashville Region.

While, currently, only Brentwood and Nashville have installed permanent installations of **Bluetooth data collection units**, there is strong interest throughout most of the region to use the technology to have a better understanding of travel patterns, travel times, and incident management characteristics.

From a connected vehicle perspective, there are several agencies in the process of **deploying DSRC along freeways and at traffic signals**. These devices will be used to display Signal Phasing and Timing information to drivers, provide real-time traveler information to drivers, and alert TOCs of incidents in real-time to provide faster response times.

Many agencies emphasized that privacy concerns exist with these technologies and steps have been and are being taken to **“anonymize” data** so that drivers cannot be tracked and their personal information cannot be logged in a database.

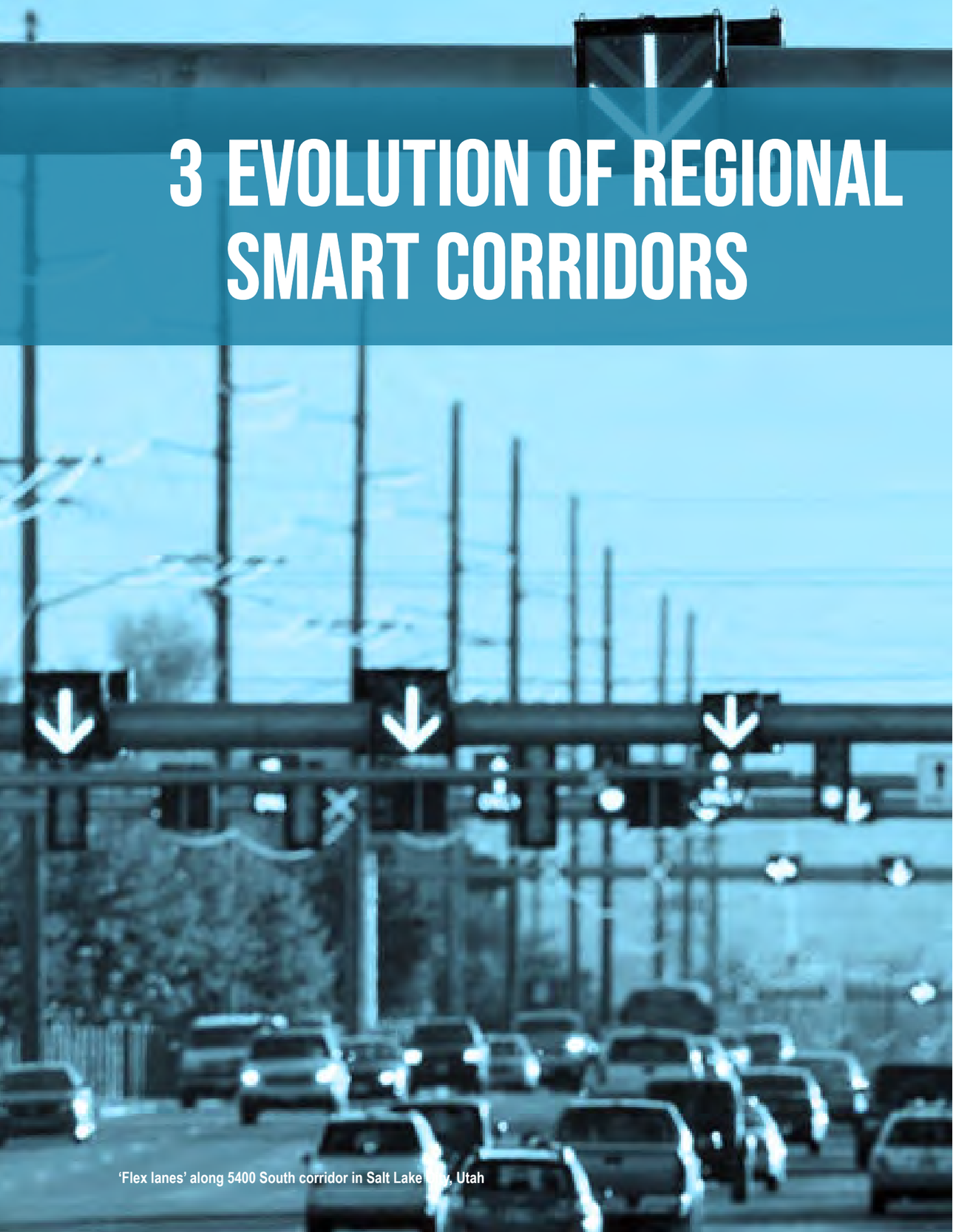
TRAFFIC OPERATIONS CENTERS

Nashville, Brentwood, Franklin and Murfreesboro have existing Traffic Operations Centers and additional ones are planned for Smyrna and Hendersonville.

TOC’s play an important role in **monitoring traffic incidents and congestion** along the roadway. Both Franklin and Nashville have dedicated staff monitoring the traffic during the day and in peak traffic times. None of the TOC’s have direct connection to the TDOT Traffic Management Center in Nashville; however, all have informal working arrangements when needed to communicate. While this is working today, some jurisdictions expressed some interest in having a **more formal communication protocol**.

As the technology in the region grows the TOC’s will play an important role in keeping the traffic moving smoothly along the main arterials connected to the interstates.

3 EVOLUTION OF REGIONAL SMART CORRIDORS



'Flex lanes' along 5400 South corridor in Salt Lake City, Utah

CREATING CONNECTED CORRIDORS

While local and regional planning efforts related to smart mobility have not yet matured, this assessment has revealed that **inter-jurisdictional coordination and collaboration is critical.** Given the interdependencies that local jurisdictions along many of Greater Nashville's primary travel corridors share there must be a focus on making these corridors integrated in order to make Smart Mobility successful in the region. There is no better time than right now to begin fostering necessary partnerships, data sharing agreements, and interconnected communications.

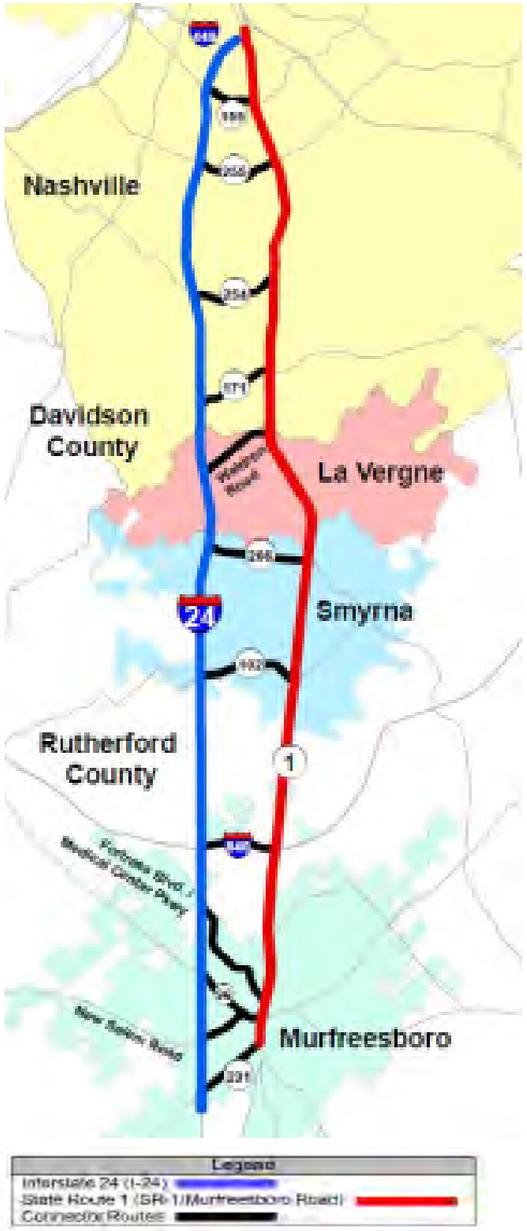
Transportation corridors often contain underutilized capacity in the form of parallel roadways, single-occupant vehicles, and transit services that could be better leveraged to improve person throughput and reduce congestion. Facilities and services on a corridor are often independently operated, and efforts to date to reduce congestion have focused on the optimization of the performance of individual assets.

THE I-24 SMART CORRIDOR

TDOT is leading the way with the implementation of the I-24 Smart Corridor using Integrated Corridor Management (ICM). The vision of ICM is that transportation networks will realize significant improvements in the efficient movement of people and goods through institutional collaboration and aggressive, proactive integration of existing infrastructure - including technology - along major corridors. Through an ICM approach, transportation professionals manage the corridor as a multimodal system and make operational decisions for the benefit of the corridor as a whole.

I-24 PURPOSE AND NEED

Interstate 24 (I-24) is an integral part of the Nashville regional transportation network and a major route for commuters and freight. Traffic volumes along this corridor have experienced exponential growth in recent years. Since 2005, traffic volumes have increased by more than 60 percent in Murfreesboro- Rutherford County segments of I-24. To respond to this increased traffic demand, the Tennessee Department of Transportation (TDOT) has initiated an Active Traffic Management Pilot Project along the I- 24 corridor, named the I-24 SMART Corridor, in partnership with the local agencies to integrate freeway and arterial roadway elements. The I-24 SMART Corridor Project serves to develop, implement and deploy a comprehensive systems management strategy that will monitor and control traffic; share information with the public; improve system and travel time reliability, and improve the safety, efficiency, maintenance and operations, and mobility of all users.



PROJECT LIMITS

The project limits for the I-24 SMART Corridor include:

INTERSTATE 24 (I-24)

approximately 28 miles along I-24 from Exit 53 (Interstate 440) in Metropolitan Nashville-Davidson County to Exit 81 (State Route 10 I US Route 231) in the City of Murfreesboro.

STATE ROUTE 1 (SR-1/MURFREESBORO ROAD)

approximately 28.5 miles along SR-1 from I-24 in Metropolitan Nashville- Davidson County to SR-10 I US-231 in the City of Murfreesboro.

CONNECTOR ROUTES

The project boundaries include approximately 30 miles of connector routes between I-24 and SR-1.

I-24 SMART CORRIDOR PROJECT PHASES

PHASE 1: SHORT-TERM DEPLOYMENTS
(Planning level cost estimate: $37 million)

Physical Improvements

- Selective Gap Closure of Communications Network (12,000 LF)
- Ramp acceleration/Deceleration Lane Extensions (7 Locations)
- Emergency Refuge Areas/Pull-offs (14 Locations)
- Roadside Traveler Information Portals (RTIPS) (38 Locations)

Hardware/Software Improvements

- Dedicated Short-Range Communication (DSRC) Deployment (162 Locations)
- Arterial Signal System Upgrades (113 Signals)
- Signal Timing Optimization of Select Roadways (113 Signals)

Operational Improvements

- Incentivized Towing Operations on I-24 Corridor
- Improve Operation Coordination for Incident Management
- Update TDOT Traffic Management Center (TMC) Procedures

PHASE 2: INTERMEDIATE DEPLOYMENTS
(Planning level cost estimate: $20 million)

Physical Improvements

- Improving Lane Widths Along I-24 (Davidson County)
- Ramp Metering
- Completion of Communications Network

Hardware/Software Improvements

- Adaptive Signal Control Technology (ASCT) Deployment

PHASE 3: LONG-TERM DEPLOYMENTS
(Planning level cost estimate: $20 million)

Physical Improvements

- Install overhead DMS for Active Traffic management System
- Bus on Shoulder (BOS)/Hard Shoulder Running

Hardware/Software Improvements

- Implement Software for Active Traffic Management for Dynamic for Speed/ Lane/Merge Control, Speed Harmonization, and Decision Support System

Operational Improvements

- Integrated Staffing/Maintenance/Operations Plan
- Center-to-Center (C2C) Communications

I-24 SMART CORRIDOR IMPROVEMENT EXAMPLES

SHORT-TERM EXAMPLES

Physical Improvements

- Gap closure of communication network
- Emergency refuge areas/pull-offs
- Roadside traveler information portals (RTIPS)

Hardware/Software Improvements

- Dedicated Short-Range Communication (DSRC) deployment
- Arterial system upgrades and timing optimization

INTERMEDIATE EXAMPLES

Physical Improvements

- Completion of communication network
- Ramp metering

Hardware/Software Improvements

- Adaptive Signal Control Technology (ASCT) deployment

LONG-TERM EXAMPLES

Physical Improvements

- Install overhead DMS for active traffic management system
- Bus on shoulder (BOS) / hard shoulder running

Hardware/Software Improvements

- Implementation software for active traffic management for dynamic for speed/lane/merge control, speed harmonization, and decision support system

FUTURE SMART CORRIDORS

Beyond I-24, the region has six additional corridors that have been identified as priorities for potential smart mobility improvements. All seven corridors have been inventoried as part of the smart mobility assessment for their technology features, including traditional “isolated” traffic signals with and without vehicle detection, coordinated signals working as a system, connected signals that are physically linked by fiber optics or radio to each other and traffic operations centers, traffic and safety cameras, traffic flow sensors, dynamic message signs, reversible travel lanes, electric vehicle charging stations, smart parking meters and more. Each corridor has the potential to better address many of the mobility needs identified by the region.

EAST CORRIDOR

The East Corridor consists of routes through Nashville, Mt. Juliet and Lebanon and includes roadways such as I-40, Lebanon Pike (Hwy 70), Briley Parkway, Donelson Pike, connector route 109, North Mt. Juliet connector route, and South Cumberland Hwy 231. Several roads have coordinated signals. Nashville’s operating TOC monitors this corridor, but no other TOC’s are currently planned for Mt. Juliet or Lebanon.

CENTRAL CORRIDOR

The Center Corridor comprises the I-440 loop around Nashville. This loop has a wide range of signals with various levels of technology integration, and a variety of smart mobility systems operate nearby on local streets, which have the potential to communicate with each other and travelers in the future.

NORTHEAST CORRIDOR

The Northeast Corridor consists of routes through Nashville, Goodlettsville, Millersville, Hendersonville and Gallatin, including I-65, Dickerson Pike (Highway 31W), Gallatin Pike South, Ellington Parkway, Vietnam Veterans Blvd., and East Main St./Nashville Pike (Hwy 31 E). Some coordinated signals exist in this corridor, but none communicate with adjoining jurisdictions. Nashville’s operating TOC monitors this corridor and both Hendersonville and Gallatin have TOC’s planned between 1 and 5 years.

SOUTH CORRIDOR

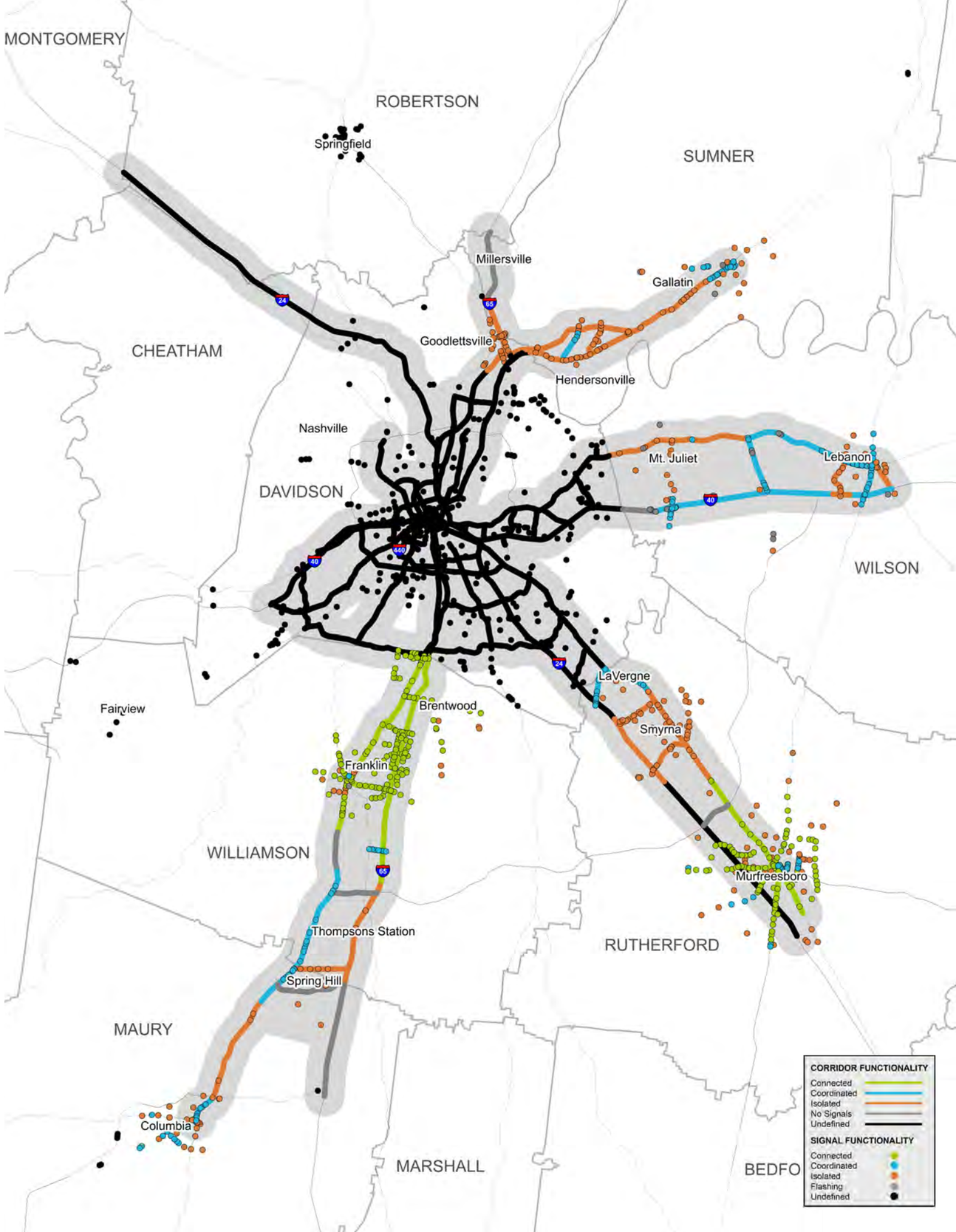
The South Corridor includes I-65 and routes connecting Nashville, Brentwood, Franklin, Thompsons Station, Spring Hill and Columbia. Other roadways include Hwy 31, Concord Road, East Church Street connector route, Duplex Road, I-840, and Saturn Parkway). Several segments host coordinated and/or connected signals, they do not share signal data between jurisdictions. Nashville, Brentwood and Franklin have active TOC’s that monitor this corridor.

SOUTHWEST CORRIDOR

The Southwest Corridor is the southwest side of Nashville including parts of I-40W and I-65S, Old Hickory Blvd, Harding Pike (Hwy 70), Briley Parkway (Hwy 155), Hwy 431, and Charlotte Pike (Hwy 70). A variety of signal technologies exist throughout this corridor.

NORTHWEST & SOUTHEAST CORRIDORS

The Northwest and Southeast Corridors include the I-24 Smart Corridor segment (see previous pages) connecting Clarksville through Nashville to Murfreesboro. TOC’s for this corridor exist in Nashville, Smyrna and Murfreesboro. In addition, Smyrna houses a large data center servicing the area.



NEXT STEPS

SUGGESTED OPPORTUNITIES

Greater Nashville's smart mobility corridors will evolve over time using many of the technologies which are in place today. While many additional technologies are still emerging, some opportunities exist which can be implemented today.

1.

RAMP METERS

Ramp meters are installed to help cars merge onto freeways smoothly and safely. Ramp meter hours are typically during commute times and as traffic conditions dictate on weekends.

2.

DYNAMIC MESSAGE SIGNS

Dynamic message signs are off unless congestion or incidents occur. Then, features such as colored arrows, X's and advisory speeds are shown. These signs can also report travel times and emergency information.

3.

ELECTRONIC TRAILBLAZER SIGNS

Local DMS on parallel arterials ("Trailblazer" signs) can activate to help cars navigate around congestion or an incident on the freeway to detour around traffic.

Vehicles wait at a ramp meter that helps control traffic flow in busy or unsafe conditions

4 BEST PRACTICES IN SMART MOBILITY

The Capital Metro pilot of a smart and electric 'Weekend Shuttle' in the Austin, TX area

VALUABLE LESSONS FROM OTHER CITIES

While this Assessment is focused on smart mobility, it is important to note that smart mobility is a subset of the larger smart city ecosystem. No matter the size of the city, **collaboration across all departments** is critical for enhancing planning efficiency and daily operations; generating revenue; and providing a sustainable, resilient working and living environment for all citizens. Cities are complex organizations, with numerous departments in charge of a wide range of essential functions such as transportation, sanitation, utilities, land usage, housing, security, and more. Operational and data fragmentation across these departments can significantly impede a city's ability to deliver services to its citizens and is a **huge source of increased costs.** Elimination of data fragmentation decreases community costs for personnel effort to manually fuse datasets in response to public inquiries for information. This allows for retraining of community personnel with valuable new skills to more efficiently serve the public.

The implementation of smart city and smart mobility solutions is still in its early stages globally; however, many valuable best practices can be studied from several of the cities who have begun testing and implementing solutions. Although the deeper dive in this section is focused on cities that are peers or comparable to the Greater Nashville Region – Columbus, OH, Pittsburgh, PA, San Francisco, CA, Austin, TX, Charlotte, NC, and Seat Pleasant, MD – it is important to recognize many other good examples of smart cities across the globe.

Multimodal transportation center in Atlanta (Source:Mollie Simon)

SMART REGIONS of all sizes are implementing a wide variety of smart mobility practices to address specific regional needs.

Autonomous shuttles in Las Vegas (Source: The Verge)

BOSTON
4,770,000
MSA population

- "Radically programmable" city streets with dynamic markings that can change from loading zones to thoroughfares to spaces for street hockey, depending on the time of day and season

SEATTLE
3,740,000
MSA population

- Shared data to provide dynamic routing for truck traffic, off peak, and overnight deliveries and to enable car share operators to deliver packages.*

LAS VEGAS
2,110,000
MSA population

- New connected autonomous shuttles transport workers to Las Vegas Boulevard, and new solar powered electric vehicle charging stations help reduce emissions.*

DENVER
2,800,000
MSA population

- One-card payment system
- Interactive kiosks*
- First/last mile pilot with Lyft partnership*
- Electric buses*
- Intelligent freight with DSRC
- Adaptive signal control integrated with smart ramp metering
- GoDenver app

DALLAS
6,300,000
MSA population

- Smart LED streetlights*
- Smart Parking
- Digital kiosks*
- Environmental/ pedestrian sensors*
- Public Wi-Fi

NASHVILLE
1,830,000
MSA pop.

ATLANTA
5,700,000
MSA population

- A network of multimodal transportation centers serving as hubs for mobility, economic development, and community activity.

NEW ORLEANS
1,260,000
MSA pop.

- Dynamically-routed on-demand minibuses provide affordable first/last mile transportation options to underserved communities.

DETROIT
4,300,000
MSA population

- Partnerships with industry leaders in the automotive and technology fields and academic institutions helps provide access to electric car shares, automated shuttles, and on-demand delivery trucks through integrated mobility apps.*

(Source: Metropolitan Statistical Area ACS population estimates for 2013-2017)

*Denotes completed project or effort

Rendering depicting Panasonic's partnership with Denver to build a smart city (Source: Linkkein)

SMART CITIES connect infrastructure, transportation, utilities, and information for a cohesive and sustainable network of systems.

(Image Source: SmartCitiesWorld)

BEST PRACTICE CASE STUDIES

In this task we investigated different cities' transportation goals and the smart mobility solutions/strategies they developed to achieve their goals. Although the cities were diverse, they faced similar mobility challenges including:

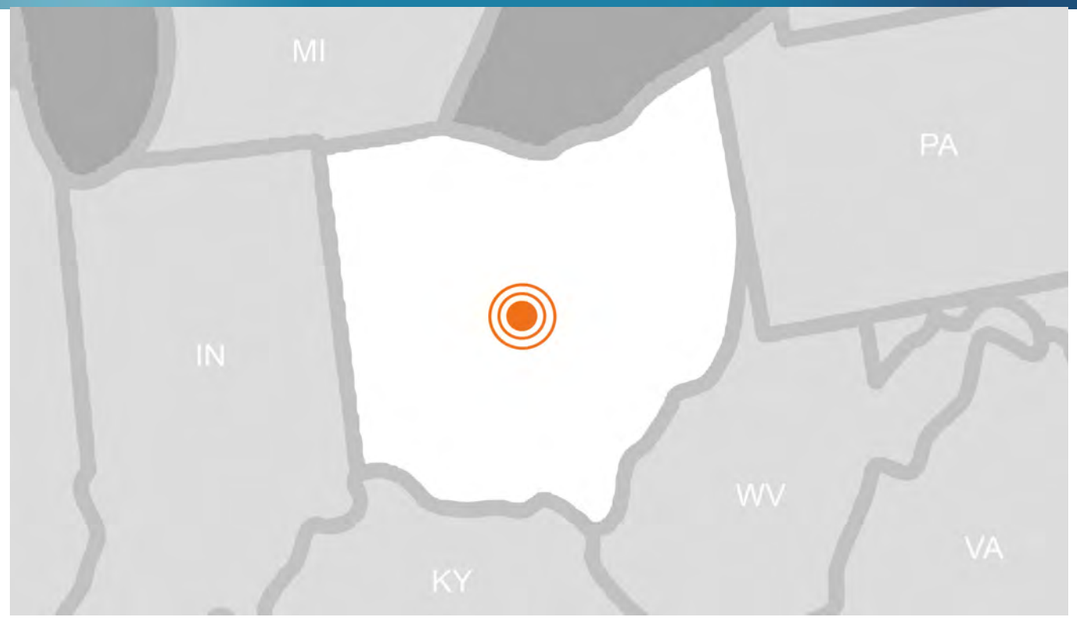
- **Connecting underserved communities** to employment opportunities by providing first-last mile solutions for transit users
- Using a **unique data collection system** across different entities and sectors
- Reducing greenhouse gas emissions
- **Improving the efficiency of the parking system**s (and payment systems)
- **Improving freight mobility**
- **Optimizing traffic flow** on congested freeways and arterials.

Depending on the cities' goals and needs, the solutions ranged widely: from using shared automated vehicles to launching curb space management systems and technologies. Most of these cities have ongoing smart cities programs that span multiple years. The general rule is 3-5 year programs and many were started in or around 2015.

COLUMBUS, OH

HIGHLIGHTS

- **Columbus's web-based data delivery platform, Smart Columbus Operating System (SCOS), will facilitate improvements in transportation and human services by sending and receiving data with transportation systems throughout the Smart Columbus area.**
- **Event parking management will be streamlined by integrating data from multiple providers into a single app showing availability and services.**
- **Access to multimodal transportation services will be streamlined through an app that will include a common payment system.**
- **Other apps will help people with cognitive disabilities to independently use the transit system and will assist pregnant women to find transportation to prenatal care appointments.**



The City of Columbus has made a goal to reduce infant mortality, to cut the health disparity gap, and to create more equitable access to safe transportation by 2020. Smart technologies will be used to achieve this.

The process of "becoming smart" will happen through the **Smart Columbus Operating System** (SCOS), a web-based, dynamic, governed data delivery platform that will serve as the technological backbone of the all current and future smart city projects. It will send and receive data with new transportation systems within the Smart Columbus area including multi-modal services and Connected Automated Vehicles (CAV). Personally Identifiable Information (PII) will be ingested and filtered through the Data Curator, then forwarded to the SCOS, where data from multiple sources can be accessed. The data stored in the SCOS will include the Smart Columbus demonstration projects, traditional transportation data, and data from other community partners, such as food and medical services. The data created by each of the abovementioned systems will be anonymized, de-identified, aggregated and stored by the SCOS for analysis and visualization. All these interrelated systems create a System of Systems (SoS), which is enabled by the SCOS to share data with external travelers and systems.

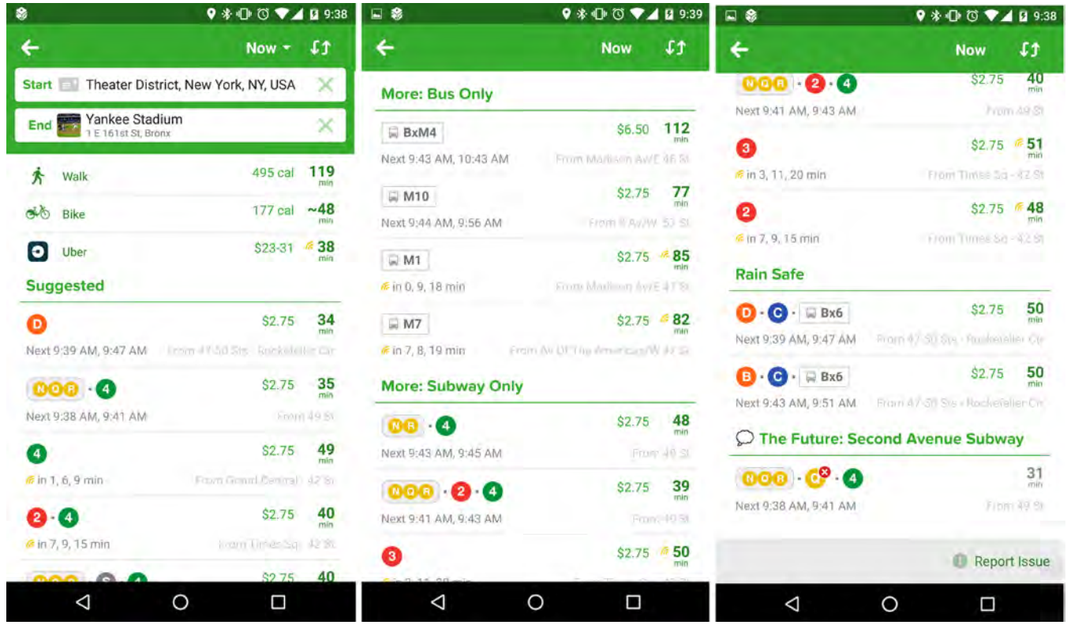
The City will connect underserved neighborhoods to jobs and services by creating a **smart corridor** that will improve bus rapid transit service (BRT). The corridor will feature smart traffic signals, smart street lighting, traveler information and payment kiosks, and free public Wi-Fi. Six electric autonomous shuttles will be deployed to increase the access of the BRT system to additional retail and business centers. A connected vehicle environment will improve safety and mobility throughout the city's transportation system using Connected Vehicle applications that focus on congested and high-crash intersections and corridors.

A suite of apps will enhance and streamline access to multi-modal transportation options. A **multimodal trip planning app with common payment system** will create a connected platform to improve accessibility to multimodal options for all. The platform integrates various transportation services like public transit, parking, bike-sharing, carsharing and ride hailing services all in one application, like the **Citymapper app**. The payment for multiple transportation system will also be facilitated by creating one common platform. This app is being used in 39 cities.

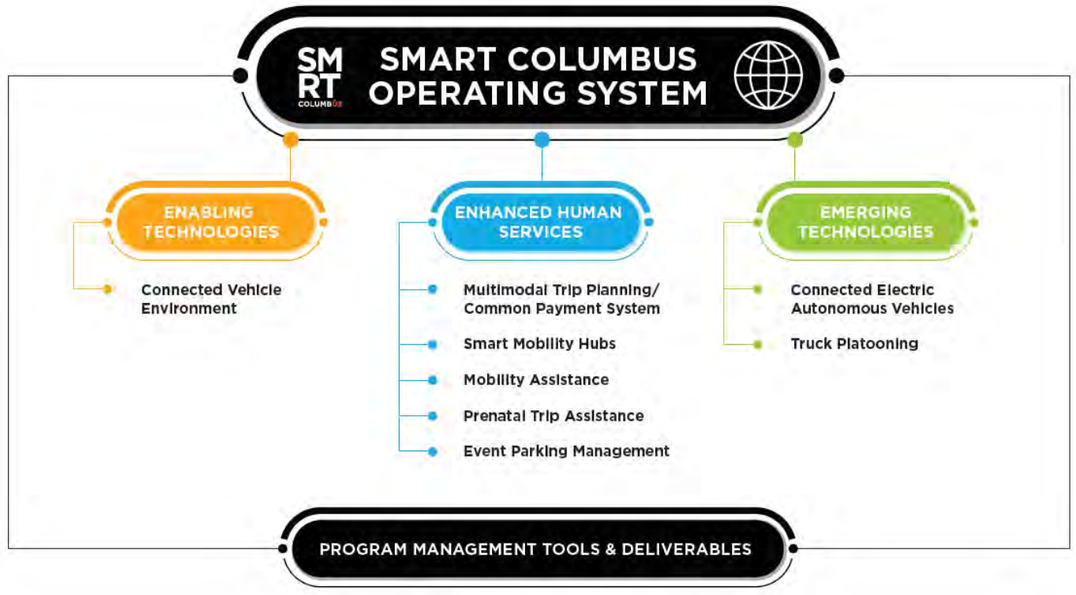
Mobility assistance for people with cognitive **disabilities and the elderly** will be provided through a mobile application that has an accurate, turn-by-turn navigator allowing people to travel easily and independently. **Prenatal trip assistance** will reduce Columbus' high infant mortality rate by helping expectant mothers get to prenatal care and integrating scheduling, transportation, and payment into one platform.

Smart technology will also be used to improve the flow of transportation and parking. WiFi-enabled **Smart Mobility Hubs** will be created to allow bus travelers to smoothly and easily access the next leg of their trip. Event parking management will **integrate parking information from multiple providers** (garages, surface lots and parking meters) into a single availability and reservation services application. Freight operations will be improved by truck platooning, which will utilize wireless communications to help trucks reduce their headways on freeways.

The Citymapper App is being used in 39 cities to offer mobility options by mode, journey time, and cost through one platform (Source: Citymapper)



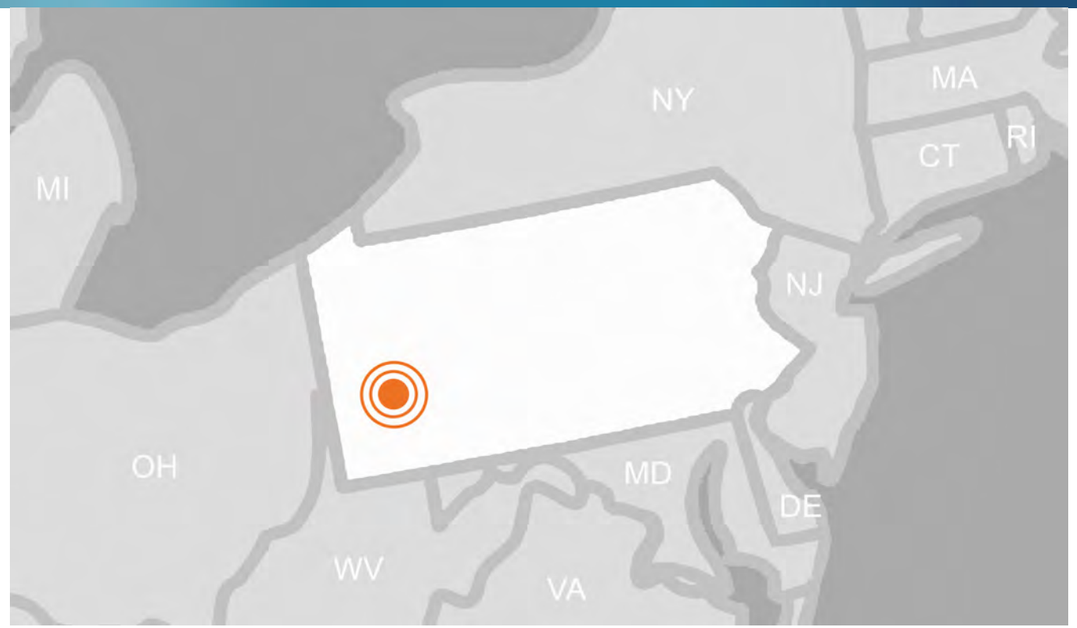
The Smart Columbus Operating System framework is being used to empower and enable mobility projects in the city (Source: City of Columbus)



PITTSBURGH, PA

HIGHLIGHTS

- **The Scalable Urban Traffic Control Program (Surtrac) optimizes traffic signal operation to reduce waiting time, congestion, and pollution.**
- **Up to 40,000 new smart streetlights equipped with sensors will further optimize traffic flows by integrating with Surtrac and will increase safety for all transportation modes, especially cyclists and pedestrians.**
- **Steps to facilitate the interoperability of new and existing transportation, public safety, environmental, and other data will improve transportation operations. Travelers will have access to real-time information on their travel options and will be able to share data with the City, further improving the system's information**



Pittsburgh is burdened by high air **pollution** levels, causing serious **health and social impacts** in the region. The city aims to halve transportation emissions by 2030 through its **Smart PGH approach**, which involves deployment of smart technology such as traffic signals, street lighting, and electric vehicles.

One of the successful solutions implemented in Pittsburgh is the **Scalable Urban Traffic Control Program (Surtrac)**, the world's first decentralized real-time adaptive traffic signal system designed specifically for urban areas. Surtrac is an innovative approach to real-time traffic signal control utilizing artificial intelligence and traffic theory. It optimizes the performance of traffic signals improving traffic flow for both urban grids and corridors and leading to less waiting, reduced congestion, shorter trips, less pollution, and happier drivers. The software was developed Carnegie Mellon University Robotics Institute and is currently being tested in a pilot area and eventually connect it to major job and transit centers. Dedicated Short-Range Communication (DSRC) units will be installed on twenty-six continuous intersections. Based on one study, Surtrac implementation reduced aggregate waiting time at intersections by 40% and decreased vehicle emissions by 21%.

The city will also convert up to **40,000 street lights to LED along the Smart Spine.** These smart lights will be equipped with sensors to collect and transmit data, improving safety for all modes, particularly walking and cycling. The lights' detection technology can be integrated with the Surtrac to further optimize traffic flows. Some origins and destinations between signalized intersection that cannot be detected by Surtrac will be detected by the streetlight sensors. For example, traffic exiting a parking garage after a large event can significantly impact traffic at surrounding intersections. Streetlight sensors can collect this data and send it to the surrounding signal controllers to optimize traffic flow. These smart streetlights will provide energy savings of 60% while also monitoring local air quality.

SmartPGH will enhance Pittsburgh's open data capabilities through an **open data ecosystem** called **Data Utility**. This will create **standards of interoperability** for data transmission:

1. from the data collection source to the network;
2. from the network to a location for archiving, anonymizing, and organization; from the storage location to the broader internet and to the public;
3. for public-sector focused application development, including both internal decision-making tools and publicly accessible applications.

The Western Pennsylvania Regional Data Center (WPRDC) will serve as a public data portal. Although the datasets currently available are generated by the City and County, the WPRDC will eventually host transportation datasets owned by Consortium partners.

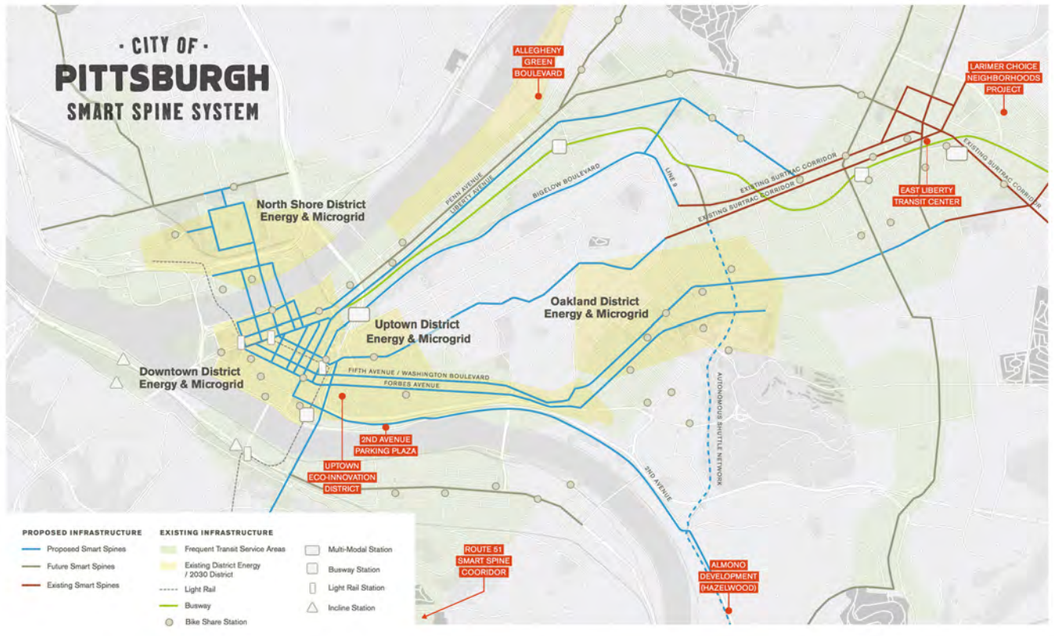
The data is currently hosted on the City's servers: as more data becomes available, the City and SmartPGH Consortium partners will secure additional capacity. Both the public and industries will have a single portal for all Consortium data. As a result of the SmartPGH deployment, new data will also be accessible along with existing data on public safety, the environment, and other topics.

This data will be made available for decision-making through apps developed by the Carnegie Mellon University's Mobility Data Analytics Center (MAC). **MOVEPGH** is one of the City's first high priority **applications**. It will provide **real-time traveler information** to residents and visitors. Travelers will be able to view comparable transportation options such as taxi, bikeshare, biking, walking, and driving and parking. The options will be compared based on real-time travel time, carbon emissions, construction detours, safety, and condition of travel paths (side walk presence/condition). Users will be able to choose to record their trips and provide the City with the mobile sensors for pedestrian, cycling and vehicular movements. The MAC will also help the City and the Pittsburgh Parking Authority expand its existing dynamic pricing pilot program from 400 to thousands of spaces along the **Smart Spine neighborhoods.**

The Western Pennsylvania Regional Data Center (WPRDC) is a public portal that will grow and evolve as its partners contribute additional datasets (Source: WPRDC)

City of Pittsburgh	Pittsburgh Parking Authority	Allegheny County Port Authority	Pittsburgh Downtown Partnership	Southwestern Pennsylvania Commission	Bike Pittsburgh
• Bicycle Lane Usage Counts • Paving Schedules • Scheduled Closings	• Parking Utilization by Zone • Garages & Lot Capacity • Garage Capacity & Real-Time Usage • Permit Parking Areas & Schedules	• Real-Time Bus Locations • Bus Routes • Bus Stops/ Schedules • Ridership Statistics	• Commuter Survey • Events	• Traffic Counts • Population & Employment • Forecasts • Traffic Models & Outputs	• Recommended Routes • Bike Racks • Recommended Service Areas

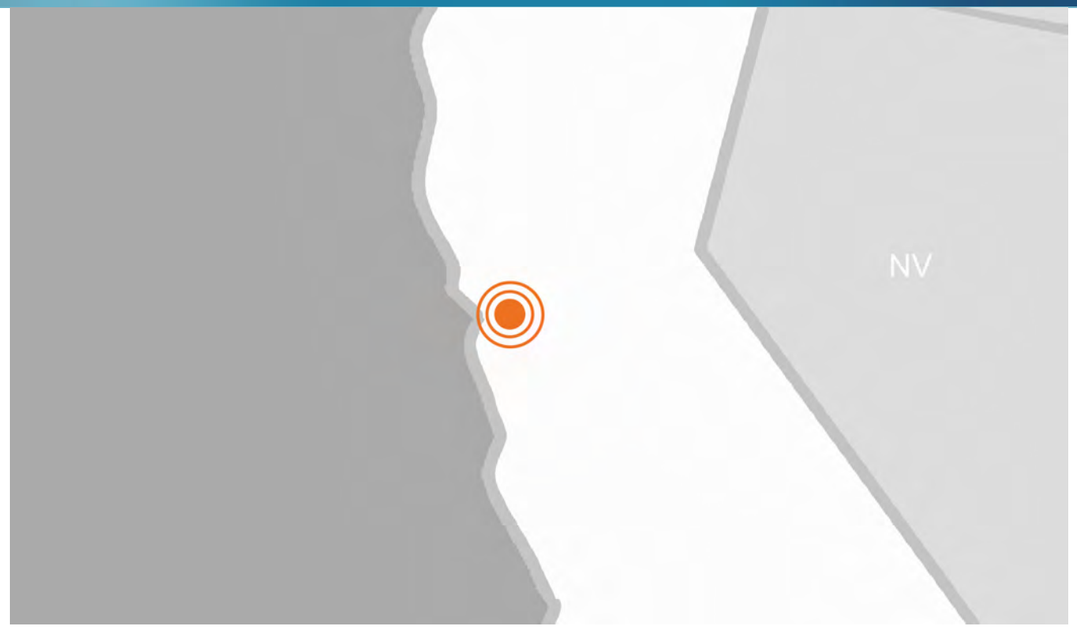
The City of Pittsburgh Smart Spine System comprises a large-scale smart strategy of improvements at 126 intersections along 8 key corridors (Source: Southwestern Pennsylvania Commission)



SAN FRANCISCO, CA

HIGHLIGHTS

- **San Francisco is using smart technology to enact its Share-Electric-Connected-Automated vision to reduce single-occupancy vehicle trips, transportation emissions, and collisions.**
- **SFpark is a parking system that uses sensors for demand-responsive pricing and helps drivers find available spaces. The pilot has successfully reduced greenhouse gases and miles traveled by drivers searching for parking and has freed up valuable curb space.**

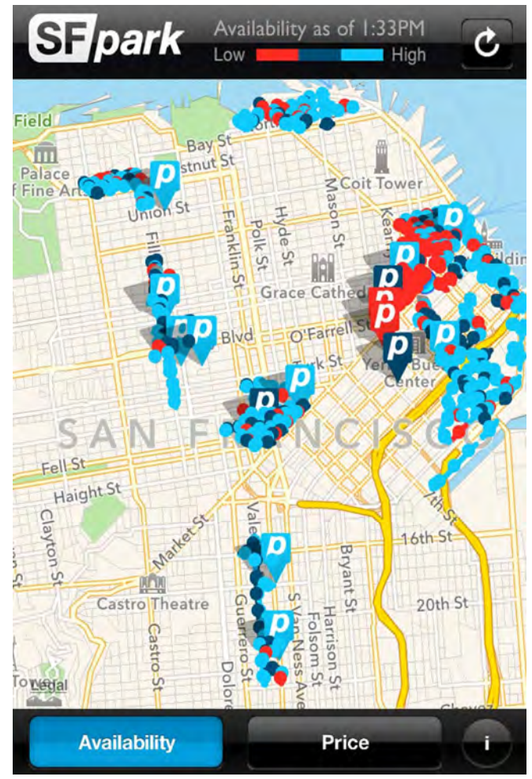


San Francisco is one of the world's hubs for innovation and is the birthplace of ride-sharing and car-sharing companies. The city's success has created more congestion. Although **more than half of trips in San Francisco use public transportation, walking, biking, and trip-sharing, there are still too many people who use personal vehicles to get around**. The city's vision is to make and promote shared transportation options so that people of all backgrounds can access affordable, safe, clean, and reliable transportation without needing to own a car. The goals are:

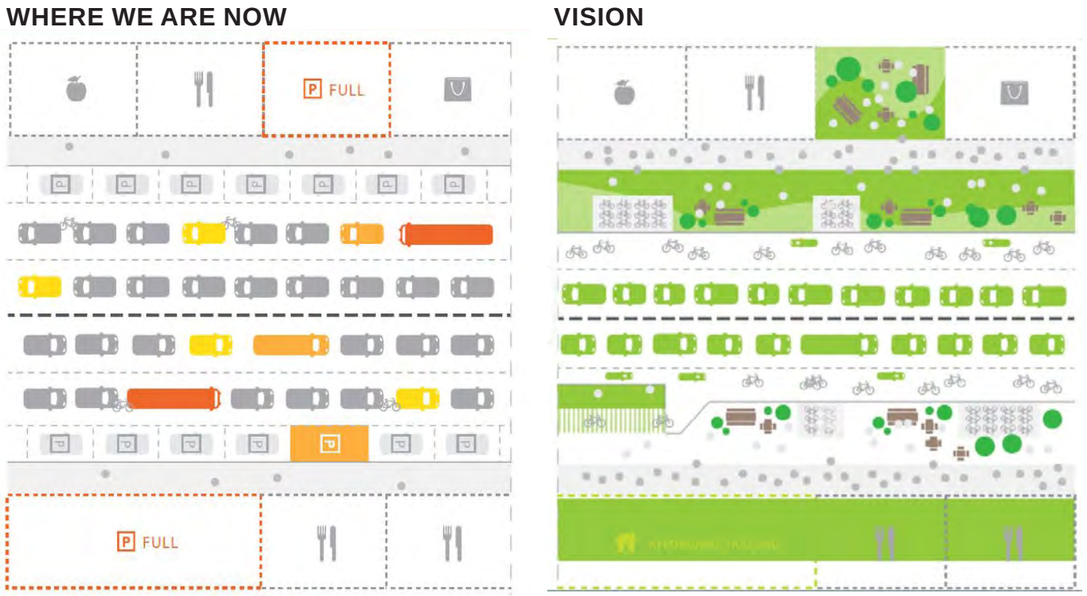
- Shifting up to 10% of single-occupancy vehicle trips to transit, shared, and active modes
- Reducing transportation emissions by 10% through electrification and demand management
- Reducing collisions and fatalities by 10% by **leveraging Vison Zero investments**
- Reducing the share of lower-income residents' household income on transportation by 10%
- San Francisco's approach to reach the goals is a three-tiered approach (regional, city and neighborhood) using a Share-Electric-Connected-Automated (SECA) vision and micro-level pilots.

One successful smart solution is **SFpark**, a parking system with demand-responsive pricing capability. SFpark uses wireless sensors to detect parking-space occupancy in metered spaces and determine the right price for parking in real time. Travelers receive the feedback on their cellphones on the closest available parking spot. SFPark was created to reduce the time people spend looking for parking, which could delay transit and block bicyclists. Parking rates are adjusted so that they are never too low to be occupied all the time or too high to leave a lot of spaces empty. Based on one study, SFPark has helped reduce 30% of greenhouse gas emission and miles traveled in the pilot area. By reducing congestion and freeing up valuable curb spaces, the City ultimately aims to increase the utilization of its curbs by integrating other modes and uses. For instance, **SFpark has helped enable the spread of commercial parklets,** which provide bike parking, restaurant space, and improved walking environments that help reduce driving.

The SFpark app demand-responsive pricing provides options at user's fingertips
(Source: SFpark)

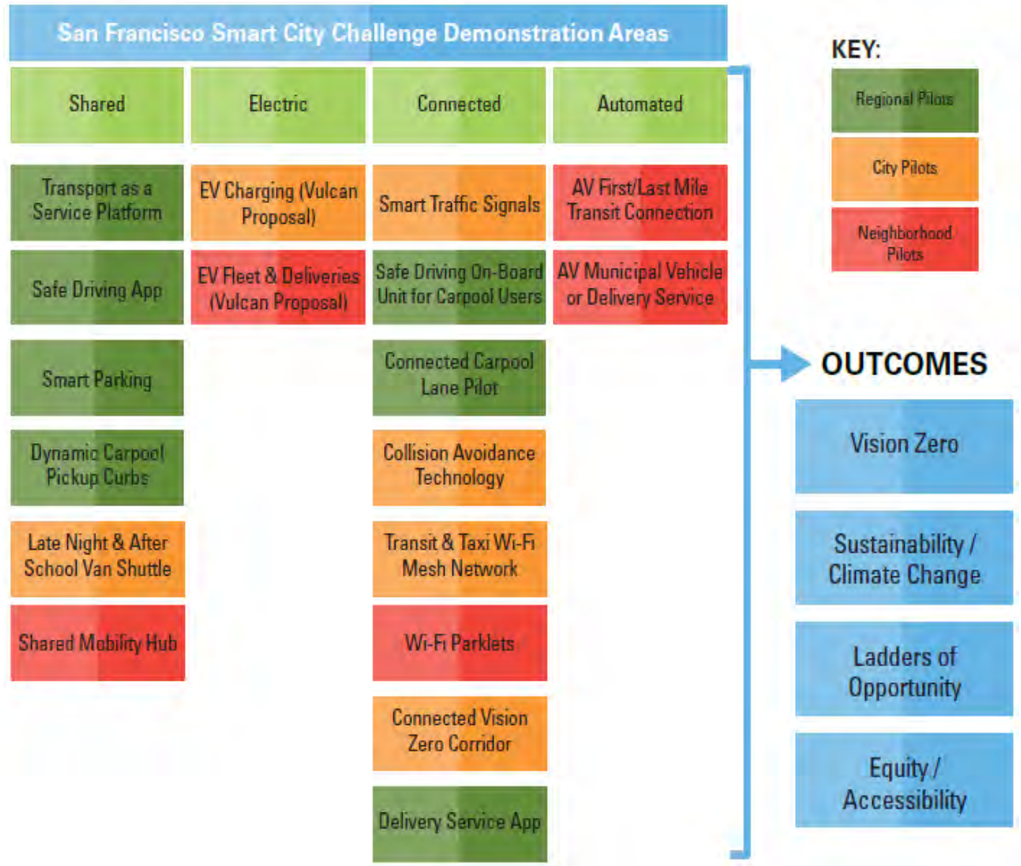


The San Francisco Share-Electric-Connected-Automated vision outlines a plan for measuring success of a vision towards less single-occupancy vehicles (Source: SFMTA)



These graphics demonstrate a future scenario that maximizes spaces currently occupied by parking. These stagnant, single-use spaces can be used instead to support safety and movement of alternative forms of transportation while also beautifying the area with public green spaces.

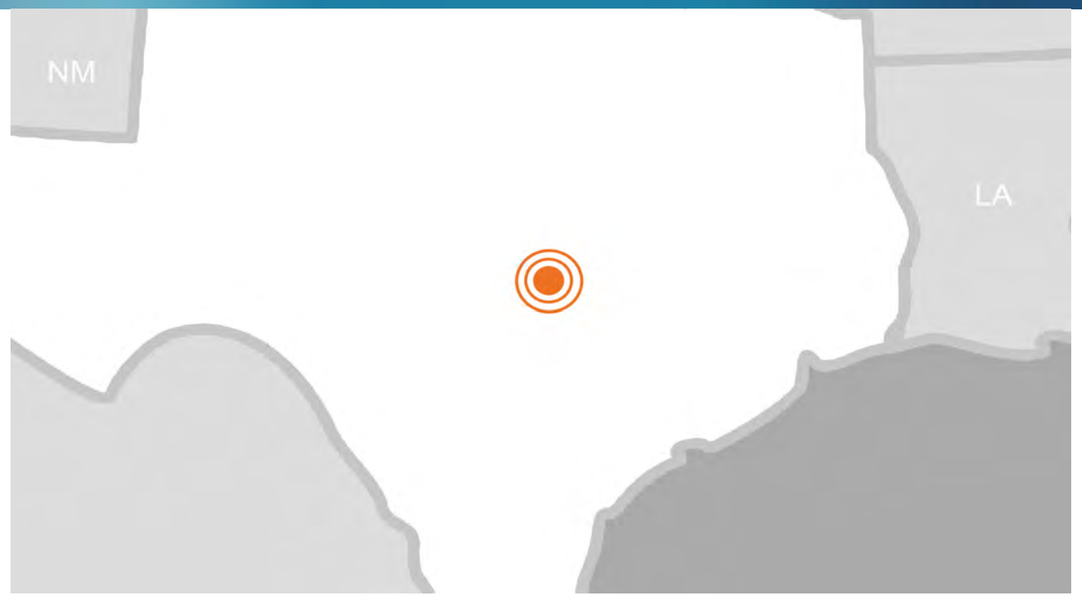
The San Francisco Smart City Challenge demonstration areas provide a framework for achieving the SECA vision (Source: City of San Francisco)



AUSTIN, TX

HIGHLIGHTS

- **Shared-use mobility, such as public transit and bicycle sharing, reduces congestion in Austin while also reducing emissions and household transportation costs.**
- **Austin is scaling up its electric vehicle fleet and infrastructure: this is estimated to save the city $3.5 million over 10 years.**
- **Austin is planning for semi- and fully autonomous fleets by 2025. These will be the forerunners of Austin's autonomous vehicle program, which will include shuttles and other vehicles.**
- **Increasing use of autonomous vehicles and delivery bots will increase transportation accessibility and reduce congestion in the city.**
- **Austin's data integration platform will support traffic management and planning, with the goal of providing real-time data access to all.**



Although Austin is America's fastest growing city and **most vital metropolitan economies**, it is the most economically segregated metropolitan area according to the University of Toronto Martin Prosperity institute. The I-35 highway built in 1960 divides the city into West and East Austin, creating racial divides by separating isolated neighborhoods with lower educational attainment and employment levels. The goal of the Austin's smart mobility plan is to c**onnect underserved communities to employment opportunities and reduce the poverty gap.** To this end, the City of Austin and Capital Metro have employed a smart mobility program encompassing five key areas:

- **Shared-Use Mobility**
- **Electric Vehicles and Infrastructure**
- **Autonomous Vehicles**
- **Data and Technology**
- **Land Use and Infrastructur**e

Shared-use mobility includes shared transportation services such as public transit, taxis and limos, bike sharing, carsharing, ridesharing, scooter sharing, shuttle services, and commercial delivery vehicles providing flexible goods and movement. Shared-use vehicle technology is already operational in Austin and helps reduce congestion, greenhouse gas emissions, and household transportation costs. One example of shared-use mobility projects is the **Riverside Mobility as a Service Pilot**. This project aims to reduce single occupancy vehicle commuting from the Riverside Corridor to Downtown Austin by service-industry employees by pairing demand with groups of employer destinations through industry associations.

Recognizing the transportation, economic, and environmental benefits of electric and autonomous vehicles, Austin is increasing its use of these vehicles. There are more than 4,000 Electric Vehicles (EVs) currently in Austin, representing approximately 22 percent of the Texas EV market. Based on a recent study by City of Austin Fleet Services, the City will save $3.5 million over the course of 10 years by deploying 330 additional EVs by 2020. The first EV charging station was installed in 2011 and **today over 600 EV charging stations are present** at 172 locations throughout Austin, including 8-10 DC Fast Chargers added to the network in 2018. Additionally, Plug-In Everywhere, which costs $4.17 per month for unlimited electric fill-ups, is provided by the Austin Energy's GreenChoice Program.

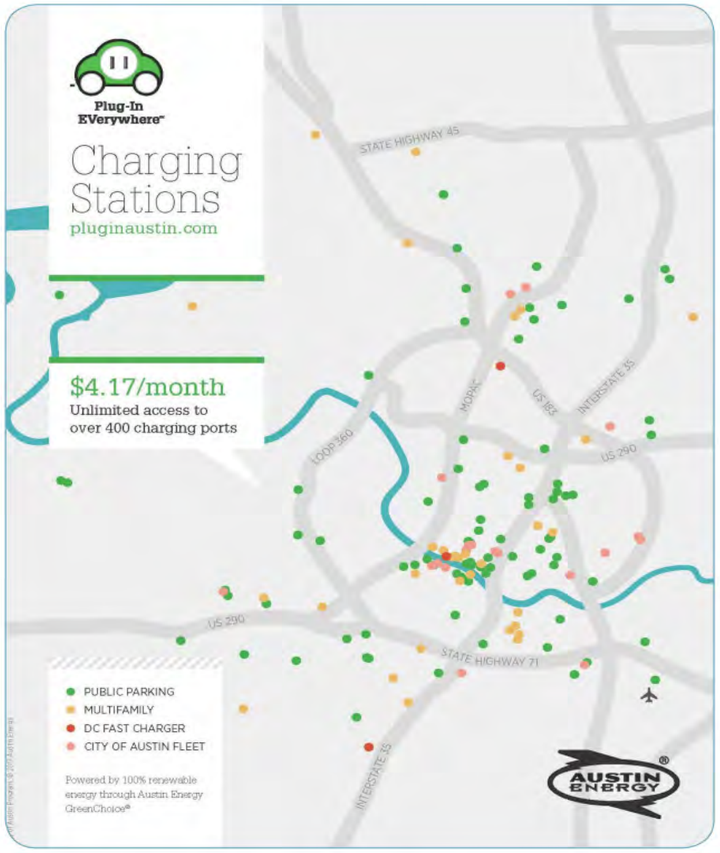
Fleet services are expected to be semi- and fully autonomous by 2025. Fleets will be the first to use autonomous vehicle (AV) technology as they can use the vehicle for longer periods to offset the higher technology-rich vehicle price. The City will eventually expand beyond autonomous fleets. Austin Transportation, Capital Metro and the Rocky Mountain Institute (RMI) are collaborating to pilot automated shuttles in the Austin area, while Austin Transportation and Capital Metro are preparing for a **pilot of Direct Short-Range Communications (DSRC)**.

The Austin City Council also recently approved the use of sidewalks for the priority of delivery bots. Additional strategies towards AV promotion include hiring an executive officer to lead shared, electric and autonomous programs.

The City of Austin will integrate data from a wide variety of public and private sources through its **Data Rodeo**. The Data Rodeo is a two-way data portal developed by the City of Austin and University of Austin to bring together data from public and private sensors and to support traffic mangement and planning in the Central Texas Region. Data will come from automated vehicles, bluetooth and smart phone data, new sensors, and other sources such as ridesharing services. The **ultimate goal is to deliver real-time data access to all.**

Austin has a multi-faceted approach for data and technology promotion. It will collaborate with public and private organizations through a co-funded, multi-year coordinated outreach/ education program with groups such as **Austin Strategy Mobility Plan (ASMP) and Project Connect.** Inter-local data sharing agreements will be created to facilitate information sharing along

The Plug-In-Everywhere program is increasing the visibility, accessibility and viability of EV charging stations (Source: pluginaustin)



Starship Technologies delivery bots like this one are being tested out in cities around Texas (Source: Starship Technologies)

with standards for data organization and data types that promote open data. Public priorities and private incentives and standards for data sharing will be established. This includes establishment of p**ublic priorities for curb and parking access for all transportation modes.** Finally, technology applications will be funded to use city fleet as transportation sensors. A goal will be to require all City vehicle purchases to come equipped with connected vehicle technology.

Several smart projects are currently being carried out by **Austin CityUP, a smart city consortium of companies, organizations, and individuals collaborating to make Austin smarter** through digital technologies, data collection and analytics.

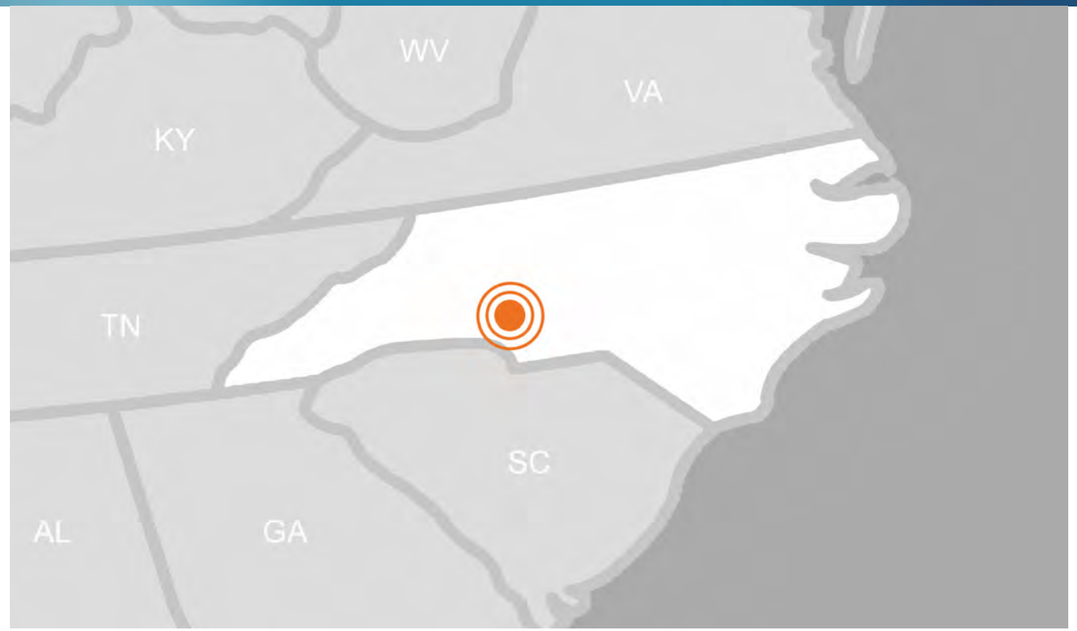
Some of the smart mobility projects currently happening in Austin include:

- **AskAustin:** This app uses natural language conversational interfaces (both text and voice) to connect community members with city services and opportunities.
- **Smart Austin Innovative Lab (SAIL)**: This project uses data from Internet of Things (IoT) devices such as beacons and sensors in a 5-block section of 2nd Street to determine safety, quality of life, and other needs.
- **Transportation kiosks:** Through this project smart kiosks with interactive touch screens and WiFi/cellular connection will be installed at transit stations in the Austin area.

CHARLOTTE, NC

HIGHLIGHTS

- **The proposed One Connect Charlotte (OCC) mobility interface will provide travelers with streamlined transportation information and a common payment system.**
- **Shared, autonomous, electric vehicles will be piloted to solve first and last mile connectivity issues.**
- **Data transmission will facilitate the smooth flow of trucks through Freight Priority Zones.**



As with Austin, Charlotte is one of the fastest growing cities in U.S. with 2,475 people per square mile and 59% urbanized area population. Although this fast growth creates enormous opportunities for the city, it also challenges the infrastructure, environment, and quality of life. The city's goal is to help residents achieve increased upward economic mobility by improving transportation choices. The focus of the smart city program is on access, choice, and opportunity for all residents. The goal will be achieved through:

- connecting communities using apps like the proposed **OneConnect Charlotte** (OCC) **mobility interface**;
- moving people by solving first and last mile issues using shared, autonomous, electric vehicles; and
- transporting commodities through implementation of a freight priority system that uses V2I technology and signal priority.

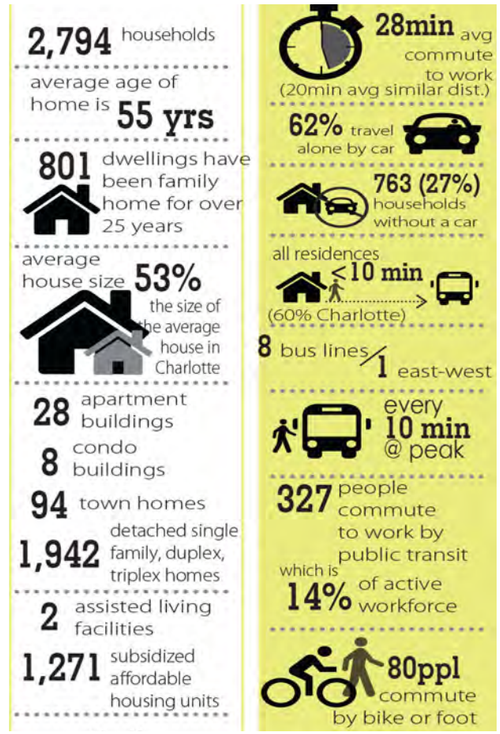
Three areas in Charlotte have been proposed areas for smart mobility solution implementations.

The OCC interface will be an app accessible through smart devices and smart kiosks to provide **trip planning between all modes of transportation** with a single payment system for all residents. OCC will leverage existing private services by integrating car sharing, automated-all-electric-transit, fixed-line transit services, bike sharing, parking, and other transportation options. Data from OCC will be fed into an **open data platform** to allow access to this information for innovation and decision making.

The city is working in **two pilot areas** to address first and last mile connectivity issues. The **North End Smart District** and University Research Park/UNC Charlotte have been drastically growing in the recent years. These areas have been chosen for a **pilot of autonomous electric transit**. A collaboration with Lyft will also be undertaken to provide transit users with monetary contributions towards Lyft trip fees to and from the study areas within a geo-fenced area. These projects will provide greater connectivity to jobs and education by supplementing affordable transportation on the first and last mile of a person's commute in areas where transit service may be too far away.

To improve freight mobility, **Freight Priority Zones** are defined in corridors with high freight volumes. As a freight truck travels through a Freight Mobility Zone, the truck's information is transmitted to the signal controller through Basic Safety Messages. The signal controller determines when the freight truck is near a traffic signal using a smart analytic platform. The signal turns green for the truck's approach and the day/time of the priority movement is recorded for further evaluation.

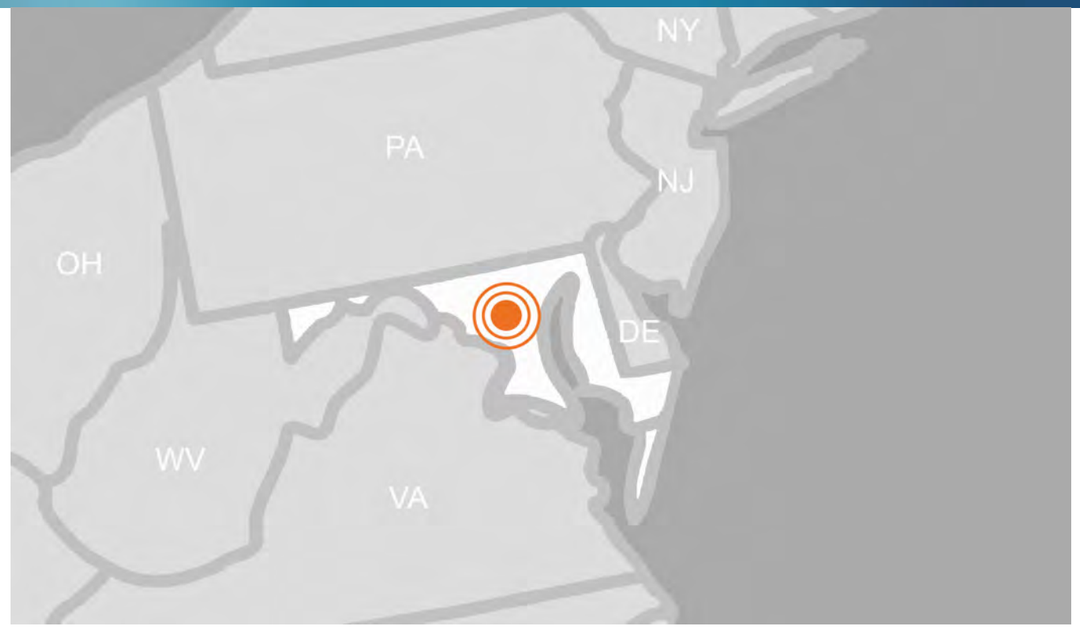
The Charlotte North End Smart District is a pilot area for autonomous electric transit that is educating on how first and last mile impacts are related to other areas in the community.
(Source: NESD)



SEAT PLEASANT, MD

HIGHLIGHTS

- The My Seat Pleasant app provides citizens with one platform from which to access a variety of city information and services.
- Seat Pleasant partnered with IBM to create an Intelligent Operations Center that facilitates data-driven decision making across city departments. This will eventually include smart fleet management and bus stops.
- Outreach and education efforts, including a mayoral video podcast, spread awareness and increase community buy-in for the smart city program.



While the cities discussed so far have been medium- to large-sized, Seat Pleasant shows that small cities can also be smart. Seat Pleasant is located just outside of Washington, DC and has a population of approximately 4,700 residents. Driven by its mayor, the city has undertaken a smart city program to streamline city services and facilitate data-driven decision making. Its comprehensive smart solution, called the **Center for Government Synergism (CGS)**, is has two main components:

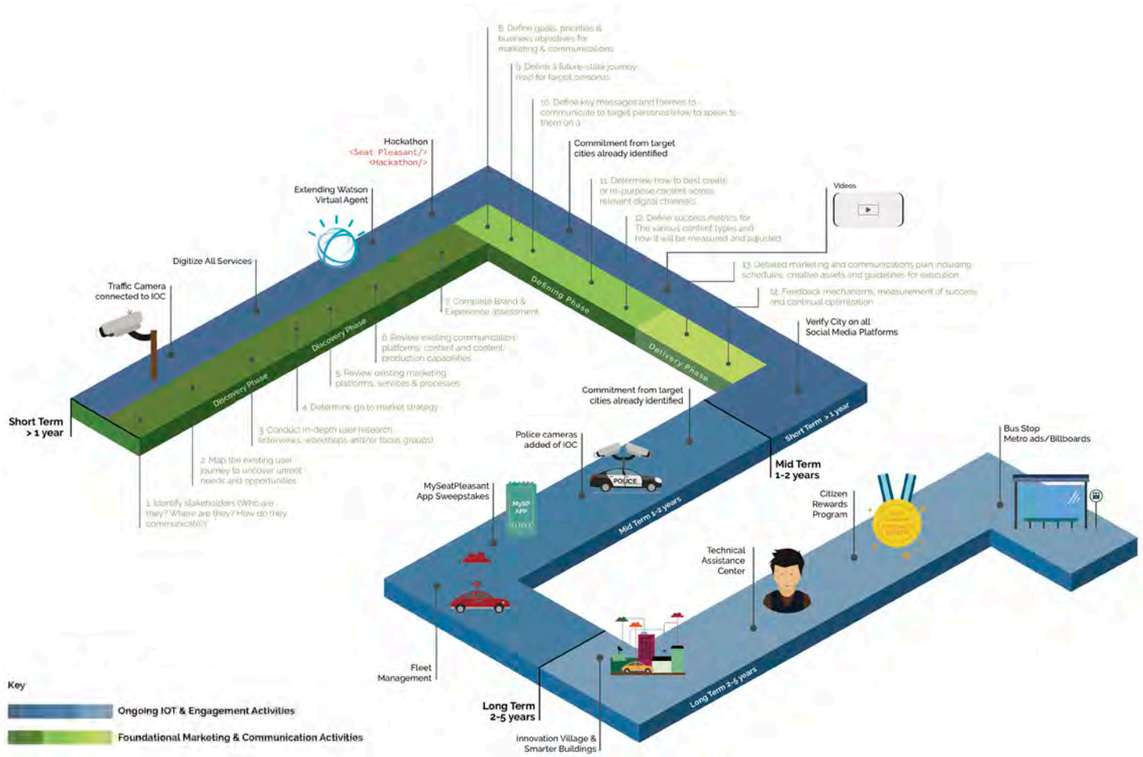
- My Seat Pleasant mobile app
- IBM's Intelligent Operations Center (IOC)

The My Seat Pleasant **mobile app** is a comprehensive public-facing platform that integrates service delivery for residents, businesses, and city employees. Among other things, the app can be used to request city services and gain access to on-demand notifications, garbage and recycling schedules, city jobs listings, and events.

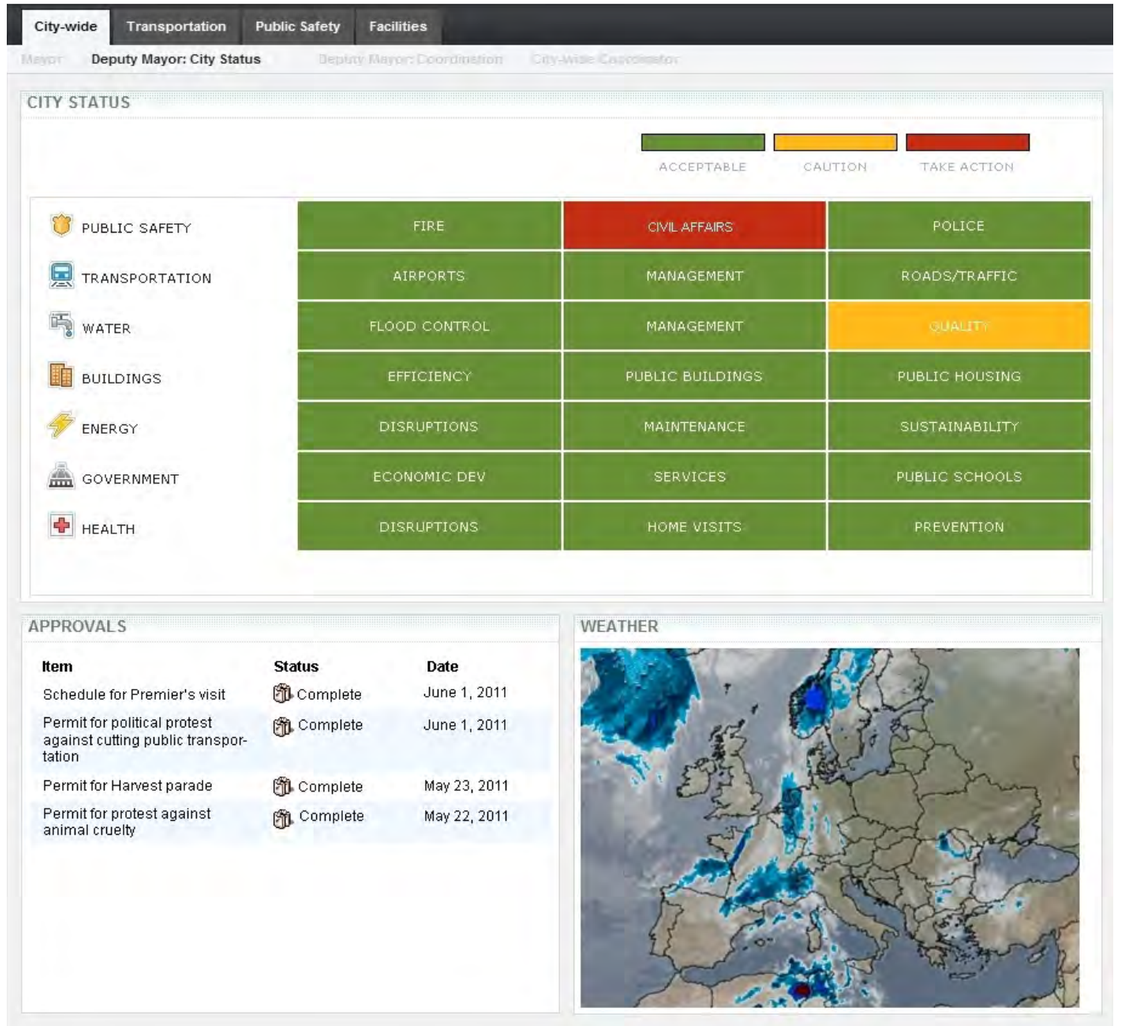
Seat Pleasant has incorporated IBM's **Intelligent Operations Software** into an Intelligent Operations Center (IOC) that provides an overview of city operations across all departments. The IOC is initially connecting the Department of Public Works, Code Enforcement, and the Police Department with real-time data to increase efficiency, facilitate data-driven decision making, and enhance communication across the departments. Future scale-up will support even more improvements in operational efficiency, public safety, and citizen service. The IOC will eventually incorporate **Internet of Things** sensors to increase the city's capacity for data-driven decision making.

Seat Pleasant has developed a road map on how to integrate smart city technology over the next several years. This includes incorporating smart technology to improve mobility, with eventual plans for smart fleet management and smart bus stops. Seat Pleasant is **including the community** throughout this process. Its mayor posts regular **video podcast**s spreading awareness of smart city benefits and progress. Additionally, the city hosts and sponsors **workshops** and **seminars** to help educate citizens and businessowners about smart cities. This increases support for Seat Pleasant's smart city program among the community.

The Seat Pleasant Road Map carves out a deliberate, consecutive approach to achieving long-term smart mobility implementations that are fully integrated. (Source: Seat Pleasant)



IBM's Intelligent Operations Software forms an operations center of collaboration between 7 city departments with real-time data shared through the interface below. (Source: IBM)



KEY STRATEGIES

Thanks to the advancement in technologies such as ubiquitous wireless connectivity and incentives like the US DOT Smart City Challenge, many U.S. cities have been able to develop infrastructure, programs, and policies that are applicable to Middle Tennessee as the region seeks to address safety, congestion, transit, smart growth, and other challenges. Some smart mobility best practices that the region's stakeholders might find valuable include:

INCREASING ACCESSIBILITY THROUGH STREAMLINED INFORMATION:

Cities are using apps to provide travelers with multimodal transportation information and payment options in one place. This increases connectivity and makes it easier for travelers to leave their cars at home. Some cities, such as Columbus, are going a step further to link transportation with human services through **comprehensive apps**.

UTILIZING SHARED-USE MOBILITY AND AUTONOMOUS VEHICLES FOR LAST MILE CONNECTIVITY:

Cities such as Charlotte are using **shared autonomous vehicles** to improve transportation access in underserved communities. These programs provide economic benefits to users while also reducing congestion and air pollution from use of single-occupancy vehicles.

OPTIMIZING TRAFFIC FLOW WITH SMART TECHNOLOGY:

Systems such as Pittburgh's Surtrac can utilize technology to reduce waiting time, congestion, and pollution at **traffic signals**. Incorporating technology into parking systems can reduce the time spent finding parking, thereby easing congestion on busy roads. Smart freight technology on key corridors can be used to reduce headways and improve mobility along busy corridors.

COLLABORATING TO PROMOTE INNOVATION:

Cities are taking advantage of partnerships with both private and public entities to develop technology, pilot projects, and grow smart city networks. Whether partnering with a university to develop technology or collaborating with a nonprofit organization to reach underserved communities, partnerships are key to obtaining meaningful results from smart city programs.

DEVELOPING OPEN DATA POLICIES AND DATA SHARING:

None of these smart city programs could function without sharing data. Cities are incorporating open data policies in order to spur informed decision making for policies, traffic operations, and individual trips. Cities such as Austin and Pittsburgh feature **real-time data for apps** and other tools as a result of data sharing agreements.

USING TECHNOLOGY FOR DATA COLLECTION:

Smart technology that uses data for decision making can also be used to actively collect data. In Pittsburgh, **smart sensors on streetlights collect data** on traffic flow as well as air quality. App users can also elect to share their travel data with the city. The result is a wealth of data that can be used to improve transportation.

PATHWAYS TO SUCCESS

The cities described above needed to take certain actions in order to carry out and achieve these strategies. While each city's pathway to success is different, there are several overlapping themes that the Greater Nashville area can use to achieve its smart city goals.

IMPORTANCE OF STRONG LEADERSHIP & ENGAGED STAKEHOLDERS:

Even the best ideas can't come to fruition without good leadership. The cities described above are putting their plans into action with the help of committed, organized leadership that can engage partners and stakeholders. In Columbus and Seat Pleasant, the **mayors** were instrumental in raising awareness and fundraising from the private sector to support smart city goals. Other cities such as Pittsburgh and Austin have created **dedicated staff positions** to advance their smart city agendas. The result is **increased buy-in**, a clear and operationalizable **vision,** and increased **community engagement**.

COLLABORATION OUTSIDE USUAL JURISDICTIONS:

Cities have leveraged a diverse array of partnerships to enact their smart city agendas. Collaborations should include **public, private, and academic entities**. In San Francisco, this meant engaging entities ranging from startups to local businesses. Pittsburgh is collaborating with a wide array of partners including many different public entities such as the Office of City Planning, the Office of Management and Budget, and even the Department of Energy. Columbus went so far as to institute a joint operating structure with co-location in a shared headquarters, ensuring that partners from various backgrounds will work together. Collaboration with diverse partners allows these cities to take advantage of various perspectives, skillsets, and resources.

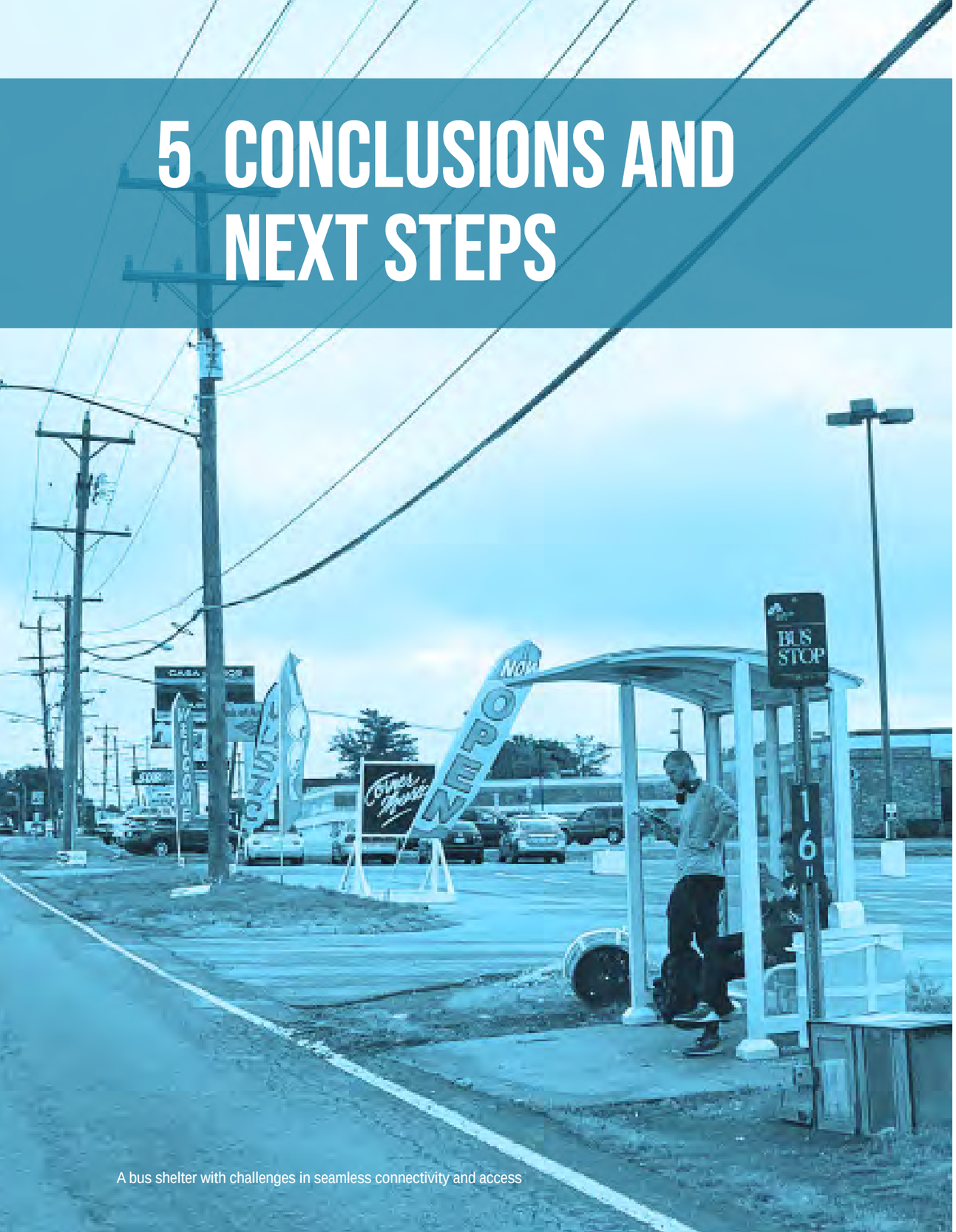
COMMUNICATION IS KEY:

Good communication is essential to raising awareness and buy-in for any smart city program. Columbus has a multi-faceted engagement strategy that maintains open communications with all interested parties. It has also developed its brand to better tell its story. Seat Pleasant has established r**egular education sessions to raise awareness** of smart city issues among citizens and to spread information on how to get involved. As a result of these efforts the two cities have been able to better channel and capture interest and engagement among stakeholders, partners, and the community at large.

THINKING OUTSIDE THE BOX:

Smart mobility is a new, growing field, and as such there is a lot of room for innovation. Thinking outside the box can be changing internal practices, working with new partners, or looking at an old problem in a new way. For example, Austin developed an innovative way of reducing the number of single-occupancy commuters. Its **Mobility as a Service Pilot** worked with employers to develop a shared mobility strategy for high demand employment destinations. Austin and other cities have leveraged creative thinking to implement successful smart city strategies.

5 CONCLUSIONS AND NEXT STEPS



A bus shelter with challenges in seamless connectivity and access

SUMMARY

Middle Tennessee is benefitted by a robust network of smart mobility communications infrastructure in several of the region's municipalities, providing the high-speed fiber and wireless networks necessary to support real-time traveler information feeds and many aspects of connected automated vehicle systems. Many intersection signal controllers also are ready for communications to connected vehicles and smart programming such as preemption. However, there is little else in the way of smart mobility infrastructure, there have been no regional initiatives to advance smart mobility until now, and collaboration across jurisdictional boundaries is minimal.

Issues which smart mobility systems can address—as reported by municipal officials in the region—are growing and range from providing mobility to the growing elderly population and increasing efficiency/frequency of transit services to relieving congestion and reducing crashes. Most municipalities in the region are looking to adopt programs which encourage less driving, but beyond brick and mortar projects, few report any initiatives underway to take advantage of smart mobility solutions.

In best practice examples from across the United States, other regions are beginning to reap the rewards of smart mobility. Initiatives applicable to Middle Tennessee include enhanced human service applications that connect those with limited mobility options to their health and social service providers through new on-call and shared-ride providers; smart lighting technologies that increase roadway, crosswalk and biking safety at night; and smart parking systems which manage valuable curb space more efficiently, opening up access for curbside dining, biking, transit lanes, and new mobility providers.

In the next phase of the Smart Mobility Assessment, stakeholders will learn how best practice solutions might be applied in Middle Tennessee. Many opportunities exist to build off of the region's existing smart technology infrastructure and develop new collaborative initiatives which address common problems of safety, congestion, equitable access, and other issues identified in local and regional planning efforts. Consensus around smarter growth, enhancing transit, and promoting less driving is broad across Middle Tennessee. This represents an opportunity to develop a regional vision now which can be supported by smart mobility infrastructure, programs, policies and new funding sources.

6 APPENDICES

People test out a scooter share pilot program.

APPENDIX A - EXISTING PLANS REVIEW

COUNTIES REVIEWED

- Davidson
- Maury
- Robertson
- Rutherford
- Sumner
- Williamson
- Wilson

Parking regulations in Brentwood

DAVIDSON COUNTY

Davidson County is located in the middle of the State and is the capital of Tennessee. The City of Nashville and the Davidson County government are merged into one county government known as the “Metropolitan Government of Nashville and Davidson County,” or “Metro Nashville”. It hosts the largest population in the 7-county MPO area and has always been the region’s center of commerce, industry, transportation, and culture. Metro Nashville is also the most advanced in both planning, policy and technology as it relates to smart mobility.

With over 90 people a day moving into the Metro Nashville region, some of the cities major challenges are transit, education and affordable housing. Many of these are addressed city planning efforts and technology investments.

INFRASTRUCTURE & ASSETS

Davidson County and the city of Nashville have several Smart Mobility components and are increasing their Right-of-Way assets in Vehicle Detection, Signals and Roadside Units. With roads equipped with fiber and/or twisted pair connection across most of the county, Davidson is leading the way in smart mobility. Nearly half of the traffic signals throughout the region are found here. Transit is largely accessible via public modes in WeGo and the Regional Transit Authority (RTA) as well as private modes in ride-sharing and scooters. Davidson County’s smart mobility initiatives are largely dependent on technology which may create a divide between those who use technology to procure services and those who don’t. This may escalate threats to equity in transit availability. With three major interstates dividing the county, Davidson and the city of Nashville coordinate with TDOT to respond to incidents and move traffic at all hours of the day.

DATA & TECHNOLOGY STANDARDS

The combined city/county government has had recent success in creating public-private partnerships to share data and protect citizens with the recent deployment of scooters in approved zones throughout the county’s urban areas. There is also increasing coordination with neighboring municipalities and local universities, though these efforts are largely enabled through interpersonal relationships and are limited by application of different technologies among the county’s neighbors.

PLANS & POLICIES

NASHVILLE

NASHVILLENEXT (2015) A GENERAL PLAN FOR NASHVILLE AND DAVIDSON COUNTY

GUIDING PRINCIPLES:

- Accessibility is critical for equity.
- We will provide transportation choices in all communities, so people have the choice to travel by foot, bicycle, car, or transit to make jobs, education, and daily needs accessible while creating a healthier and more sustainable community.

IMPACT ACTION ITEMS:

- Create a high capacity transit system to provide genuine accessibility to jobs, housing, and services, as well as regional connectivity.
- Making Complete Streets the Metro Standard
- The NashvilleNext policies and action items reinforce that Metropolitan Government will uphold Complete Streets as the standard
- Improving sidewalks and bikeways in Nashville Centers
- Prioritize projects that upport walkability and transit access in centers identified in the Growth & Preservation Concept Map and fill in gaps that the private sector is unlikely to address through the redevelopment process.

COORDINATION:

Incorporate recommendations from the Mayor’s Bicycle and Pedestrian Advisory Committee’s Connectivity Study, Public Works’ Downtown Multimodal Mobility Study, and the Planning Department’s Major and Collector Streets Plan.

NEIGHBORHOOD GREENWAYS:

Outfit strategically identified local street corridors with traffic calming measures that maintain access for all road users but prioritize local and active transportation, such as curb extensions, road diets, diverters, and roundabouts.

BIKESHARE:

Integrate bikeshare locations into identified Centers, High Capacity Transit Corridors, MDHA housing, and new or redeveloped Metro Government facilities to provide Nashvillians with transportation choices and help transit riders complete the last mile of their trips.

END OF TRIP FACILITIES:

Create incentives or tax credits to encourage developers and employers to provide end of trip facilities like showers, lockers, and secure indoor bike parking.

ENCOURAGEMENT:

Support Safe Routes to School programming and community events that encourage people to take advantage of active transportation.

A SMART CITIES COUNCIL

The Plan calls for the appointment of a Smart City Advisory Council, which should oversee incorporation of new technology into Metro operations. In particular, the council should 1) take an inventory of existing smart city assets including “gaps and overlaps,” 2) seek to better leverage existing investment in smart city technology, 3) pragmatically assess commercially available technology to fill identified gaps, and 4) address emerging trends and technologies (e.g. smart buildings and connected vehicles). The Smart City Advisory council should include sub-councils to address the following:

1. Smart transportation including parking, transit, traffic management, connected vehicles
2. Smart water including waterway management, storm water, wastewater, and freshwater supply
3. Smart public safety
4. Smart energy (supply-side) including electric and natural gas utilities, renewable energy policies
5. Smart buildings
6. IT and connectivity
7. City-wide integration of 1 – 6

Ultimately, the creation of a Smart City Advisory Council should result in citizen-centric improvements to livability, efficiency, sustainability, and resiliency.

ACCESS NASHVILLE 2040

A more efficient system developed within the constraints of the existing street network can work better for drivers, too. Efficiencies are achieved while reconfiguring streets for additional transportation modes and implementing elements that can improve traffic flow through traffic signal coordination and smart signal systems, reallocating travel lanes to respond to changing land uses, reconfiguring lanes for other travel modes, or reducing congestion related to crashes.

USING TECHNOLOGY TO MAKE CITY STREETS MORE EFFICIENT

TDOT maintains ITS (Intelligent Transportation System) components including traffic cameras, dynamic message signs, and the sensors in pavement that determine road surface conditions. These components are located on state-maintained facilities to manage traffic congestion. They help TDOT monitor conditions, warn of traffic issues, and recommend alternative routes. TDOT also supplies this information to local media outlets, online, and through the Smartway app for smartphones. Anyone can access the cameras, dynamic message boards, and road conditions at any time before driving. Additionally, Metro Public Works equips most traffic signals with cameras or other sensors that detect vehicles and has developed signal timing plans for major arterials through Davidson County. These signal timing plans are updated every few years as land use and traffic conditions change. Other cities like Franklin and Murfreesboro also provide traffic camera information online for public access.

Technology is also moving into the transit system with BRT Lite routes indicating arrival times at station locations. MTA is also developing a smartphone app to deliver transit user information on the location of buses, so the transit system information is delivered in real time and can be used to determine when the next bus will arrive.

Today, the ITS components managed by the agencies in Nashville are mostly basic elements to monitor existing conditions and have not been used to actively manage traffic congestion. In the future, there is tremendous potential to expand ITS components as part of a smart infrastructure system to manage lanes during peak travel times, establish variable speed limits according to the road conditions, synchronize signals to maintain calmer traffic speeds with green lights along a corridor, and detour traffic to arterial streets as needed. Transit signal priority can be expanded to more routes where traffic signals detect the approach of transit vehicles and prolong the green signal to keep the bus on schedule. As cars become equipped with more technology, communication between smart infrastructure components can make mobility more efficient and connect to other municipal infrastructure. The data that is collected as part of these infrastructure systems should be open, so transportation users can make informed decisions about their routes.

KEY STEPS TO MANAGING TRAVEL LANES:

Outreach: Develop a real-time, automated, centralized reporting system for closures and detours for all modes of transportation, including a publicly accessible website and a machine-readable data feed with real-time information for application developers.

Prioritization: Conduct a study with the Nashville Area MPO, TDOT, Metro Public Works, Nashville MTA, RTA, and Metro Planning to assess regional corridors for feasible managed highway lane concepts including HOV lanes, reversible lanes, high-occupant toll (HOT) lanes, and ramp metering. Also explore transit concepts to utilize bus-on-shoulder applications on highways and queue jump lanes with transit signal prioritization at specific intersections on arterial streets.

Assess and prioritize streets appropriate for road reconfigurations and transitions into Complete Streets to incorporate turning lanes, bike lanes, on-street parking, transit accommodations, parklets, plazas, and other spaces for all transportation modes. Actively work with neighborhoods and residents to determine potential strategies for implementation within the public right-of-way.

Enhance highways and arterials with additional ITS components to assess traffic conditions and pavement conditions, adjust signal phasing and timing, inform motorists of conditions, and direct motorists to alternative routes in real time. Coordinate traffic signals across major corridors and during high traffic events. Consider smart components to integrate infrastructure systems. Example components that manage travel lanes:

- Reversible lanes
- Bus-on-shoulder applications
- HOV lanes
- HOT lanes
- Reversible highway lanes
- Ramp metering

CARPOOLING CULTURE IN NASHVILLE

Carpooling in Nashville has typically involved commuters finding others who work and live nearby to share rides to and from work during the work week. Both the RTA and TMA Group operate services to promote carpooling like utilizing vans to commute to and from work through vanpools. They also offer ride-matching services to find commuters with similar schedules, and emergency ride home programs encourage carpooling and reduce the amount of traffic on area roadways.

FOREST HILLS

The comprehensive Plan speaks about the challenges the City is facing in regards to transportation connections. Support exists for creating new connections between neighborhoods within the City and connections with the City's neighboring communities. Such connections could be developed as sidewalks, bikeways and greenways. Specific objectives outlined in the comprehensive plan are as follows:

- Connecting the City with Sidewalks, Bikeways and Greenways. The City should establish a program for the purpose of creating connections between neighborhoods in the City and between the City and its neighbors…"
- Sidewalks, Bikeways, and Connecting the Community. Forest Hills has the potential to develop three types of connections: Pedestrian and bicycle corridors . . . include sidewalks, various classes of bike lanes, medians and crosswalks.

KEY ISSUES / FOCUS AREAS

- Develop new walk/bike connections between neighborhoods

No information found for the following:

BELLE MEADE

MAURY COUNTY

Maury County is located in the southernmost end of the GNRC MPO region. Its county seat is Columbia and it includes two other municipalities. While it is largely rural and agriculture in nature, the north end of the county is growing quickly because of its adjacency to Williamson. A large percentage of its residents commute to Nashville and surrounding areas for employment. The downtown attracts tourists seeking a hometown atmosphere with live music and local artists.

Day-to-day operational challenges with schools, roads, and economic growth leave little time for the community to focus on smart mobility and/ or its technology advancements. The community relies on adjoining counties for “lessons learned” and sample policy and data standards.

INFRASTRUCTURE & ASSETS

Maury County’s Smart Mobility infrastructure is largely limited to Right-of-Way management, where it is also expanding with new traffic signals and controllers. With several manufacturers throughout the county, there is limited ability to coordinate signal systems, though coordination among neighboring municipal staff is exceptional. The county and its municipalities are planning additional safety improvements, though are limited in communications capability to enable increased coordination among the county’s municipalities and its neighbors. Ride-share and an RTA exist within the county and in Spring Hill, respectively, though largely in operation during business hours as Maury County is a bedroom community to neighboring Williamson and Davidson counties.

DATA & TECHNOLOGY STANDARDS

Maury County’s transportation data is largely contained within its proprietary transportation systems, such as Siemens, McCain, Peak & Eagle. There has been little need to develop open data or cyber security policies. Planning and analysis are limited to moving traffic to/from highways and interstates during peak volume hours throughout the weekdays.

PLANS & POLICIES

SPRING HILL (LOCATED IN BOTH MAURY AND WILLIAMSON COUNTIES)

SPRING HILL RISING 2040

Spring Hill Rising 2040 was adopted in November 16, 2015. The Comprehensive Plan has a number of strategies and policies that pertain to transportation and connectivity. Selected strategies are listed below:

Goal One: We will create a balanced transportation network.

Encourage efficient, multi-modal transportation options that increase mobility and access to jobs and services, reduce travel times and congestion, and are fiscally sustainable.

Policy: *Establish citywide, multi-modal transportation pla*n

Create a coordinated transportation strategy that supports the future development goals of the community and increases the efficiency, safety and breadth of the city’s transportation system.

- Strategy: Develop a citywide, multi-modal transportation plan that accommodates all travel modes including walking, biking, driving, public transportation, rail, and air.
- Strategy: Develop street typologies guide that promotes context sensitive street designs and appropriate street cross sections.

Policy: *Improve transportation connectivity, safety, and options.*

Support transportation enhancements that reduce automobile dependency and that improve safety and alternative transportation modes, including walking and biking.

- Strategy: Require sidewalks in all new development.
- Strategy: Review and modify access management regulations to promote orderly and efficient traffic circulation along corridors identified in the Future Development Guide.
- Strategy: Review and modify site design requirements to promote context sensitive street design and multimodal transportation options such as pedestrian and bicycle facilities.

Policy: *Improve regional transportation connectivity and options*

Support transportation enhancements that improve connections and travel options to areas outside of Spring Hill.

- Strategy: Work with regional and state transportation agencies to create meaningful transportation connections to other areas of the Cumberland region and state.
- Strategy: Work with Cumberland region transportation agencies and governments to connect Spring Hill to a regional transit system.

KEY ISSUES / FOCUS AREAS

- Encourage efficient transportation options
- Integrate technology into future planning efforts (citywide multimodal plan, street typologies, etc.)
- Reduce automobile dependency
- Improve regional connectivity

MAURY COUNTY

THE MAURY COUNTY COMPREHENSIVE PLAN

This plan covers all unincorporated areas within the county and contains a number of Smart Growth initiatives and policies. The policies call for well-planned, environmentally-sensitive development, protected open space and farmland, revitalized communities, affordable housing and more transportation choices.

Maury County is committed to smart growth and sustainable development patterns promotes accessible and equitable new economic and physical development. Creating safe, walkable routes to schools and provisions for elderly services are ways we promote and maintain, the health, safety, and livability of our community.

Primary Issues identified in the plan include: Additional transportation options are needed, particularly for the elderly population. Primary Opportunities identified in the plan propose regional transit services that can connection Maury County to the greater Cumberland Region

KEY ISSUES / FOCUS AREAS

- Need for Smart Growth
- Increase transportation options
- Accommodating and aging population
- Improving regional transit services

COLUMBIA

CONNECT COLUMBIA TRANSPORTATION AND LAND USE PLANS (COLUMBIA’S FRAMEWORK)

This plan’s Guiding Principles encourage decisions that support options to allow safe and efficient movement of people and goods by a variety of transportation modes.

Future Land Use Development Plan Policies included in the plan promote strong connectivity, directly through street, sidewalks, bikeways, greenways, and trails, and indirectly, through a mixture of housing and business types, should be encouraged throughout Columbia.

Key Issues / Focus Areas

- Increase transportation options
- Improve the mix of housing and business types
- Focus on greater physical connectivity

MOUNT PLEASANT

The City refers to the County Plan in lieu of Comprehensive Plan or Transportation Plans.

ROBERTSON COUNTY

Robertson County is located on the northern border GNRC, MPO area. Its county seat is Springfield, however features seven additional cities.

While the county is largely rural and agriculture-focused, a large percentage of its residents commute to Nashville and surrounding areas for employment. Bus commuter service is available for Springfield but there are a limited number of runs per day. Both I-65 and I-24 run through the county, making it a target for heavy arterial traffic when accidents occur on either of these interstates.

The communities face day to day operational challenges with schools, roads, and economic growth, leaving little time for focus on smart mobility and/or its technological advancements. The community looks to adjoining counties for "lessons learned" and sample policy and data standards.

INFRASTRUCTURE & ASSETS

Robertson County's smart mobility assets include several Right-of-Way components with planned expansion of current signaling and roadside collection devices. The City of Springfield has fiber communications and is well positioned to coordinate with neighboring municipalities during peak traffic hours.

DATA & TECHNOLOGY STANDARDS

Robertson County's transportation data is largely contained within its proprietary transportation systems. There has been little need to develop open data or cyber security policies. Planning and analysis are largely limited to moving traffic to/ from highways and interstates during peak volume hours throughout the weekdays.

PLANS & POLICIES

Objective 2.3: Multi-Modal System. The County and participating cities shall promote alternative modes of transportation to achieve a safe and efficient multi-modal system and to provide for a possible reduction of individual motor vehicle travel.

Policy 2.3.1: Major roadways should be designed as complete transportation corridors incorporating bicycle and pedestrian features, and planning for transit features to start creating a true multi-modal system whenever feasible.

Policy 2.3.2: Where feasible, the County and cities should require development to provide roadways that are designed utilizing Complete Streets2 standards.

Policy 2.3.3: Within urban areas, pedestrian, bicycle and roadway connectivity shall be designed with the highest number of connections to encourage non-motorized modes of transportation. Cul-de-sacs should be discouraged countywide.

Policy 2.3.4: New subdivisions shall be required to "stub-out" to adjoining undeveloped lands to achieve road connectivity, and to connect to existing roadways that are "stubbed-out" at their boundaries.

Policy 2.3.5: The County and cities shall coordinate to develop a pedestrian/bicycle improvement plan.

Policy 2.3.6: Sidewalks shall be mandatory on all new internal development roadway construction.

Policy 2.3.7: The County and cities will encourage wider sidewalks in high pedestrian/bicycle traffic areas.

Policy 2.3.8: In order to keep impervious surface area to a minimum, the County and cities shall consider developing standards for maximum number of parking spaces to encourage walking, bicycling, ridesharing, and shared parking.

Policy 2.3.9: Adequate pedestrian circulation and safety shall be considered as a required component of all development and roadway system management, with implementation and required construction.

Policy 2.3.10: The County and cities shall continue to coordinate with the Middle Tennessee Regional Transit Authority (RTA) for the provision of existing and future transit service.

Policy 2.3.11: Continue to coordinate with CSX railroad in siting of new intermodal facilities within the County.

Policy 2.3.12: Coordinate with the Springfield Robertson Airport to determine opportunities for interconnecting intermodal facilities.

Policy 2.3.13: Evaluate, in close coordination with the MPO, the potential for a future rail transit corridor from Springfield to Nashville.

KEY ISSUES/FOCUS AREAS

- Promote alternative modes (i.e. require sidewalks, consider wider sidewalks, focus on pedestrian circulation, etc.)
- Improve safety and efficiency
- Develop complete streets / "transportation corridors"
- Increase connectivity / decrease cul-de-sacs
- Consider parking maximums
- Freight & airport opportunities

WHITE HOUSE

COMPREHENSIVE PLAN (2008)

Policies in the plan indicate that future residential development should emphasize interconnectivity, housing diversity, and a mixture of lot sizes, within the acceptable zoning districts. Additionally, new development should create a pedestrian-friendly environment by adding sidewalks and/or creating other pedestrian-friendly multiuse paths in order to link current and future neighborhoods and major destinations such as the Library, community centers, health facilities, personal services, commercial clusters, parks, schools, or other such uses.

Additionally, new development in Mixed Use areas and the West Character Area should create a pedestrian-friendly environment by adding sidewalks and/or creating other pedestrian-friendly multi-use trail/bike routes in order to link current and future neighborhoods.

KEY ISSUES / FOCUS AREAS

- Pedestrian safety / increasing sidewalks and paths
- Bike/trail routes to link current and future neighborhoods

SPRINGFIELD

Urban Growth Boundary in city website
County future land use map includes Springfield

The following Included information in County plan:

CROSS PLAINS

COOPERTOWN

No information was found for the following:

GREENBRIER

ORLINDA

CEDAR HILL

RUTHERFORD COUNTY

Rutherford County is located in the southeast GNRC MPO region. Its county seat is Murfreesboro,[3] the geographic center of State of Tennessee. It features two cities, and subdivisions and local businesses are popping up regularly in this booming community.

The I-24 Corridor connects Murfressboro to Nashville and is currently the busiest corridor in the region. TDOT, Murfressboro, LaVergne, Smyrna, and Nashville have all signed MOU's to be included in Tennessee's first pilot for Integrated Corridor Management (ICM). Bluetooth sensors, updated signals, and Dedicated Short Range Communication, DSRC, and almost 170 Digital Message Boards will be installed along the corridor to help alleviate some of the most serious traffic problems in the area. This agreement has sparked multiple technology investments in the local communities including CCTV cameras, Traffic Operations Center, and much more. The communities are committed and excited about the pilot project.

INFRASTRUCTURE & ASSETS

With significant assets in all categories, Rutherford has been rapidly expanding its Smart Mobility infrastructure in the Right-of-Way category. Pursuing expansion in signals, the county and its municipalities of Murfreesboro and Smyrna utilize several manufacturers including Econolite, Peak & Eagle. The county has an Advanced Traffic Management System (ATMS) system and is able to share traffic information within the county and among its neighbors. With the I-24 interstate spanning the entire county, Rutherford also heavily coordinates with TDOT to respond to incidents and move traffic volume in peak hours.

With fiber connected infrastructure, the county and its municipalities are expanding data lines into the city of Smyrna and are adding roadside units throughout the county .

The county's university system operates in coordination with a regional transportation system to provide transportation resources to the public. Rideshare is available, and Murfreesboro is considering other transportation programs, such as scooters.

DATA & TECHNOLOGY STANDARDS

Historically, most of Rutherford County's policies, security, and planning has been at the local level with little need to consider open data or cyber security policies and procedures. Recently, the county has significantly increased coordination with TDOT to coordinate systems along the I-24 corridor. The county has the region's most progressive set of data and security agreements.

PLANS & POLICIES

MURFREESBORO

The City of Murfreesboro is currently updating their Comprehensive plan. Chapter 3 – Mobility is under development, but it will address:

- Plan for multimodal transportation
- Plan for transit-oriented development
- Coordinate regional transportation investments with job clusters
- Provide complete streets serving multiple functions
- Plan for mixed land use patterns that are walkable and bikeable

BEST PRACTICES FOR PLAN PRINCIPLES:

- Plan for multimodal transportation. A multimodal transportation system reduces dependence on automobiles and encourages more active forms of personal transportation, improving health outcomes and increasing the mobility of those who are unable or unwilling to drive. Fewer cars on the road
- Plan for transit-oriented development. Transit-oriented development (TOD) is characterized by a concentration of high-density, mixed-use development around transit stations and along transit lines, such that the location and the design of the development encourage transit use and pedestrian activity.
- Coordinate regional transportation investments with job clusters. Coordination of regional transportation systems and areas of high employment densities can foster both transportation efficiency and economic development.
- Provide complete streets serving multiple functions. Complete streets are streets that are designed and operated with all users in mind - including motorists, pedestrians, bicyclists, and public transit riders of all ages and abilities - to support a multimodal transportation system.
- Plan for mixed land use patterns that are walkable and bikeable. Mixed land use patterns are characterized by residential and nonresidential land uses located in close proximity to one another. Mixing land uses and providing housing in close proximity to everyday destinations (e.g., shops, schools, civic places, workplaces) can increase walking and biking and reduce the need to make trips by automobile
- Delineate designated growth areas that are served by transit. A designated growth area is an area delineated in an officially adopted local or regional comprehensive plan where higher density development is permitted or encouraged and urban services - including public transportation (where feasible) - are (or are scheduled to be) available. The purpose of a designated growth area is to accommodate and focus projected future growth (typically over a 20-year timeframe) within a municipality, county, or region through a compact, resource-efficient pattern of development. Ensuring that new growth areas are served by transit improves residents' access and mobility and helps reduce dependence on personal automobiles for travel throughout the region.

KEY ISSUES / FOCUS AREAS

- Future planning for multimodal transportation, TOD, regional transport, complete streets, mix of uses

SMYRNA

The Comprehensive Plan for the City of Smyrna is currently beginning its update in 2019. The previous plan contains minimum goals and policies in regards to transportation and smart mobility. The plan contains general policies that encourage the use of boulevards and pedestrian-friendly roadways.

No information was found for the following:
RUTHERFORD COUNTY
LAVERGNE

SUMNER COUNTY

Sumner County is located in the northeast corner of the GNRC MPO area. Its county seat is Gallatin, and its largest city is Hendersonville. Other cities include Goodlettsville (partly in Davidson County) and Millersville, Mitchellville, Portland, and White House (all partly in Robertson County).

While the county is largely rural and agriculturally-focused, a large percentage of its residents commute to Nashville and surrounding areas for employment. I-65 runs through the southern tip of the county through Millersvile and SR 109. SR 386 act as a by-pass route for a large part of the traffic routes from Nashville. There is some focus on technology improvements along these state routes as they are targets target for heavy arterial traffic when accidents occur on the interstate.
The community looks to adjoining counties for "lessons learned" and sample policy and data standards and primarily look to TDOT and other federal funding sources for road improvements and technology upgrades.

INFRASTRUCTURE & ASSETS

With significant assets in all categories, Sumner county has been rapidly expanding its Smart Mobility infrastructure in both the ATMS and Right-of-Way. Pursuing expansion in signals, the county and its municipalities of Murfreesboro and Smyrna utilize several manufacturers including McCain, Peak & Eagle. The county is planning to implement Wavetronix vehicle detection infrastructure as well as an Econolite ATMS system to share traffic information within the county and among its neighbors. With the exception of Millersville, the remaining municipalities are connected with Fiber communication lines.

The county operates a regional transportation system to provide transportation resources to the public, including rideshare.

DATA & TECHNOLOGY STANDARDS

Sumner County's transportation data is largely contained within its proprietary transportation systems, including McCain, Peak & Eagle (Econolite will have data in the future as transportation developments continue). There has been little need to develop open data or cyber security policies. Planning and analysis is largely limited to moving traffic to/from highways and interstates during peak volume hours throughout the weekdays.

PLANS & POLICIES

SUMNER COUNTY

Briefly mentions transit & multimodalism

KEY ISSUES / FOCUS AREAS

Briefly mentions transit/multimodal planning

GALLATIN

GALLATIN ON THE MOVE 2020

This Plan utilizes the best planning practices and smart growth principles to guide the future planning and growth management of the City of Gallatin. Focus is placed on improving a connected, multimodal network that will provide access to the City and to the Region. Specific objectives and goals are summarized below:

Objective: Connect roads and sidewalks designed for new suburban neighborhood developments to adjacent established neighborhoods to provide connectivity to greenspace, commercial, recreation areas

Goal: A multi-modal, safe and sustainable transportation network that is accessible to all residents and local businesses; enhances movement throughout the City and between regional centers; provides regional commuting alternatives; and enables desired growth

Objective: Work with the Nashville Area MPO, RTA, and TDOT to implement multi-modal solutions including a Comprehensive local public transit system that addresses the elderly and the underserved, providing access to Downtown, the hospital and shopping areas, and inner-city mobility/Mass transit that provides service between Gallatin and Nashville through Hendersonville.

Objective: Develop a comprehensive pedestrian transportation system

Objective: Retrofitting and operational improvements to the City's corridors

Established corridors in the City would benefit from a series of operational improvements such as a more sophisticated traffic signal synchronization system, increased access management, and expansion, where needed, of ROW to include dedicated left-turn lanes, bicycle lanes, curb/gutter, and sidewalks. These types of improvements could significantly enhance both the safety and efficiency of the existing system. Synchronization of traffic signals would help smooth traffic flow, reduce congestion, and improve travel times at peak traffic hours. The net result would be a more enjoyable driving experience, less fuel waste, lower vehicular emissions, and time savings for Gallatin's residents, workers, and businesses. Access management on established corridors such as South Water Avenue could provide order to what have become continuous curb cuts on each side of the street and resulted in an unattractive, pedestrian-unfriendly, confusing roadway. Access management, in association with other improvements listed above, could work to create well-managed, walkable corridors that serve the needs of all types of travelers including drivers and pedestrians. ROW expansion on corridors such as Lock 4 Road will help these streets transition from rural to suburban and better respond to the needs demanded by residents and visitors.

Objective: Develop a complete, connected system of roads

Chapter 4– Multi-Modal Transportation Plan

Project #16. Walkable/bikeable small-scale collector system for emerging residential area – Create a walkable and bikeable small scale collector system for the area roughly bound by Long Hollow Pike on the north, Bison Trail Extension on the south, Big Station Camp Boulevard on the west, and GreenLea Boulevard on the east. The purpose of this system is to provide multimodal access to this developing residential area. The road network should use existing roadways when appropriate but be established by way of development specific access plans, created by the development community, that provide access from development projects to major collectors. This network will most likely be financed with private funds by the development community. The concept for connected road network was generated as a part of the SR-386 Area Study.

Project #34. Long-term Traffic Signal Timing Maintenance – address outdated signal timing plans along major corridors throughout Gallatin (e.g. Main Street, US-31E, Long Hollow Pike). Better traffic signal management would improve traffic flow, reduce congestion, and improve safety for motorists and pedestrians. The Federal Highway Administration (FHWA) recommends performing signal retiming whenever a new signal is added or access is changed, but at a minimum every three years. Gallatin's Traffic Signal Timing and Coordination Plan were last updated in 2003. Since then, little maintenance has been done on the system. Currently, Gallatin's City Engineer is responsible for all of the signals in the network. The city has approximately 40 signals in service. The FHWA recommends that an agency should have at least one (1) signal technician for a network of this size.

KEY ISSUES / FOCUS AREAS

- Implement local transit system (flex bus)
- Future planning for pedestrian transportation system
- Retrofitting corridors for signal tech, particularly synchronization
- Retrofitting corridors to increase bicycle / ped facilities
- Increasing bicycle/ped connectivity in road network

BICYCLE AND PEDESTRIAN
All roadways should be designed and constructed under the assumption that they will be used by cyclists or pedestrians who will compete with vehicles to share the right-of-way. Sidewalk presence is currently sporadic throughout the City, though more recently developed portions of Gallatin generally include sidewalks on at least one side of the street. The City of Gallatin's Greenway Master Plan designated several bicycle/pedestrian trails throughout the City. These trails would be valuable assets to the community and should augment a city-wide bicycle/pedestrian system.

In general, the designated use of sidewalks for bicycle travel is unsatisfactory. The development of wide sidewalks does not necessarily add to the safety of sidewalk bicycle travel. Bicycles should be discouraged from using sidewalks, as bicycle traffic on sidewalks can create sight-distance and driver expectancy issues at driveways and intersections. However, it should be noted that it is common for young children to ride bicycles on sidewalks in residential areas. Given the lower speeds, the potential for conflicts is lessened. However, it would still be inappropriate to sign these facilities as bicycle routes.

BIKE LANES
Bike lanes are planned and/or proposed along many roadways within the planning area. Bike lanes are generally a portion of roadway that has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicycles. Typically bike lanes require additional pavement to separate bicycle lanes from the vehicle lanes. Bike lanes are typically provided by the use of paved shoulders or wide outside vehicular traffic lanes. Plan included a list of where Bikelanes and sidewalks are recommended.

TRANSIT
Currently, the only transportation service available to the City of Gallatin is a demand-responsive (dial-a-ride) service. The service currently established is operated by the Mid-Cumberland Human Resource Agency (MCHRA)18. Accessible vans are used to serve the 12 counties in the Mid-Cumberland Region.

In addition to the Gallatin on the Move 2020, the 2005 Transit Feasibility Study recommended the establishment of a Flexible Bus Service to meet this goal.

HENDERSONVILLE

CITY OF HENDERSONVILLE'S LAND USE & TRANSPORTATION PLAN

This plan includes the following:

INTELLIGENT TRANSPORTATION SYSTEM
Intelligent Transportation Systems (ITS) have many potential benefits when implemented in concert with an overall transportation management strategy. ITS solutions use communications and computer technology to manage traffic flow in an effort to reduce crashes, mitigate environmental impacts such as fuel consumption and emissions, and reduce congestion from normal and unexpected delays. Successful systems include a variety of solutions that provide surveillance capabilities, remote control of signal systems components, seamless sharing of traveler information with the public, and even allow emergency vehicles to have priority to proceed safely through signalized intersections.

SIGNALIZATION
The volume of traffic attracted to some side streets or site driveways is more than can be accommodated acceptably under an unsignalized condition. Delays for minor street movements as well as left-turn movements on the main street may create or contribute to undue delays on the major roadway and numerous safety issues. The installation of a traffic signal at appropriate locations can mitigate these types of issues without adversely affecting the operation of the major roadway provided they are spaced appropriately. Approximate construction cost is $75,000 to $100,000 per signal. Additional costs would be expected if enhancing the signal placements with mast arms.

PROGRESSIVE-CONTROLLED SIGNAL SYSTEM
A progressive-controlled signal system coordinates the traffic signals to move through multiple signals without stopping. Traffic signals are spaced appropriately and synchronized so when a vehicle is released from one intersection the signal at the next intersection will be green by the time the vehicle reaches it.

Likewise, adaptive signal control involves continuously collecting automated intersection traffic volumes and using the volumes to alter signal timing and phasing to best accommodate actual-real-time-traffic volumes. Adaptive signal control can increase isolated intersection capacity as well as improve overall corridor mobility by up to 20% during off-peak periods and 10% during peak periods. Approximate construction cost is $250,000 per system and $10,000 per intersection in addition to 25% of capital costs in training, etc.

The City is currently undergoing a signalization project, TIP #99-New-29. Planning and engineering for the project took place in 2008, with construction underway in 2009.

DYNAMIC MESSAGE SIGNS (DMS)
Dynamic Message Signs alert vehicles of congestion or incidents. DMS units give general alerts, such as "congestion ahead" or specific details on the location of the incident or predicted travel times so motorists can mentally prepare. Often, drivers are more patient if they can anticipate how long the delay will be or how far the congestion spreads. Perhaps most importantly, DMS informs drivers who can choose alternate travel routes during heavy congestion, thereby reducing the volume on the freeway, the likelihood of additional incidents, and the average travel time for the system as a whole.

CLOSED CIRCUIT TELEVISION TRAFFIC MONITORING
Closed Circuit Television (CCTV) cameras are primarily used on interstate facilities and major arterials to provide visual traffic volume and flow information to traffic management or monitoring centers. These centers use this information to deploy incident response patrols/equipment and to provide roadway travel delay information to motorists. By having visual roadway information, traffic management centers are able to identify incidents quickly and respond appropriately and efficiently, helping to reduce the effect of incidents on a single location or on multiple roadways. Approximate construction cost is $20,000 per location.

EMERGENCY VEHICLE PREEMPTION
This strategy involves an oncoming emergency or other suitably equipped vehicle changing the indication of a traffic signal to green to favor the direction of desired travel. Preemption improves emergency vehicle response time, reduces vehicular lane and roadway blockages, and improves the safety of the responders by stopping conflicting movements. Approximate construction cost is $5,000-$7,000 per intersection plus $2,000 per equipped vehicle.

COMPLETE STREETS
Guiding Principles include: "Design in balance so that traffic demands do not overshadow the need to walk, bicycle, and ride transit safely, efficiently, and comfortably. The design should encourage people to walk."

MULTI-MODAL CORRIDORS
Balance between travel modes within the same transportation corridor fosters an environment of choice for mobility that could lead to reduced congestion on major roadways and a healthier citizenry. On a complete street, safe and convenient access to the transportation network for bicycles, transit, and automobiles is afforded within the travelway realm. Travel lanes for automobiles and transit vehicles should measure between 10 and 11 feet wide, depending on the target speed, to manage travel speeds and reinforce the intended character of the street. Parking lanes incorporated into the travelway realm should not exceed 8 feet in width (including the gutter pan) and may be protected by bulb-outs evenly spaced throughout the corridor.

Bus stops located along the corridor should be well-designed to include shelters, as well as benches that comfort patrons while waiting for

transit service. On-street bicycle lanes (typically 4 to 6 feet wide) should be considered when vehicle speeds range from 30 to 40 miles per hour. Wide outside lanes may be preferred on streets with higher speeds. To avoid situations where citizens with only basic bicycle skills may be attracted to a corridor, designated bicycle routes on parallel corridors may be the best option when speeds on the major street exceed 40 mph.

OPERATIONS:
Traffic signals or roundabouts are the two most appropriate applications for traffic control devices that also could maintain the pedestrian scale of the street reinforced in the context, pedestrian, and travelway realms. The merits of a traffic signal for intersection control should be determined on a case-by-case basis after taking into consideration key issues such as desired traffic speed, availability of right-of-way, anticipated traffic patterns, and the context of the built environment surrounding the intersection.

KEY ISSUES / FOCUS AREAS

- Improve signalization through ITS, installing new signals, and progressive-controlled systems
- Also noted: Dynamic message signs, closed circuit television traffic monitoring, emergency vehicle preemption
- Design for complete streets/multimodal access

WESTMORELAND
LAND USE AND TRANSPORTATION PLAN

Westmoreland is severely deficient in sidewalks. The only sidewalk that exists is along the downtown commercial district. The Plan speaks to the urgency of the local elected officials to research state and federal funding to expanded sidewalks, especially along Hawkins Drive where school facilities are located.

The Land Use and Transportation Plan should be a step towards smart growth explicitly integrating the environment, economy and community.

DEVELOPMENT GOALS:

- To provide adequate and efficient public facilities and services, with access to shopping, recreational and cultural activities that is convenient for the automobile, and to the extent possible pedestrian traffic.
- To provide an efficient and effective transportation system with appropriate linkages and capacities.

KEY ISSUES / FOCUS AREAS

- Expand sidewalks
- Smart growth
- Reduce the focus on the automobile

MICHELLVILLE
Limited information included in county plan

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WILLIAMSON COUNTY

Williamson County is due south of Nashville and is one of the wealthiest counties in the United States. A large part of the population growth in the region is expected to re-locate to Williamson County. One of the biggest draws to the area are its excellent public schools. Other cities in the county are also experiencing tremendous growth. Over 40,000 commuters pass through Williamson County every day. Franklin Transit helps connect people in the Franklin and Cool Springs Area. The service is managed and operated by The TMA Group for the Franklin Transit Authority.

INFRASTRUCTURE & ASSETS

Williamson County and its municipalities of Brentwood, Franklin and Thompsons Station maintain a robust inventory of Smart Mobility assets. The cities of Brentwood and Thompsons Station maintain numerous Econolite signals and ATMS, while the City of Franklin utilizes a Siemens signaling system.

The county's municipalities are planning significant expansion of Bluetooth data collection devices, including Blyncsy and Blue Toad products. There is also strong coordination with TDOT to respond to incidents and move traffic volume in peak hours.

DATA & TECHNOLOGY STANDARDS

Williamson County and its municipalities of Fairview, Franklin, Brentwood and Thompson's Station, have adopted individual standards that align with different signal & ATMS manufacturers (Siemens, Econolite & Peak). This creates challenges for coordination of digital systems and data and has resulted in a lack of data and/or technology standards. The individual municipalities frequently coordinate, sometimes on a daily basis, to manage incidents and demand during -peak hours.

POLICIES & ORDINANCES

There has been little need to develop open data or cyber security policies. Planning and analysis is largely limited to moving traffic to/from highways and interstates during peak volume hours throughout the weekday.

FRANKLIN

ENVISION FRANKLIN (2017)

MAJOR OBJECTIVES:
Emphasize active transportation for both destinations and recreation by connecting land uses through multiuse paths, sidewalks, and trails.

New development and redevelopment should contribute to a convenient and functional multi-modal transportation system by providing accessible street and pedestrian connections on all sides, integrating bicycle or multi-use paths, and incorporating transit provisions.

COMPACT RESIDENTIAL:

- Vehicular connections should be provided through adjacent developments and connect to the existing street network. Infill development should provide an interconnected street and sidewalk network in a grid or modified grid pattern.
- New streets should be designed per the Corridor Character Matrix and Connect Franklin.

BICYCLE AND PEDESTRIAN:

- New development should provide sidewalks, multi-use paths, and trails throughout its open spaces. They should connect to other conservation areas, paths, adjacent uses, and streets. These bicycle, pedestrian, and multi-use path connections should be designed and provided per the Corridor Character Matrix, Connect Franklin, and Parks Master Plan
- Transit stops and/or stations should be provided along existing or planned routes.

OTHER RESIDENTIAL CATEGORIES

- New development should provide sidewalks, multi-use paths, and trails throughout its open spaces. They should connect to other conservation areas, paths, adjacent uses, and streets. These bicycle, pedestrian, and multi-use path connections should be designed and provided per the Corridor Character Matrix, Connect Franklin, Parks Master Plan, and this Plan.

REGIONAL COMMERCIAL

- New development should provide sidewalks, multi-use paths, and trails throughout its open spaces. New development should provide connections between uses on the site and between the site and adjacent properties and rights-of-way. Internal pedestrian systems should provide direct access from sheltered transit stops to buildings. These bicycle, pedestrian, and multiuse path connections should be designed and provided per the Corridor Character Matrix, Connect Franklin, Parks Master Plan, and this Plan.
- Transit should be enhanced in this area to serve and support existing and future businesses, residents, and visitors. Sheltered transit stations should be provided along existing or planned routes. Employer-transportation programs are encouraged in order to reduce the percentage of trips made by single-occupant vehicles and to encourage use of alternate modes.
- Large developments should consider using internal shuttle systems for efficient vehicular patterns.

KEY ISSUES / FOCUS AREAS

- Congested major thoroughfares due to over-reliance on arterials from lack of neighborhood connectivity
- Evolving transportation needs and desires, including frequent and convenient regional and local transit and on-demand travel options
- Demand for more sidewalks and bicycle facilities

CONNECT FRANKLIN (2016)

TRANSPORTATION GOALS:

- Improve mobility, accessibility and transportation alternatives to provide for the safe and efficient movement of people and goods;
- Safe, efficient and convenient movement of people and goods
- within the City and its UGB by integrating land uses, circulation routes and transportation facilities;
- Implement industry accepted best practices in transportation planning and transit-oriented planning and ensure they are in conformance with the Regional Travel Demand Model developed by the Nashville Area Metropolitan Planning Organization (MPO); and Implement a smart growth policy that promotes sustainable economic development, maintains the character throughout the city, and improves health and safety by increasing the amount of recreation and open space.

SUSTAINABILITY EFFORTS:

- Installation of bike bollards and bike racks in Downtown Franklin;
- Installation of Electric Vehicle charging stations in 2nd and 4th Ave parking garages;
- Awarded $212,000 Safe Routes to School Grant;

SUSTAINABILITY INITIATIVES:

- A direct bus service to downtown Nashville was established using ARRA funds;
- Planning and installation of a comprehensive electric vehicle charging infrastructure;
- All traffic signals use LED lighting resulting in reduced operation and maintenance costs;
- The City of Franklin is utilizing Federal Surface Transportation Block Grant

(STBG) funds, along with a 20% local funds match, to design and implement Adaptive Signal Control Technology (ASCT) at several intersections in the Cool Springs area. When completed, this ASCT system will automatically adjust (in stepped increments) traffic signal timings at the connected intersections to better reflect changing traffic conditions. After completing a thorough qualifications-based process, the City has selected the Split, Cycle, and Offset Optimization Technique (SCOOT) system from Siemens Industry, Inc. for this project.

TRANSIT

- Pursue a park-n-ride lot and bus stop in the Cool Springs area for the RTA regional bus service. Linking to the Route 91X would provide a regional bus connection with Franklin, Brentwood, and Downtown Nashville; linking to Route 95X would provide a regional bus connection with Thompson's Station, Spring Hill, and Downtown Nashville.
- Evaluate the addition of a dedicated Cool Springs route for the Franklin Transit.

KEY ISSUES / FOCUS AREAS

- Reduce congestion along major thoroughfares
- Improve connectivity
- Focus on active transportation
- New development should provide multimodal facilities, including transit stops and/or shuttle systems as well as bike lanes, sidewalks
- Planning/installation of EV charging infrastructure
- Adjust transit service park & ride, additional routes

BRENTWOOD

BRENTWOOD 2030 PLAN (2013)

This plan calls for associated multi-modal accommodations to be provided for many of the improvements. A multi-use path (MUP) is recommended alongside primary traffic routes where pedestrians and cyclists would benefit from separation from traffic. An example is the path which already exists alongside Concord Road. Bicycle lanes (BL) are recommended where lesser traffic exists or where bike lanes are more appropriate contextually. Sidewalks are generally assumed to be a part of most any roadway reconstruction (if no MUP is recommended) and are not specifically called out.

SPECIFIC OBJECTIVES

Objective 4.D.1

Actively participate in planning for a regional transit system that includes a route along the I-65 corridor through Brentwood

Policy 4.D.1a: Any regional transit system along the I-65 corridor should be designed to facilitate ease of use by Brentwood residents commuting outside Brentwood and maximize use for employees commuting to work in Brentwood.

Objective 4.E.2

Encourage strategies and technology solutions to help reduce the number of single-occupancy vehicles on Brentwood's major roadways. The following Traffic Demand Management strategies should be encouraged:

- Increased ridesharing for work/school trips
- Increased telecommuting for businesses in Brentwood
- Increased flextime and staggered work hours for businesses in Brentwood.
- Employer incentives to increase bicycle commuting such as lockers, shower facilities and bicycle racks

Objective 4.E.3

Maximize the use of technology to reduce demand on, and improve the efficiency of, Brentwood's transportation system.

Policy 4.E.3a: To reduce traffic demand, the City will encourage the introduction of retail and restaurants in buildings within those sections of office parks where it currently doesn't exist or is prohibited by zoning regulations.

Policy 4.E.3b: The City will work with adjoining jurisdictions to maximize coordination of traffic signal system operations to more efficiently maximize the flow of traffic.

4.E Traffic Demand Management Actions

- Consider implementation of adaptive traffic signal timing technology in heavily congested corridors where use is appropriate.
- Continue to expand and improve the use of technology to improve traffic flow, manage incidents, and reduce delays.
- Example - The Traffic Operations Center uses video feeds from intersection cameras. The system manages the traffic flow and monitor for signal synchronization. City website and public access television Channel 19 provide real time traffic feeds at key intersections during peak commuting times.

KEY ISSUES / FOCUS AREAS

- Increase multimodal (bike, ped) accommodations
- Planning for regional transit with a focus on commuting
- Reduce the number of SOVs through TDM
- Mixing uses in office parks etc.
- Coordinate traffic signal operations
- Pursue tech such as adaptive signal technology, traffic flow management in real-time

THOMPSON'S STATION

THOMPSON STATION GENERAL PLAN

The plan contains a number of policies to encourage compact, walkable and connected communities throughout the City

Policy 7.2 – Encourage development in the form of complete, walkable neighborhoods within the Intended Growth Sector of the Sector Plan.

Policy 1.2 – Develop design standards for roadways, including but not limited to paved width, shoulder, curb and gutter, sidewalks or trails and parkways.

Policy 2.1 – Pursue alternative forms of transportation.

Policy 2.2 – Establish requirements for a system of sidewalks and pathways for residents through neighborhoods and into commercial areas.

Policy 2.3 – Encourage bike paths through developments and along roadways.

Policy 2.4 – Develop, where feasible, a system of multi-purpose trails along the West Harpeth River and its tributaries with connections with parks, schools, and other recreational uses.

Policy 2.5 – Promote carpooling or ride sharing opportunities through the development of park and ride facilities.

Policy 2.6 – Encourage urban development in central areas along major thoroughfares to control higher traffic volumes and emphasize walking, biking and other alternate forms of transportation.

KEY ISSUES / FOCUS AREAS

- Future planning efforts: design standards, park and ride facilities
- Alternative transportation, bike paths, multi-purpose trails

FAIRVIEW

The previous comprehensive plan in Fairview was adopted in 2000. The City is currently updating there comprehensive plan, a draft is not available to the public at this time. The currently adopted plan makes reference to the Nashville MPO goals and strategies.

NOLENSVILLE

The Nolensville Comprehensive Plan contains policies to create an interconnected, safe, and useable pedestrian and bicycle network throughout the Town.

WILLIAMSON COUNTY

The Williamson County Comprehensive Plan did not have an explicit goals and policies pertaining to smart mobility.

WILSON COUNTY

Wilson County is located northeast of Nashville along I-40 and is rapidly growing. Its county seat is Lebanon and the largest city is Mt. Juliet. The Wilson County Fair is one of its great attractions, drawing in more than 500,000 people to the community.

Wilson County plans on taking advantage of one of its unique assets, the Music City Star, as it plans for smart mobility. The Regional Transit Authority oversees the Music City Star Regional Rail. The first segment of the regional rail connects Davidson and Wilson counties. The East Corridor utilizes a 32-mile section of track belonging to the Nashville & Eastern Railroad Authority. Tracks, signals and bridges were recently upgraded and replaced, and various grade crossings have been improved. Its three trains provide weekday morning and evening service at six stations: Riverfront, Donelson, Hermitage, Mt. Juliet, Martha and Lebanon.

INFRASTRUCTURE & ASSETS

Wilson County, including the City of Mt. Juliet and the City of Lebanon, has been rapidly expanding their Smart Mobility infrastructure in both the Automated Teller Machines (ATMS) and roadside data collection devices. The City of Mt. Juliet utilizes a McCain ATMS, the same manufacturer of their signals, and plans to implement fiber communications in the coming year. This will aid in communications with neighboring municipalities of Lebanon & Davidson County. The county operates a regional transportation authority to provide transportation resources to the public. Rideshare is also present within the county.

DATA AND TECHNOLOGY STANDARDS

Wilson county's transportation data is largely contained within its McCain transportation infrastructure system. There has been little need to develop open data or cyber security policies. Planning and analysis is limited to moving traffic to/from highways and interstates during peak volume hours throughout the weekdays.

PLANS AND POLICIES

MT JULIET

FUTURE LAND USE AND TRANSPORTATION PLAN UPDATE 2016

TOWN CENTER OBJECTIVE:
Coordinate with the Regional Transit Authority (RTA) the highest and best use for this land area, particularly in a Transit-Oriented Development (TOD), or other alternate and more efficient form(s) of public transportation.

TRANSPORTATION OBJECTIVES:

- 2. Utilize pedestrian ways and bike routes, wherever possible, to connect residential areas with nonresidential centers, schools and parks.
- 3. Establish more pedestrian ways and bike trials/routes to encourage fewer automobile trips as envisioned in the Mt. Juliet Greenway, Bike and Pedestrian Master Plan.
- 4. Develop a bicycle system that will join parks and recreational areas, schools and commercial activity centers in the City of Mt. Juliet.
- 5. Adopt a Multi-Model Major Thoroughfare Plan that provides an efficient interchange between modes for all types of trips and addresses interconnections between pedestrian, bicycle, auto, and rail in order to maximize choices for mode of travel.
- 14. Future development in the region shall be planned and designed to be pedestrian-friendly, with full accommodation for safe, comfortable and convenient walking on a continuous, well-connected system of sidewalks, walkways and safe street crosswalks, in accordance with Americans with Disabilities Act (ADA) requirements.
- 15. Encourage mixed use neighborhoods, activity centers, and employment centers supported by a network of pedestrian, bicycle, and automotive systems.
- 16. Coordinate with the Regional Transit Authority (RTA) the highest and best use for land encompassing RTA lands, particularly in a Transit-Oriented Development (TOD), or other alternate and more efficient form(s) of public transportation to ensure compatibility of any new development with the transportation system.
- 17. Encourage the establishment and use of park and ride lots.
- 18. Increase ridership to extend Music City Star commuter schedule to longer hours during the business week and to weekends.

KEY ISSUES / FOCUS AREAS

- Connect residential + nonresidential with bike/walk facilities
- Encourage a mix of uses
- Encourage TOD on RTA lands if relevant
- Increase park and ride lots
- Increase all modes of connectivity

WILSON COUNTY

Wilson County has adopted a bike plan that addresses bike lanes on state routes only. They have recently updated the General Plan, however, it does not address complete streets or anything else relevant to smart mobilty.

LEBANON

The City of Lebanon has an adopted 1984 Comprehensive Plan and 2006 Land Use Plan. The City is updating their Plan in 2019.

No information was found for the following:

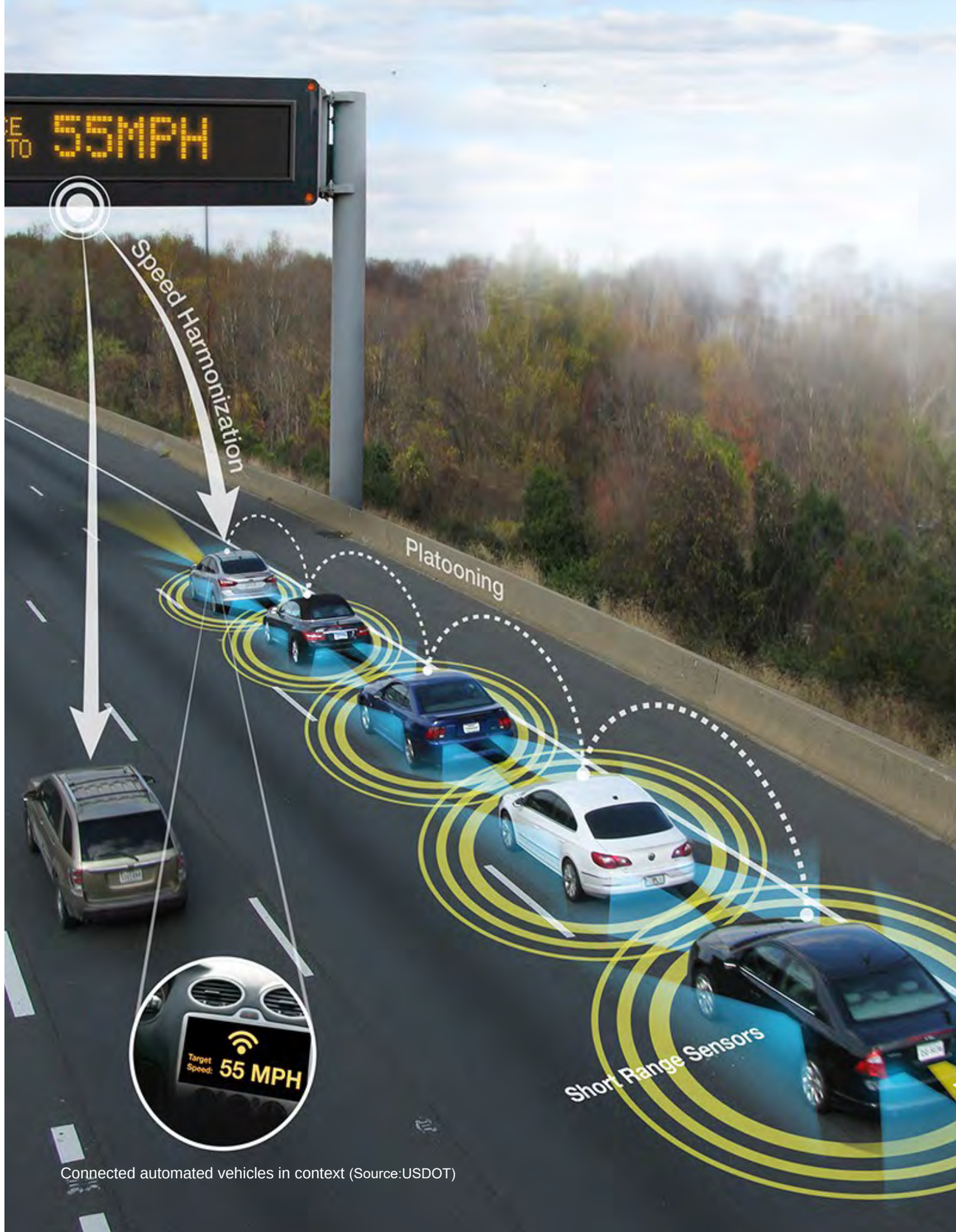
WATERTOWN

APPENDIX B - SMART TECHNOLOGY GLOSSARY

TECHNOLOGY OF SMART MOBILITY

With ever-increasing traffic congestion and its side effects, such as pollution, fatalities and wasted time, smart mobility solutions are becoming necessary in Middle Tennessee to reduce climate impacts, increase safety, improve travel conditions, foster economic competitiveness, and ensure regional equity. Smart mobility is a term referring to using advanced technologies, including Connected Automated Vehicles (CAV), Internet of Things (IoT) and Artificial Intelligence (AI), to improve the efficiency of the existing transportation system and to help travelers from all the backgrounds access safer, faster, more reliable and cleaner transportation options.

The essence of Smart Mobility systems is their ability to share real-time data about transportation conditions. There are many different technologies to consider and multiple field devices that can be used when creating a communications backbone for Smart Mobility. Different elements of a smart network interact with different types of communication media, as shown in the figure below. The data is sent back and forth between a central location and one or more field devices using a communication medium. Different communication media are explained in the following section.



Connected automated vehicles in context (Source:USDOT)

TECHNOLOGY GLOSSARY

COMMUNICATION TECHNOLOGIES

5G WIRELESS (FROM "5TH GENERATION")

5G is the latest generation of cellular mobile communications. It succeeds the 4G (LTE-A, WiMax), 3G(UMTS, LTE) and 2G (GSM) systems. 5G performance targets high data rate, reduced latency, energy saving, cost reduction, higher system capacity, and massive device connectivity. The first phase of 5G specifications in Release-15 will be completed by April 2019 to accommodate the early commercial deployment. The second phase in Release-16 is due to be completed by April 2020 for submission to the International Telecommunication Union (ITU) as a candidate of IMT-2020 technology. There is great debate about whether DSRC or 5G should be the automotive vehicle to vehicle and vehicle to infrastructure communication. While the battle plays itself out it is reasonable to believe both technologies will be useful and will likely have to "play nice together". On-board units (OBU) – Communication device mounted on vehicles or mobile units. It allows DSRC and/or Cellular communications with other on-board units/ road side units (RSU).

CELLULAR

Cellular communications uses the cellular modems to connect various devices to each other and caries data between devices. In places without fiber optic connectivity cellular communications can be a cost-effective alternative if bandwidth needs and cellular coverage are within reason. While there are many efforts underway to make broadband cellular data available across the US, there are still areas where cellular data is not available.

CLOSED CIRCUIT TELEVISION (CCTV) CAMERAS

CCTV cameras are utilized by TMCs and TOCs to monitor traffic, identify traffic incidents, and proactively reduce/mitigate congestion. With the use of a 511 system such as TDOT's SmartWay website, the driving public can also access these cameras to plan ahead for their journey.

COPPER

Copper communications include short range communications cables such as CAT 6 and longer-range communications cables such as twisted pair. Twisted pair has largely been replaced by fiber optics, but copper is still used to make the final connections between fiber optic switches and field devices at the same host site (e.g. CCTV camera cabinet).

DSRC

Dedicated short-range communications are one-way or two-way short-range to medium-range wireless communication channels specifically designed for automotive use. The DSRC Service involves vehicle-to-vehicle (on board unit to on board unit) and vehicle-to-infrastructure (on board unit to roadside unit) communications, helping to protect the safety of the traveling public. DSRC operates in the 5.9 GHz band that has been reserved by the FCC for vehicle-to-vehicle and vehicle-to-infrastructure communications.

DYNAMIC MESSAGE SIGNS (DMS)

A DMS is an electronic traffic sign often used on roadways to give travelers information about travel times, travel warnings, amber alerts and special events.

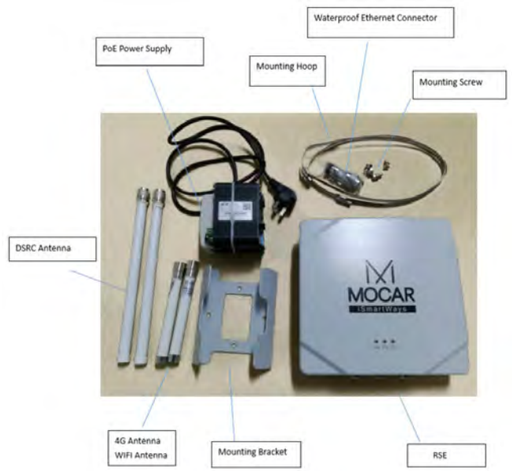
FIBER

Fiber optic cable is an assembly similar to an electrical cable but containing one or more glass optical fibers that are used to carry light. The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed. Different types of cables are used for different applications, for example long distance communication relies on single mode fiber while shorter distance communications, such as within buildings, relies on multimode fiber. Many fiber networks exist thought the middle TN region; however, in many instances there is no accurate inventory of where the cable exists or who is the owner of the cable.

CCTV camera

On-Board Unit (OBU) equipment

Roadside Unit (RSU) equipment



LTE (LONG-TERM EVOLUTION)

A 4G wireless broadband technology that provides speeds of up to 100 Mbps download and 30 Mbps upload.

ON-BOARD UNITS (OBU)

Communication device mounted on vehicles or mobile units. It allows DSRC and/or Cellular communications with other on-board units/ road side units (RSU).

ROADSIDE UNITS (RSU)

Communication device mounted on pole or sign on the side of the roadway. It allows DSRC and/ or Cellular communications with vehicle on board unit.

VEHICLE DETECTION

Vehicle detection devices are used to detect when a vehicle moves from one point to another. The most common use for vehicle detectors are at signalized intersections where they are used to detect vehicles in each approach lane of the intersection to control the phasing and timing at the intersection. Vehicle detection devices can also be an important tool when addressing many safety concerns including the level of traffic congestion, wrong way driving, oversized vehicles and many more. There are many vehicle detection devices available including wire loops embedded in the pavement (the most traditional device), video detection that uses static cameras, radar detection, and magnetometers (similar to wire loops but with quicker installation and wireless connections).

TRAFFIC MANAGEMENT CENTER (TMC) / TRAFFIC OPERATION CENTER (TOC)

TDOT currently operates four TMCs 24 hours per day, 7 days per week in the following locations: Knoxville, Chattanooga, Nashville, and Memphis. The TMCs are responsible for identifying and managing incidents as well as working to prevent secondary crashes. TMC operators are provided a variety of tools to perform their duties including closed circuit television (CCTV) Cameras, dynamic message signs (DMS), radar detection

systems (RDS), video detection systems (VDS), highway advisory radio (HAR), height and speed warning systems, fog warning systems, portable variable message signs (PVMS), and portable CCTV (PCCTV) Cameras. TMC operations are focused on providing efficient incident management along the freeways and managing congestion.

Several cities in the Middle TN region also operate their own Traffic Operations Center (TOC). The TOC's have a similar function as the TDOT TMC but on a smaller scale and with more focus on arterials rather than freeways. Each center operates independently and data sharing between the TDOT TMC is typically on an ad-hoc basis. The TOC's have access to CCTV cameras and some have video detection systems at some of their traffic signals. The major difference is that the TOC's are tasked with managing the traffic signals throughout their city.

TRAFFIC SIGNALS

Traffic signals play a significant role in how a city improves traffic flow and congestion and how it advances smart city efforts. In the State of Tennessee, TDOT does not own, maintain or control any traffic signals. All traffic signals are owned and maintained by cities and counties. Traffic signals are primarily used to address conflict between various traffic flows – whether that be directions of travel or varying modes of transportation. Ideally, controlled intersections ensure all traffic types move through a given point safely and efficiently. Traffic signals have advanced over the years and now employ a number of technological features that offer a number of operational and user benefits. For purposes of the Regional Smart Mobility Assessment, traffic signals are broken out into the following categories:

1) isolated signals,
2) synchronized signals
3) connected signals that are not interoperable
4) connected signals that are interoperable

ISOLATED SIGNALS operate on a timer, with newer versions also containing a detection system that is triggered by the presence of a vehicle. The sensors may be located within the pavement or attached to the signal pole.

SYNCHRONIZED SIGNALS contain vehicle detection systems but also allow coordination of operation between multiple signal systems, such as along a corridor. With multiple signals coordinated, traffic engineers are able to program signals in order to optimize traffic flow through a certain area.

CONNECTED SIGNALS contain vehicle detection systems and are physically linked, either by fiber, copper, cellular modems or short range radio, with multiple signals, and are also able to respond to real-time conditions as well as accept instructions remotely. However, not all connected signals are interoperable with other connected signal systems. Signals which are connected and interoperable with other signal systems are also physically linked, either by fiber, copper, cellular modems or short range radio, with multiple signals, and are also able to respond to real-time conditions as well as accept instructions remotely.

WI-FI

Wireless connectivity, often known as Wi-Fi, is the technology that allows a PC, laptop, mobile phone, or tablet device to connect at high speed to the internet without the need for a physical wired connection.

WIRELESS RADIO

Wireless radios can be used to connect devices in a number of various arrays including point to point and point to multipoint. Wireless radios can utilize licensed and unlicensed frequencies. Licensed frequencies can be expensive to obtain, but interference is less likely. Unlicensed frequencies are available but are shared with other wireless devices so bandwidth and reliability are limited. Line of sight is required to connect two wireless radios which can make deployments expensive – particularly in areas with significant terrain variations.

A corridor in Brentwood that has been proposed for traffic signal improvements (Source:Tenneesean)

APPENDIX C - SMART MOBILITY INVENTORY OF ASSETS & TRENDS

Municipality	Nashville/ Davidson Co.	Columbia	Spring Hill	Maury County	Thompson's Station	Franklin	Brentwood	Williamson County	Springfield	
ATMS Software	Econolite Centracs					Siemens TACTICS	Econolite Centracs			
Traffic Operations Center	✓					✓	✓			
VEHICLE OPERATIONS										
Transit	WeGo, Vanderbilt, and RTA		RTA	RTA		Franklin Trolley with AVL		RTA	RTA	
DSRC Onboard Units							30			
Navigation App Usage	✓	Limited								
Ride Share Usage	✓		Limited				Hytch			
Bike/Scooter Share	✓									
RIGHT-OF-WAY MANAGEMENT										
Number of Traffic Signals	5 850	2 46	21	0	1 5	114	51		20	
Controller Manufacturers	Econolite	Siemens and Eagle	McCain ATC Peak, Eagle, McCain		Econolite and Peak	Siemens	Econolite			
Automated Traffic Signal Performance						CMAQ				
Advanced Traffic Signal Controllers	850					100	45 10		1	
Adaptive Signal Control						19 (Coming Soon)				
Vehicle Detection	Wavetronix Loops and Video	Loops	Wavetronix and Loops			Wavetronix Loops	45 HD Cameras		Video and Loops	
CCTV Cameras	6	Police				28	29 (Traffic and Police)			
Bluetooth Collection Devices	✓					6 (Blyncsy) (DEMO)	25 (BlueTOAD)			
DSRC Roadside Units	40					CMAQ	55 (BlueTOAD)			
SAFETY AND COMMUNICATIONS										
Communications	Fiber and Twisted Pair	Cellular				Fiber	Fiber		Fiber	
Preemption	Railroad preemption and transit priority	Applied Information ✓	✓			Opticom ✓	Sonem		✓	
POLICY										
Open Data	Open Data Portal									
Cyber Security										
PLANNING AND ANALYSIS										
Traffic Engineering Staff		7	2			4	2		1	
OTHER										
Improvement Opportunities	More Robust Vehicle Detection	Safety Improvements				CMAQ	CMAQ		Congestion Relief	
Other	Smart Parking			Corridor agreement with Williamson Co				Corridor agreement with Maury Co.		

Indicates an upward trend

Robertson County	Murfreesboro	Smyrna	Rutherford County	Hendersonville	Gallatin	Sumner County	Mt. Juliet	Lebanon	Wilson County
	Econolite Centracs	Econolite Centracs		Econolite Centracs	Econolite Centracs		McCain OmniX	CMAQ	
	✓	✓		1 Year	3-5 Years			CMAQ	
VEHICLE OPERATIONS									
RTA	MTSU, Murfreesboro, and RTA	RTA	RTA	RTA	RTA	RTA	RTA	RTA	RTA
							✓		
	✓	✓		✓			✓	✓	
RIGHT-OF-WAY MANAGEMENT									
0	155	51		31	42		28	60	9
	Econolite Cobalt Econolite, Peak, and Eagle			Econolite Cobalt, 3 McCain McCain, Peak, and Eagle	Econolite Cobalt Peak 3000		McCain ATC	Eagle, Peak, Econolite	
							✓	4	
	15						✓	Wavetronix, Loops, Radar, Fish Eye Camera, Video	
				Wavetronix Video and Loops			Wavetronix and Loops	CMAQ	
	Traffic and Police				Police		Police		
	✓	✓							
	DSRC	DSRC	DSRC						
SAFETY AND COMMUNICATIONS									
	Fiber	Fiber Fiber		Fiber	Fiber		Fiber Cellular	Fiber	
	Econolite	✓		✓	✓			Peak	
POLICY									
		State Data Center							
PLANNING AND ANALYSIS									
	1 ✓	2 ✓		1 ✓			2	2 plus 2 in the works	
OTHER									
	Strava	Rutherford County Partnership		CMAQ	CMAQ		DDI	CMAQ	
				Park and Ride Available	HAWK Signals		Multi-use path and street grid connectivity	Sidewalk score card	