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Triangle Region ITS Strategic Deployment Plan Update

PREPARED FOR:

CAMPO NC Capital Area Metropolitan Planning Organization

DCHC Metropolitan Planning Organization Planning Tomorrow Today

PREPARED BY:

vhb iteris ICF

Capital Area MPO
421 Fayetteville Street, Suite 203
Raleigh, NC, 27601
919.996.4400

Venture I
940 Main Campus Drive, Suite 500
Raleigh, NC 27606-5217
919.829.0328

Table of Contents

List of Tables

List of Figures

Acronyms

ATDM	Active Transportation and Demand Management
ATM	Active Traffic Management
AVL	Automatic vehicle location
BOSS	Bus on Shoulder System
BRT	Bus Rapid Transit
CAMPO	Capital Area Metropolitan Planning Organization
CAP	Commuter Alternative Program
CAV	Connected and Automated Vehicles
CR	Commuter Rail
CCTV Cameras	Closed-Circuit Television cameras that are used in transportation network to transmit images to a specific limited number of televisions on the same network or circuit.
DCHC MPO	Durham-Chapel Hill-Carrboro Metropolitan Planning Organization
DMV	Division of Motor Vehicles
DOT	Department of Transportation
DSRC	Dedicated Short Range Communication
ECC	Emergency Communications Center
EMS	Emergency Medical Services
ERH	Emergency Ride Home
FHWA	Federal Highway Administration
HAZMAT	Hazardous Materials
ICM	Integrated Corridor Management
ICT	information and communication technologies
IMAP	Incident Management Assistance Patrol
IOO	Infrastructure Owners and Operators
IoT	Internet of Things
ITS	Intelligent Transportation Systems
IVR	Interactive Voice Response
LAPP	Locally Administered Projects Program
LRT	Light Rail Transit
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
NCDMV	North Carolina Division of Motor Vehicles
NCDOT	North Carolina Department of Transportation
NCTA	North Carolina Turnpike Authority
NOCoE	National Operations Center of Excellence
OEM	Original Equipment Manufacturer
RTMC	Regional Traffic Management Center
SDP	Strategic Deployment Plan
SOVS	Single-Occupant Vehicles
SPaT	Signal Phase and Timing
SPOT	Strategic Prioritization Office of Transportation
STI	Strategic Transportation Investments
STOC	State Traffic Operations Center
STRNC	Share the Ride North Carolina
TDM	Transportation Demand Management
TIM	Traffic Incident Management
TIMS	Traffic Incident Management System
TMC	Traffic Management Center
TOC	Traffic Operation Center
TSMO	Transportation Systems Management and Operations
UNC	University of North Carolina
WCTS	Wake Coordinated Transportation Services

Managed Motorways	Managed Motorways is a collection of strategies and technologies that work in concert to provide a holistic approach to managing traffic operations of a freeway. The integration of these systems is critical to the ability of this concept to increase on-road outcomes by: ▪ Enhancing safety ▪ Improving reliability ▪ Reducing congestion ▪ Providing traveler information ▪ Improving lane utilization
IOO	Infrastructure Owner or Operator (IOO) generally, refers to entities responsible for the design, build, maintenance and operation of the roadway infrastructure. For example, this would include State and local departments of transportation.
OEM	Original Equipment Manufacturer (OEM) refers to the original producer or manufacturer of a vehicle's components. The term is regularly used to describe vehicle or automotive manufacturers.
ITS	Intelligent Transportation System (ITS) means electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface. (*https://ops.fhwa.dot.gov/its_arch_imp/policy_1.htm*)
ITS Architecture	Intelligent Transportation System (ITS) Architecture is a planning tool to effectively plan for technology applications and integration to support more effective planning for operations within the region. A regional ITS architecture provides context for ITS projects so that each project can build a piece of the envisioned transportation system. By using the architecture as a planning tool, the steps taken by each project will be on the path to fulfilling the larger objectives set forth in the long-range transportation plan. (*https://local.iteris.com/arc-it/html/archuse/planning.html*)
TSMO	Transportation Systems Management and Operations (TSMO) is "[A set of] integrated strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects." (MAP-21, Section 1103, a, 30) "Integrated strategies" means: • Regional integration • Intermodal coordination • Interagency collaboration • Technical integration
Smart City	A Smart City is a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities to reduce resource consumption, wastage and overall costs. The overarching aim of a Smart City is to enhance the quality of living for its citizens through smart technology. (*https://www.techopedia.com/definition/31494/smart-city*)
SPaT	Signal Phase and Timing (SPaT) is a real-time provision of traffic signal phase and timing information to vehicles approaching signalized intersections.

Definitions

Executive Summary

ES.1 Introduction

The Triangle Region lies in the heart of North Carolina and features incredible public school systems, three major universities, a growing system of technical and community colleges, a diverse population, and seemingly endless opportunities for recreation and cultural expansion. The byproduct of these attractive qualities is growing congestion on regional roadways. To address this congestion, new roads are constructed, existing roads are widened, and opportunities for transit, pedestrian and bicycle travel are incorporated into roadway improvement projects more often, making it that much more critical to operate and maintain these facilities safely and efficiently. Regional leaders are recognizing the importance of utilizing innovative and emerging technologies to maximize the safety, efficiency, and reliability of the transportation systems within the Triangle Region.

ES.1.1 Background

North Carolina's Triangle Region boasts a large, diverse, and growing population. Regional leaders have committed significant funding and allocated resources to plan, design, and implement innovative and emerging technologies to combat the region's increasing congestion. The goal of these efforts is to maximize the safety, mobility, efficiency, and reliability of the existing and future regional transportation system. Agencies leading these efforts include:

- Capital Area Metropolitan Planning Organization (CAMPO)
- Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO)
- North Carolina Department of Transportation (NCDOT)

At the core of this mission, is the Triangle Region's three foundational planning documents:

- Connect 2045, the Metropolitan Transportation Plan for CAMPO and DCHC MPO
- NCDOT's Mobility and Safety: Systems Management and Operations Strategic Plan
- Triangle Region's 2010 Intelligent, Transportation Systems (ITS) Strategic, Deployment Plan (SDP)

The four main objectives of the Triangle Region ITS Strategic Deployment Plan Update are:

- Analyzing existing conditions, assessing needs and gaps and examining technology trends
- Developing ITS strategies
- Updating the regional architecture
- Developing a project prioritization methodology

This update to the Triangle Region ITS Deployment Plan assesses the current state of ITS in the region, establishes goals and objectives for future investment in ITS, and identifies actions to fill gaps to achieve the desired goals in the near-term, mid-term, and long term. Activities included reviewing recent regional and statewide transportation studies and projects, holding multiple stakeholder workshops, performing small group stakeholder interviews, and performing a literature review of current and trending technology.

It is estimated that over the next several years, the Triangle Region will account for one-third of the state's population growth.

ES.1.2 The Triangle Region

The Triangle Region includes several jurisdictions and operating agencies. Home to approximately 1.9 million people, the region encompasses the combined membership of the Durham-Chapel Hill MPO (DCHC MPO) and the Capital Area MPO (CAMPO) – Town of Angier, Town of Apex, Town of Archer Lodge, Town of Bunn, Town of Carrboro, Town of Cary, Town of Chapel Hill, Chatham County, Town of Clayton, Town of Creedmoor, City of Durham, Durham County, Franklin County, Town of Franklinton, Town of Fuquay-Varina, Town of Garner, Granville County, Harnett County, Town of Hillsborough, Town of Holly Springs, Johnston County, Town of Knightdale, Town of Morrisville, Orange County City of Raleigh, Town of Rolesville, Wake County, Town of Wake Forest, Town of Wendell, Town of Youngsville, Town of Zebulon (see Figure ES.1.)

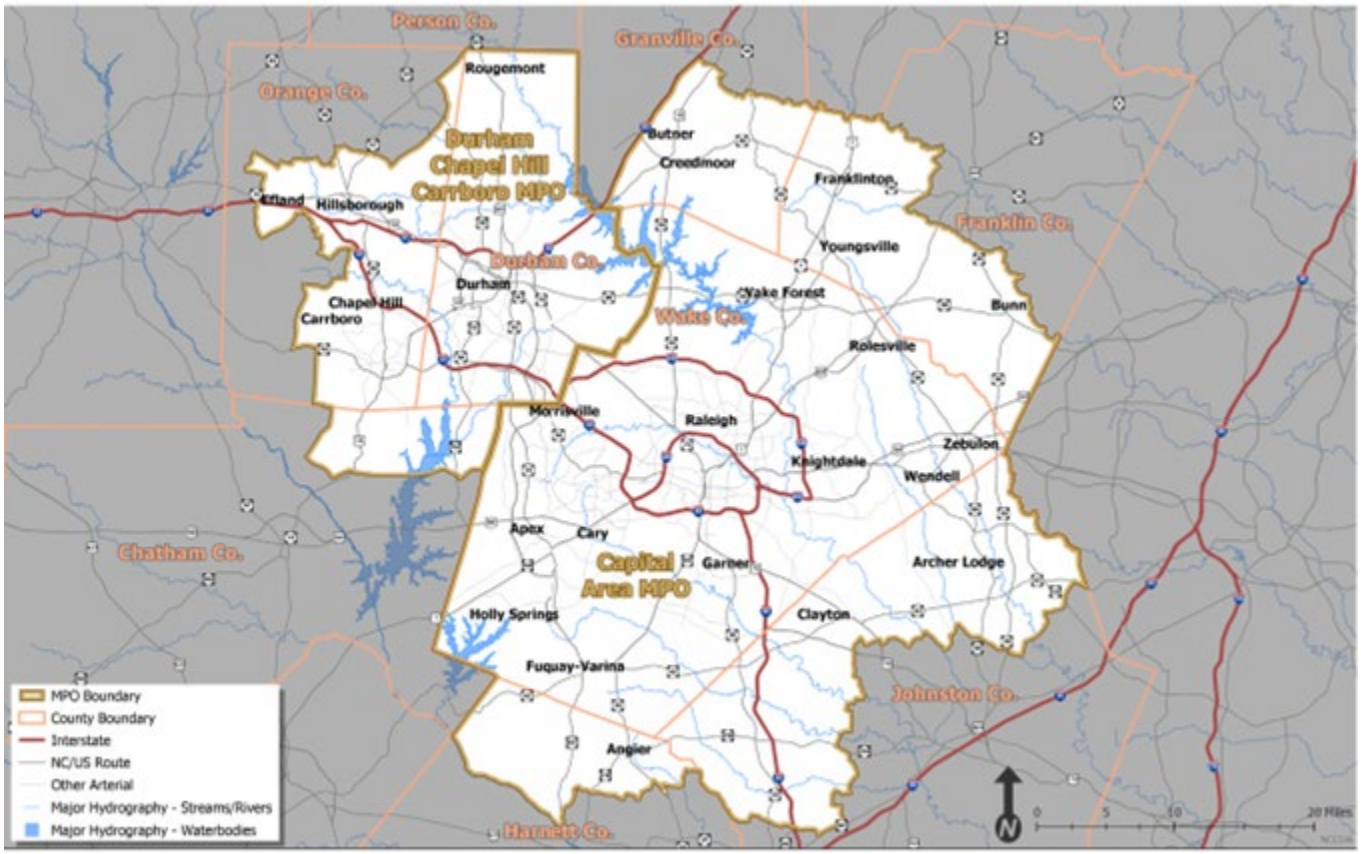


Figure ES.1 Geographic Composition of the Triangle Region

ES.2 Vision, Goals and Objectives

Transportation technologies are evolving rapidly. From the advent of automated vehicles, to increasingly ubiquitous data, mobile applications, the Internet of Things, and the introduction of technology-enabled transportation services, new and emerging technologies will have a significant impact on transportation during the next 10 to 20 years. These technologies, all of which fall under the term of today's "ITS", will change how transportation systems are planned, managed, and operated in the future. Increasingly there is recognition that it is not enough to simply forecast changes in demographics, land use, and travel demand — a broader consideration of the vast implications of potentially disruptive and transformational technologies is also necessary.

The update of the ITS Strategic Deployment Plan included a high level of stakeholder outreach. Stakeholder outreach activities included stakeholder workshops with all stakeholders invited to participate; small group stakeholder interviews to gather more specifics on current ITS uses and objectives; and individual conversations and exchanges for stakeholders that were not available to participate in the stakeholder workshops or group interviews. The participants in the small group stakeholder interviews were invited to participate based on commonalities between the stakeholders such as geographic location, modal operations, and existing and desired partnerships.

The Triangle Region has taken significant steps towards an intelligent transportation network, including the successful deployment of

- Integrated signal systems
- Transit real-time information
- NCDOT Strategic Prioritization (SPOT) funding for ITS
- Infrastructure to vehicle technology
- Interoperability
- Reliable traveler information
- Open AVL data
- Incident Management Assistance Patrol (IMAP) certification and training

While their successes have been significant, the region still experiences challenges with deployment of new systems and/or update existing ones. Key challenges include:

- Aging hardware, including outdated fiber and communications
- Lack of resources, such as staffing, and training, for operating and maintaining systems
- Coordination across municipalities (institutional and technological)
- Transit limitations
- Dedicated funding for Operations and Maintenance

VISION STATEMENT

A region that provides effective, innovative, and seamless integrated services to enhance safety, mobility, reliability and interoperability through ITS solutions.

The vision, goals and objectives are the results of the strategic planning process and stakeholder outreach activities. Objectives were initially identified through review of existing regional transportation planning documents and the early stages of the stakeholder outreach activities (primarily the first stakeholder workshop). The objectives were further refined through continued stakeholder outreach activities (stakeholder workshops and small group stakeholder interviews). The resulting objectives are defined in Figure ES.2.

CONNECT 2045 MTP GOALS	TSMO STRATEGIC PLAN-FUNCTIONAL AREAS	2019 ITS SDP UPDATE OBJECTIVES	2019 ITS SDP UPDATE OBJECTIVES DESCRIPTION
Support Vision Zero Policy in the region	Freeway Management (TIM/Tactical)	**Support Vision Zero**	**Engage with Vision Zero stakeholders to identify how ITS can support safety in the region**
Manage congestion and system reliability	Freeway Management (Ops/Strategic) Arterial Management	**Support reliability across an integrated transportation network**	**Identify how technology can support travel time reliability and manage congestion between the freeway and arterial systems**
Enhance network mobility	Freeway Management (Ops/Strategic) Arterial Management	**Enhance network mobility**	**Enhance network mobility by coordinating technology across all municipalities**
Promote multimodal and affordable travel choices Connect people Ensure equity and participation	Arterial Management Traveler Information Partner Agencies	**Improve multimodal connectivity and equitable access**	**Use technology-enabled multimodal travel options to improve equitable access to transportation**
Improve infrastructure condition	Asset Management Data and Performance Measures	**Improve, monitor, and manage assets**	**Monitor and manage transportation assets using technology to data, assess performance, and identify life-cycle costs**
Stimulate economic vitality	Return on investment	**Support economic vitality**	**Implement cost-effective ITS solutions to support the regional economy**

Table ES.1 2019 SDP Update Objectives

Support Vision Zero	Support Reliability across an Integrated Transportation Network	Enhance Network Mobility
Safety was one of the main focuses in the development process of this SDP. It was decided that recognizing the region's Vision Zero policy would be an effective way to support the design of a safe transportation system, protecting all roadway users. Vision Zero policies are aimed at eliminating all traffic fatalities and severe injuries while increasing safe, healthy and equitable mobility throughout the region. The DCHC MPO and the City of Durham have officially adopted this approach and promote the philosophy as part of the North Carolina Vision Zero program. This objective will focus on safety related strategies including variable speed limits, ramp metering, traffic incident management programs to reduce secondary crashes, decreasing incidents involving vulnerable roadway users, and infrastructure based and cooperative safety systems.	A reliable network has consistent performance and provides its users with expected level of service quality. A major focus for reliability includes congestion management strategies (e.g., active traffic management (ATM), bus lanes on shoulders, responsive ramp metering, smart work zones, reduced work zone speeds, and variable speed limits). There is also a need to identify and utilize the proper tools to gather and analyze data for more informed decision-making using a decision support system. Improvements to real-time information sharing between transportation agencies and emergency response teams are also needed as are transit and inter-jurisdictional travel.	ITS infrastructure improvements are one of the key drivers for improved mobility in the region. An emphasis on enhanced mobility includes offering choices to system users by providing accurate, timely and convenient information. Strategies will focus on the importance of collecting real time data and making it available for dissemination to the traveling public in numerous ways. Strategies to consider may include 511 and other traveler information systems, TMCs and Computer Aided Dispatch Integration, Traffic Incident Management (TIM) programs, Integrated Corridor Management (ICM) and Active Transportation and Demand Management (ATDM) and integrating these programs into a decision support system.

Figure ES.2 2019 ITS SDP Objective Descriptions

Improve Multimodal Connectivity and Equitable Access	Improve, Monitor, and Manage Assets	Support Economic Vitality
Enhanced formal agreements are needed across jurisdictional boundaries to enable more seamless travel. Agencies and municipalities should increase their focus on pedestrians and cyclists when enhancing infrastructure and technology; and the use of public-private partnerships should be considered for transit and parking management. Transit plans could be better utilized for future decision-making as it relates to ITS. Additionally, there should also be consideration for transit technologies and the use of ride sharing as incentives to enhance transit ridership.	Although Transit Asset Management Plans are in place for both the DCHC MPO and CAMPO, there are currently no consistent asset management systems for ITS infrastructure in use across the Triangle Region. Agencies and municipalities across the region could be managing their ITS infrastructure assets more efficiently using ITS solutions. Suggested focus areas include fiber and other communication networks (i.e., wireless, Bluetooth), equipment device inventories, work zone management, road weather management, and over-weight/over-height detection systems.	The economy depends on transportation to connect people to jobs and move goods from producers to buyers. Stakeholders have interest in transportation technologies but largely in the context of addressing other regional concerns. As economic activity and population grows, the need for transportation solutions that support this growth becomes very important and the progression of technology and ITS strategies offers opportunities to address growth in freight movement, improved travel-time reliability, potential partnerships that support regional cost-effective solutions.

Figure ES.2 2019 ITS SDP Objective Descriptions (Continued)

ITS investments should consider the mobility needs of the region without regard to jurisdictional boundaries. Transportation networks should provide seamless operations throughout the region.

ES.3 ITS Strategic Direction

Strategic planning provides a vision, goals, objectives and strategies for building on existing organizational strengths, addressing needs, bridging the gaps and overcoming existing and anticipated challenges to reach the final success. Multiple regional stakeholders were involved in the strategic planning process to address and consider technical, operational and organizational concerns. Together, the identified vision, goals, gaps and needs laid out the foundation for the strategic deployment plan and guided the team to the next logical step: strategy development.

ES.3.1 Recommended Strategies

Feedback that was gathered through several brainstorming sessions, discussions, and stakeholder workshops resulted in seven strategies. The action items identified through the process were then mapped to the proposed strategies.

Seven main strategies illustrated in Figure ES.3, are being proposed and recommended for implementation in the Triangle Region.

The proposed strategies were carefully aligned with regional goals and objectives with most strategies addressing multiple objectives. For example: "Establish and develop partnerships for operations, communication, and information dissemination" addresses the following objectives:

1. Improve Multimodal Connectivity and Equitable Access
2. Support Reliability Across an Integrated Transportation Network
3. Enhance Network Mobility
4. Support Vision Zero
5. Support Economic Vitality

Aligning each strategy with specific objectives can help in implementing the prioritization process, as some strategies that address multiple objectives may be more critical to implement and, therefore, the projects that would result from these strategies could receive higher prioritization.

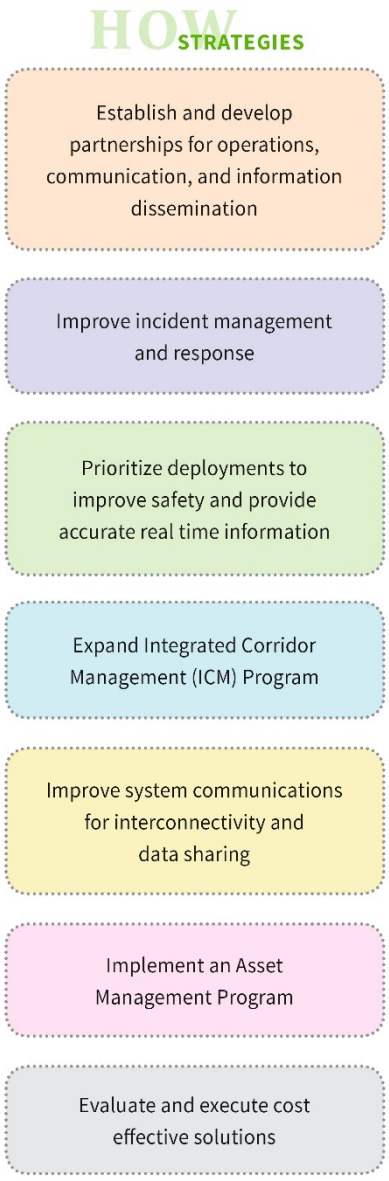


Figure ES.3 Proposed ITS Strategies

ES.4 ITS State of the Practice and Regional Project Roadmap

This section details ongoing and planned projects for the region (Capital Area Metropolitan Planning Organization - Durham-Chapel Hill-Carrboro Metropolitan Planning Organization) focusing on non-infrastructure projects – those that are intended to reduce congestion through the deployment, operation and maintenance of different ITS and emerging technology systems and strategies. In addition, this section will discuss the emerging trends in traffic technology from a regional and national perspective.

Estimated costs for the signal system projects will vary based on the requirements to upgrade existing systems or to install brand new systems. The costs will be driven by the number of traffic signals that require upgrades, the number of new signals, the length of new fiber communication cable required, and the extent of the upgrades of existing infrastructure, i.e. new cabinets instead of reusing existing cabinets.

ES.4.1 Traffic Technology and Emerging Trends

Technological improvements and advancements continue to make transportation more accessible. These same technological improvements can also serve to improve safety and reduce traffic congestion, and its negative social, economic, and environmental impacts. Big data enables better estimation of travel behavior through trends analysis and forecasting to better identify patterns and inform decisions, as connectivity is being captured at the individual level and data exchange occurs in (near) real-time. A key driver for this is that users of the transportation network are more virtually connected (i.e., online) than ever, which is the foundation of incentive-based applications and the new shared mobility transportation alternatives, particularly vehicle- and bike-share services.

Many cities are developing and deploying smart city technologies, such as GPS for emergency and transit vehicle preemption and CCTV and dynamic traffic technology, using Internet of Things (IoT) that allows the extension of Internet connectivity into physical devices and provides users with real-time information and available options. Figure ES.4 illustrates how data and connectivity set the stage for how planning entities and infrastructure owners and operators (IOO) can prepare for the future of transportation safety and mobility.

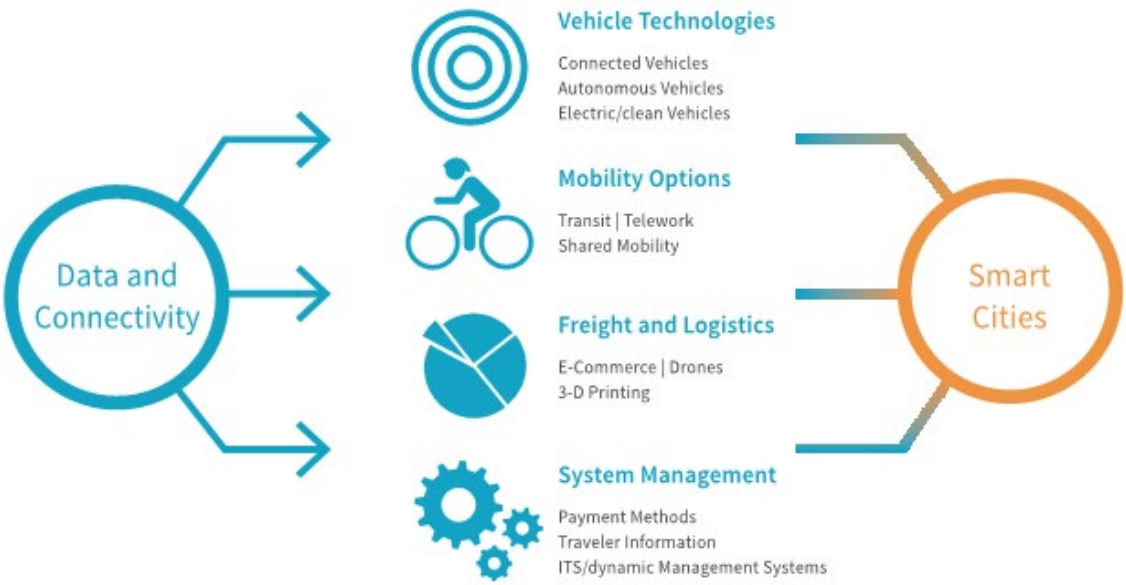


Figure ES.4 Comprehensive Picture of ITS

Major investments are being made in the smart infrastructure that allows implementation of the following systems:

- Smart signals networks;
- Integrated payment methods systems;
- New traveler information and incentives systems;
- Integrated corridor management systems, and
- Active Transportation Demand Management (ATDM) systems

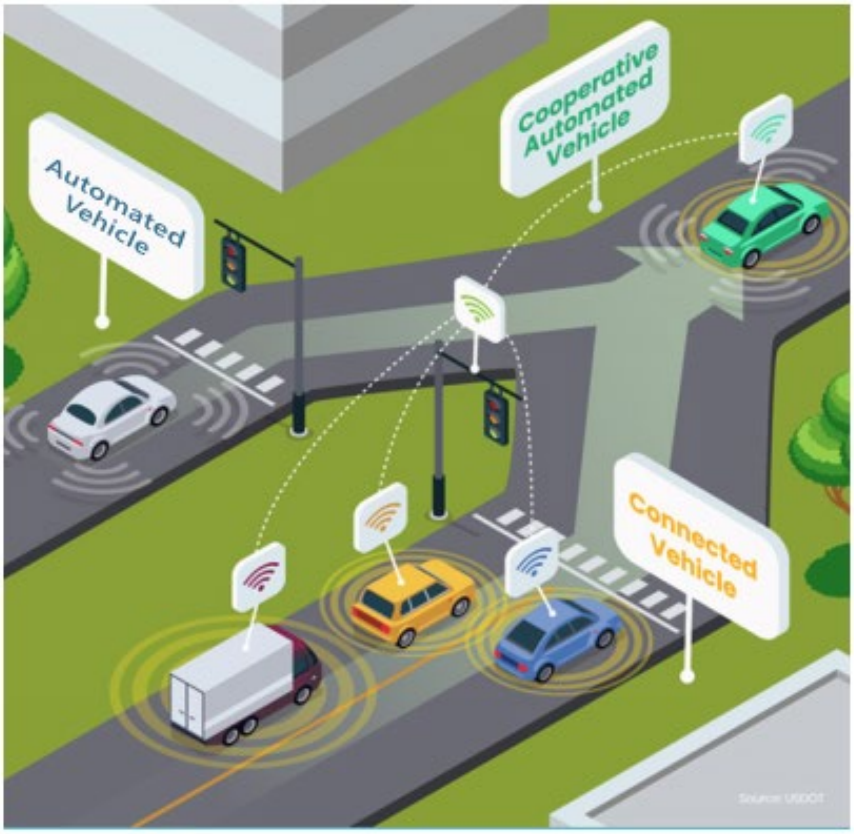
Advancements in these technologies give CAMPO, DCHC MPO and NCDOT an opportunity to seek out potential partnerships and projects with local and regional transit agencies and local municipalities to embrace these technologies for the betterment of the traveling public. Improved mobility and safety are the key drivers behind these investments for the Triangle Region and although, the time frame for implementation of many of these technologies may be uncertain; there are investments that can be made now that will support future mobility solutions. For example, investments in a communications network infrastructure and system operations will always have value even as the technology evolves.

Emerging technologies associated with connected and automated vehicles (CAVs) may significantly affect travel, but the nature and scale of these impacts remains highly uncertain and may achieve substantial market penetration only in the long-term.

However, as advanced computing, sensors and telecommunications technology are changing and enhancing surface transportation networks, NCDOT and the Division of Motor Vehicles (NCDMV) took a lead in assessment of the NC readiness for CAVs, determining how the State of North Carolina should be positioning to prepare for CAV technology and

identifying an activities roadmap over the next 10 years1. These technologies are transforming transportation systems by combining connectivity with the self-driving features and by allowing vehicles to share information with other vehicles, the infrastructure, and devices.

Improved safety and mobility are expected to some of the primary benefits of increased connectivity. Vehicles communicating with each other, and the surrounding infrastructure, as illustrated in Figure ES.5, provide warning information and critical data to drivers allowing them to proactively respond to potentially unsafe or congested conditions.



Connected and Automated Vehicles (CAVs) are expected to provide **increased safety** while also **supporting economic vitality**. CAVs are expected to be a significant component of future automotive industry.

Figure ES.5 Connected and Automated Vehicles (CAVs)

There are still arguments against deploying these technologies or at least slowing down implementations. Concerns continue to surface, such as the safety of vulnerable road users (i.e., bicyclists, pedestrians), whether traffic will get worse, and whether transit ridership will be affected negatively.

1 NC Readiness for Connected and Autonomous Vehicles (CAV), NDOT CAV Roadmap Development Project, Final Report: http://www.ncav.org/wp-content/uploads/2016/03/NC-Roadmap-for-CAV_Final_ALL.pdf

ES.4.2 Proposed Project List and ITS Roadmap

The objectives and strategies guide the identification process of ITS deployments in the near-term (0-5 years), mid-term (5-10 years), and long-term (10+ years) outlooks; however, it is also important to recognize projects that have already been identified, some of which are already being considered for funding and implementation. This section lists ITS deployment projects and supporting programs that have been identified through feedback during the workshops and stakeholder interviews and through review of current regional transportation planning documents. In addition, the relative project costs and schedule for implementation have been identified for the current and potential list of projects and are presented in the project roadmap. The projects that have been identified satisfy multiple objectives and are key to addressing many of the needs that were expressed by stakeholders.

LOW = ($) UP TO $3M, MEDIUM = ($$) $3M TO 10M, HIGH = ($$$) OVER $10M

PROJECT TYPE	NEAR-TERM (0-5 YEARS)	MID-TERM (5-10 YEARS)	LONG-TERM (10+ YEARS)
Transit Signal Priority/Bus Rapid Transit	$$		
Unified Transit Farebox System	$		
Implement AVL technology for Transit	$$		
New Municipal Traffic Signal System - Fuquay-Varina (U-6022)	$$		
New Municipal Traffic Signal System - Knightdale (U-6026)	$		
New Municipal Traffic Signal System - Morrisville (U-5967)	$		
New Municipal Traffic Signal System - Wake Forest (U-6023)	$$		
New Municipal Traffic Signal System - Clayton (U-5943)[5]	$		
Upgrade Municipal Traffic Signal System - Apex (U-6117)		$	
New Municipal Traffic Signal System - Garner (U-6194)		$	
Upgrade Municipal Traffic Signal System- Raleigh (U-6119)		$$	
New Municipal Traffic Signal System - Holly Springs			$$
Traffic Signal System Upgrade City of Durham (U-5968)	$$$		
Traffic Signal System Upgrade - Town of Cary		$$	
Complete Regional Fiber Network - NCDOT[6]			$$
Consolidate Municipal Signal Systems Management[6]			$
Establish Agreements for System Consolidation and Management	$		
Assess New Sub-Regional TMC		$	
Centralize Data Warehousing and Distribution		$	
Coordinated Corridor Traffic Signal Timing	$$		
Establish software and hardware platforms to serve connected vehicles and automated vehicles	$		
Regional standards for software, hardware, and communication platforms	$		
Inventory current deployments	$$		
Replace/upgrade outdated devices	$		
Integrated Corridor Management[6]			$$
Managed Motorways	$$$		
Training for Incident Response	$		
Emergency Pre-emption	$		
Adaptive Traffic Signal Systems		$$	
Occupancy Detection in Parking Decks		$	
Staff Training for Operation and Maintenance of ITS Equipment	$		
Expand Travel Information Coverage	$		

Table ES.2 Proposed Project List and ITS Roadmap

5 Project will go into implementation in near-term period and continue through mid-term, might continue through the long-term period.

6 Project may go into implementation in near-term or mid-term period, but could continue through the long-term period.

ES.5 Triangle Regional ITS Architecture

The Triangle Regional ITS Architecture Update is part of the overall effort to update the Triangle Region ITS SDP, last updated in 2010. The updated Architecture is now based on the USDOT's Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) Version 8.2. https://local.iteris.com/arc-it/

Intelligent Transportation Systems (ITS) has evolved since the Triangle Regional ITS Architecture was previously published. Advances in communications, mobile electronics, and vehicle technology are changing the capabilities of infrastructure equipment and mobile platforms making possible the emergence of connected and automated vehicles.

The Triangle region has evolved as well since 2010. The North Carolina Turnpike Authority now has several tolled freeways. The North Carolina Department of Transportation (NCDOT) has increased its coverage of ITS field devices used to monitor the areas roadways. NCDOT has also begun to implement a Managed Motorways program that will provide new tools for NCDOT to manage the freeways, including dynamic lane assignment, speed monitoring, and shoulder running. In transit, the region has changed with the branding of "Go Triangle" and the other "Go" partner agencies to bring an integrated brand to the region's travelers.

The Triangle Regional ITS Architecture includes all of the components that make up a regional ITS architecture per the Federal Highway Administration (FHWA) regulation 23CFR940 for ITS Architecture & Standards. The software tool, Regional Architecture Development for Intelligent Transportation (RAD-IT) was used to convert the original 2010 architecture and update it to be compatible with the current version of ARC-IT.

Detailed tables and data provided in the architecture are not intended to be printed out in their entirety and are too extensive to include in the body of this document. The detailed information can be found at the following website: https://local.iteris.com/ncarch/.

Definitions for each of the navigation sites are as follows:

- **Scope:** the geographic scope, timeframe, and services included in the architecture
- **Planning:** this section links the Objectives for the region from the ITS Plan update to the services in the architecture
- **Stakeholders:** lists the agencies and private sector organizations that play a role in the implementation, management, or operation of ITS systems and contributing systems in the region
- **Inventory:** lists the things – the systems and devices that make up ITS in the region as well as non-ITS systems that have data needed by the ITS systems or that take data from ITS
- **Services:** based on Service Packages in the national reference architecture (ARC-IT), this section shows the portions of the overall ITS architecture that combine to deliver a particular service
- **Needs:** lists the user needs that are derived from the services and define the overall needs for the stakeholders in the region pertaining to the intelligent transportation system

- **Roles & Responsibilities:** lists the roles & responsibilities for the stakeholders based on their participation (owner/operator) with elements that are assigned to the service packages
- **Functionality:** lists the functions for each element in the architecture; this is based on the elements assigned to 'subsystems' of the ARC-IT model – the elements that have ITS functionality and not the elements (devices/systems) on the fringe of ITS
- **Interfaces:** lists the interfaces between elements built from the element assignment and their mapping to the service packages
- **Standards:** lists the ITS and Communications standards that are related to the interfaces in the previous section
- **Agreements:** lists the inter-agency agreements that will be needed (some may already be in place) to carry out the services and interfaces called for by this architecture. Some of these agreements are already in place in the region. The Town of Morrisville and the Town of Cary have an agreement in place that enables the Town of Cary to operate and maintain traffic signals in the Town of Morrisville. The Town of Carrboro and the Town of Chapel Hill have a similar agreement that allows the Town of Chapel Hill to operate and maintain traffic signals in the Town of Carrboro. Additionally, NCDOT and municipalities have agreements in place that provides reimbursement of costs from NCDOT to municipalities to operate and maintain traffic signals that are part of the NCDOT traffic signal systems.
- **ITS Projects:** will list projects from the architecture needed to implement the vision in the ITS architecture.

ES.6 Plan Implementation

Stakeholders have identified ITS deployment strategies and developed necessary action items to move forward in developing a roadmap for potential ITS deployments. This chapter presents a summary of action items and a path for implementing the plan.

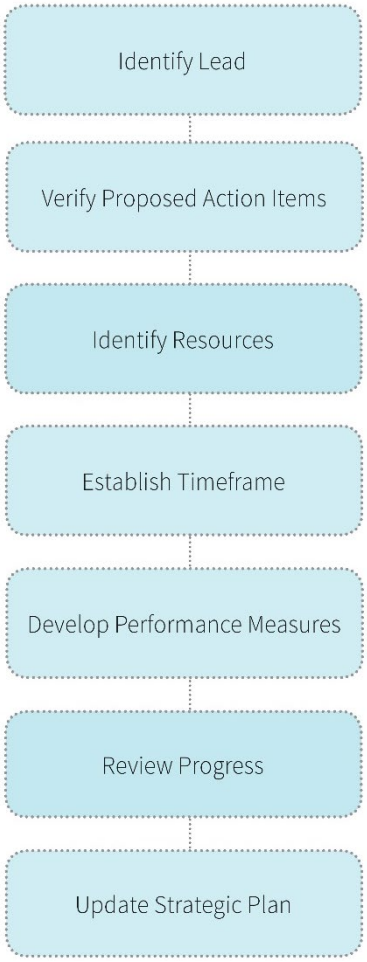


Figure ES.6 Steps to Implementation

1

Introduction

The Triangle Region lies in the heart of North Carolina and features great public schools, three major universities, a growing system of technical and community colleges, a diverse population, and seemingly endless opportunities for recreation and cultural expansion. The byproduct of these attractive qualities is growing congestion on regional roadways. To address this congestion, new roads are constructed, existing roads are widened, and opportunities for transit and bicycle travel are incorporated into roadway improvement projects, making it that much more critical to operate and maintain these facilities safely and efficiently. Regional leaders are recognizing the importance of utilizing innovative and emerging technologies to maximize the safety, efficiency, and reliability of the transportation systems within the Triangle Region.

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- NCDOT's Mobility and Safety: Systems Management and Operations Strategic Plan
- Triangle Region's 2010 Intelligent Transportation Systems (ITS) Strategic Deployment Plan (SDP)

ITS SDP provides a future vision for the region and recommends sustainable strategies that will introduce new technologies and services for regional deployment.

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This update to the Triangle Region ITS Deployment Plan assesses the current state of ITS in the region, establishes goals and objectives for future investment in ITS, and identifies actions to fill gaps to achieve the desired goals.

1.2 The Triangle Region

The Triangle Region includes several jurisdictions and operating agencies. Home to approximately 1.9 million people, the region encompasses the combined membership of the Durham-Chapel Hill MPO (DCHC MPO) and the Capital Area MPO (CAMPO) – Town of Angier, Town of Apex, Town of Archer Lodge, Town of Bunn, Town of Carrboro, Town of Cary, Town of Chapel Hill, Chatham County, Town of Clayton, Town of Creedmoor, City of Durham, Durham County, Franklin County, Town of Franklinton, Town of Fuquay-Varina, Town of Garner, Granville County, Harnett County, Town of Hillsborough, Town of Holly Springs, Johnston County, Town of Knightdale, Town of Morrisville, Orange County City of Raleigh, Town of Rolesville, Wake County, Town of Wake Forest, Town of Wendell, Town of Youngsville, Town of Zebulon (see Figure 1).

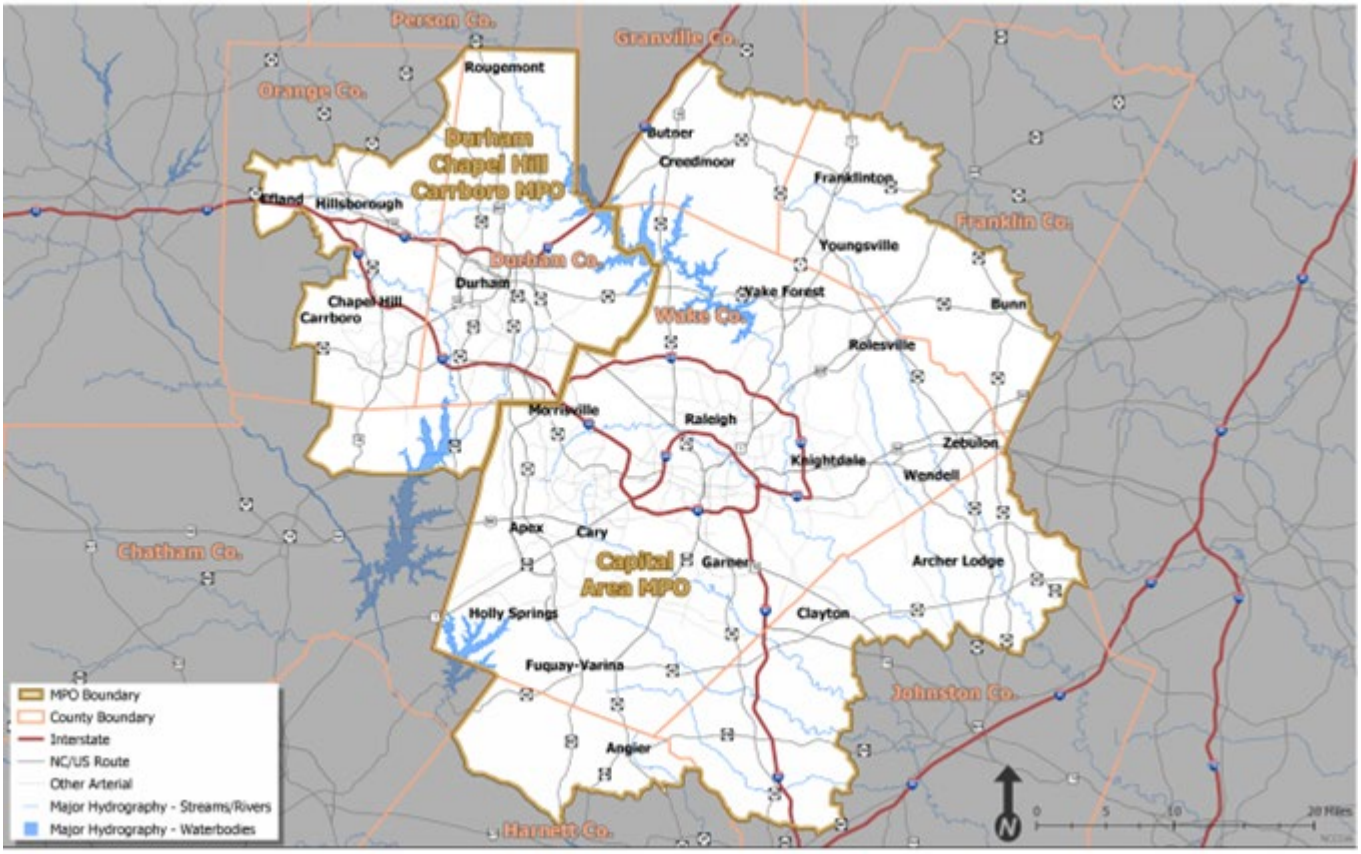


Figure 1 Geographic Composition of the Triangle Region

1.3 Triangle Region ITS Strategic Deployment Plan Process

The Triangle Region ITS Strategic Deployment Plan (SDP) process was developed to provide a consistent and maintainable approach for future ITS project planning and deployment. The process used to develop the plan is illustrated in Figure 2 and explained as follows:

The planning process includes multiple steps to gather information, assess current needs, and develop a vision, goals and objectives that lead to strategies that are sustainable for the next ten years. In order to analyze and update the current state of ITS in the Triangle region, a comprehensive review of existing regional planning documents and regional ITS architecture documents were conducted. Several stakeholder workshops and interviews were performed to assess the current state of the practice and identify gaps and needs that have risen since the 2010 ITS SDP recognizing rapidly evolving technology advancements in transportation. For the benefit of the stakeholders as addressed at the workshops and in this document, regional and national ITS trends and emerging technologies have been introduced to identify applicable ITS strategies and potential deployments and technologies that would best serve the region. Based on the findings, strategies and recommended projects were derived.

Figure 2 Triangle Region ITS Strategic Deployment Plan Process

2

Vision, Goals, and Objectives

Transportation technologies are evolving rapidly. From the advent of automated vehicles, to increasingly ubiquitous data, mobile applications, the Internet of Things, and the introduction of technology-enabled transportation services, new and emerging technologies will have a significant impact on transportation during the next 10 to 20 years. These technologies will change how transportation systems are planned, managed, and operated into the future. Increasingly there is recognition that it is not enough to simply forecast changes in demographics, land use, and travel demand — a broader consideration of the vast implications of potentially disruptive and transformational technologies is also necessary.

Figure 3 Process for Regional ITS Assessment

2.1 Literature Review

In an effort to update the ITS SDP, a thorough literature review of available documents regarding ITS-related efforts was conducted. Three key documents provided the foundation of our research:

1. CONNECT 2045: THE RESEARCH TRIANGLE REGION'S METROPOLITAN TRANSPORTATION PLAN

Serves as the metropolitan transportation plan for the Triangle Region and provides a comprehensive overview of the regions' plan for improving its transportation network and services.

2. NCDOT'S 2018 MOBILITY AND SAFETY TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO) STRATEGIC PLAN

Provides guidance to NCDOT on TSMO-focused strategies and activities that will expand or enhance programmatic and agency integrations.

3. INTELLIGENT TRANSPORTATION SYSTEMS STRATEGIC DEPLOYMENT PLAN (2010 UPDATE) AND REGIONAL ITS ARCHITECTURE

Provides an overview of ITS practices at the time, as well as planned ITS projects.

Additional documents such as the Strategic Highway Safety Plan, Vision Zero and Complete Streets plans give the region an opportunity to think holistically and align regional goals and objectives to create an interoperable and fully integrated ITS program. In order to accomplish this vision, the Region's ITS architecture must also be included and well thought out with a broad regional perspective. The ITS Architecture is a planning tool used to effectively plan for technology applications and integration to support more effective planning for operations within the region. The regional ITS architecture provides context for ITS projects so that each project can build a piece of the envisioned transportation system. The process used to analyze existing conditions and to conduct a regionally useful needs assessment while considering the larger developments that are occurring nationally and

internationally is illustrated in Figure 3. The results of each step within the process are summarized in the following subsections.

2.2 Stakeholders Engagement

Engaging stakeholders in the process of development of regional goals and objectives and thereafter analyzing future needs is a key to identifying agency considerations when developing an ITS strategic plan and a new ITS Regional Architecture. Complementing the literature review, the team also conducted several outreach activities to gather feedback from regional stakeholders. These activities included:

- **Kickoff Meeting – May 18, 2018.** Introduced project objectives, established expectations of stakeholders and received initial feedback from stakeholders present at the meeting.
- **Team's First Workshop –July 10, 2018.**

Validated objectives for the ITS SDP update based on regional planning documentation and resulting stakeholder input.

- **Stakeholder Interviews – October 26, 2018 – January 23, 2019.** In-person group interviews were conducted. Groups were based on jurisdictions with common interests and those that are interfacing via their technology systems. A full list of interviewees is provided in Appendix A.
- **Stakeholder Surveys – March 2019.** Surveys conducted to gather input from safety and emergency management personnel across the Triangle Region.
- **Team's Second Workshop – March 14, 2019.** Verified alignment of ITS Architecture updates with current and future needs for the transportation community.
- **Team's Third Workshop – May 30, 2019.** Presented regional ITS Architecture update and reviewed draft architecture web pages. Proposed strategies and engaged stakeholders in development of action items.

A full list of participants in workshops, interviews, and surveys is provided in Appendix A.

Table 1 represents all stakeholder agencies that participated in the outreach activities. Individual participation by agency can be found in Appendix B. Additionally, detailed notes developed from each stakeholder activity are provided in Appendices C, D, E, F and G. Presented in the following section are the vision, goals, and objectives that were developed based on the information gathered during all stakeholder involvement efforts.

STAKEHOLDER	DESCRIPTION
Town of Apex	Various government departments and agencies of the Town of Apex.
CAMPO	Regional organization responsible for transportation planning for the eastern part of the Research Triangle area in North Carolina.
Town of Cary	Various government departments and agencies of the Town of Cary.
Town of Carrboro	Various government departments and agencies of the Town of Carrboro.
Town of Chapel Hill	Various government departments and agencies of the Town of Chapel Hill.
Chapel Hill Transit	Transit agency that operates public bus and van transportation services within the contiguous municipalities of Chapel Hill and Carrboro and the campus of the University of North Carolina at Chapel Hill in the southeast corner of Orange County in the Research Triangle metropolitan region of North Carolina.
Chatham County	Various government departments and agencies of the Chatham County.
Town of Clayton	Various government departments and agencies of the Town of Clayton.
DCHC MPO	Regional organization responsible for transportation planning for the western part of the Research Triangle area in North Carolina.
Duke University	A private research university in Durham, North Carolina.
City of Durham	Various government departments and agencies of the City of Durham.
Durham County	Various government departments and agencies of the Durham County.
FHWA	Federal agency that supports State and local governments.
Franklin County	Various government departments and agencies of the Franklin County.
Town of Fuquay-Varina	Various government departments and agencies of the Town of Fuquay-Varina.
Town of Garner	Various government departments and agencies of the Town of Garner.
GoCary	Transit agency that provides transit services in the Town of Cary.
GoDurham	Transit agency that operates bus service in the City of Durham.
GoRaleigh	Transit agency that operates bus service in the City of Raleigh.
GoTriangle	Transit agency that operates regional bus and shuttle service, paratransit services and vanpools; provides commuter resources and an emergency ride home program.
Granville County	Various government departments and agencies of the Granville County.
Harnett County	Various government departments and agencies of the Harnett County.
Town of Hillsborough	Various government departments and agencies of the Town of Hillsborough.
Town of Holly Springs	Various government departments and agencies of the Town of Holly Springs.
Johnston County	Various government departments and agencies of the Johnston County.
Town of Knightdale	Various government departments and agencies of the Town of Knightdale.
Town of Morrisville	Various government departments and agencies of the Town of Morrisville.
NCDOT	Provides transportation facilities for travelers throughout North Carolina and includes highways, rail, aviation, ferries, bicycle and pedestrian facilities, and public transit.
NC Turnpike Authority (NCTA)	The NCTA is authorized to design, establish, purchase, construct, operate, and maintain the toll roads.
Orange County	Various government departments and agencies of the Orange County.
City of Raleigh	Various government departments and agencies of the City of Raleigh.
Wake County	Various government departments and agencies of Wake County.
Town of Wake Forest	Various government departments and agencies of the Town of Wake Forest.

Table 1 Participation by Agency

2.3 Vision, Goals, and Objectives

The vision, goals and objectives are the results of the strategic planning process and stakeholder outreach activities.

Stakeholder outreach activities included stakeholder workshops with all stakeholders invited to participate; small group stakeholder interviews to gather more specifics on current ITS uses and objectives; and individual conversations and exchanges for stakeholders that were not available to participate in the stakeholder workshops or group interviews. The participants in the small group stakeholder interviews were invited to participate based on commonalities between the stakeholders such as geographic location, modal operations, and existing and desired partnerships. The results of stakeholder outreach activities culminated into a vision statement that provides a forward-looking path defining how ITS solutions can enhance program effectiveness and set program direction. The goals and objectives may change with the rapid evolution of emerging technologies, but the vision should remain constant throughout the 10-year planning process.

The Triangle Region has taken significant steps towards an intelligent transportation network, including the successful deployment of

- Integrated signal systems
- Transit real-time information
- NCDOT Strategic Prioritization (SPOT) funding for ITS
- Infrastructure to vehicle technology
- Interoperability
- Reliable traveler information
- Open AVL data
- Incident Management Assistance Patrol (IMAP) certification and training

While their successes have been significant, the region still experiences challenges with their effort to deploy new systems and/or update existing ones. Key challenges include

- Aging hardware, including outdated fiber and communications
- Lack of resources, such as staffing, for operating and maintaining systems
- Coordination across municipalities (institutional and technological)
- Dedicated funding for Operations and Maintenance

VISION STATEMENT

A region that provides effective, innovative, and seamless integrated services to enhance safety, mobility, reliability and interoperability through ITS solutions.

Objectives were initially identified through review of existing regional transportation planning documents and the early stages of the stakeholder outreach activities (primarily the first stakeholder workshop). The objectives were further refined through continued stakeholder outreach activities (stakeholder workshops and small group stakeholder interviews).

Table 2 provides an overview of these objectives, followed by a description of each. As a result of these objectives, strategies will be developed through the lens of ITS and emerging technology solutions.

CONNECT 2045 MTP GOALS	TSMO STRATEGIC PLAN- FUNCTIONAL AREAS	2019 ITS SDP UPDATE OBJECTIVES	2019 ITS SDP UPDATE OBJECTIVES DESCRIPTION
Support Vision Zero Policy in the region	Freeway Management (TIM/Tactical)	**Support Vision Zero**	**Engage with Vision Zero stakeholders to identify how ITS can support safety in the region**
Manage congestion and system reliability	Freeway Management (Ops/Strategic) Arterial Management	**Support reliability across an integrated transportation network**	**Identify how technology can support travel time reliability and manage congestion between the freeway and arterial systems**
Enhance network mobility	Freeway Management (Ops/Strategic) Arterial Management	**Enhance network mobility**	**Enhance network mobility by coordinating technology across all municipalities**
Promote multimodal and affordable travel choices Connect people Ensure equity and participation	Arterial Management Traveler Information Partner Agencies	**Improve multimodal connectivity and equitable access**	**Use technology-enabled multimodal travel options to improve equitable access to transportation**
Improve infrastructure condition	Asset Management Data and Performance Measures	**Improve, monitor, and manage assets**	**Monitor and manage transportation assets using technology to data, assess performance, and identify life-cycle costs**
Stimulate economic vitality	Return on investment	**Support economic vitality**	**Implement cost-effective ITS solutions to support the regional economy**

Table 2 2019 ITS SDP Update Objectives

Support Vision Zero	Support Reliability across an Integrated Transportation Network	Enhance Network Mobility
Safety was one of the main focuses in the development process of this SDP. It was decided that recognizing the region's Vision Zero policy would be an effective way to support the design of a safe transportation system, protecting all roadway users. Vision Zero policies are aimed at eliminating all traffic fatalities and severe injuries while increasing safe, healthy and equitable mobility throughout the region. . The DCHC MPO and the City of Durham have officially adopted this approach and promote the philosophy as part of the North Carolina Vision Zero program. This objective will focus on safety related strategies including variable speed limits, ramp metering, traffic incident management programs to reduce secondary crashes, decreasing incidents involving vulnerable roadway users, and infrastructure based and cooperative safety systems.	A reliable network has consistent performance and provides its users with expected level of service quality. A major focus for reliability includes congestion management strategies (e.g., active traffic management (ATM), bus lanes on shoulders, responsive ramp metering, smart work zones, reduced work zone speeds, and variable speed limits). There is also a need to identify and utilize the proper tools to gather and analyze data for more informed decision-making using a decision support system. Improvements to real-time information sharing between transportation agencies and emergency response teams are also needed as are transit and inter-jurisdictional travel.	ITS infrastructure improvements are one of the key drivers for improved mobility in the region. An emphasis on enhanced mobility includes offering choices to system users by providing accurate, timely and convenient information. Strategies will focus on the importance of collecting real time data and making it available for dissemination to the traveling public in numerous ways. Strategies to consider may include 511 and other traveler information systems, TMCs and Computer Aided Dispatch Integration, Traffic Incident Management (TIM) programs, Integrated Corridor Management (ICM) and Active Transportation and Demand Management (ATDM) and integrating these programs into a decision support system.

Figure 4 2019 ITS SDP Objective Descriptions

Improve Multimodal Connectivity and Equitable Access	Improve, Monitor, and Manage Assets	Support Economic Vitality
Enhanced formal agreements are needed across jurisdictional boundaries to enable more seamless travel. Agencies and municipalities should increase their focus on pedestrians and cyclists when enhancing infrastructure and technology; and the use of public-private partnerships should be considered for transit and parking management. Transit plans could be better utilized for future decision-making as it relates to ITS. Additionally, there should also be consideration for transit technologies and the use of ride sharing as incentives to enhance transit ridership.	There are currently no asset management systems in use across the Triangle Region. Agencies and municipalities across the region could be managing their infrastructure assets more efficiently using ITS solutions. Suggested focus areas include fiber and other communication networks (i.e., wireless, Bluetooth), equipment device inventories, work zone management, road weather management, and over- weight/over-height detection systems.	The economy depends on transportation to connect people to jobs and move goods from producers to buyers. Stakeholders have interest in transportation technologies but largely in the context of addressing other regional concerns. As economic activity and population grows, the need for transportation solutions that support this growth becomes very important and the progression of technology and ITS strategies offers opportunities to address growth in freight movement, improved travel-time reliability, potential partnerships that support regional cost-effective solutions.

Figure 4 **2019 ITS SDP Objective Descriptions (Continued)**

ITS investments should consider the mobility needs of the region without regard to jurisdictional boundaries. Transportation networks should provide seamless operations throughout the region.

2.4 Gap and Needs Assessment

The section below provides an overview of overarching takeaways of the current and future state of ITS from a local, regional, and statewide viewpoint. Additionally, detailed analysis of practices, gaps, needs, and priorities is discussed.

Gaps in regional fiber optic communication.

Multiple regional stakeholders noted gaps in fiber optic communication coverage. Similarly, from a statewide perspective, there is a lack of existing fiber inventory and freeway fiber is not universally available. It is also not fully connected to associated transportation management centers (TMCs). There is also a lack of interoperability between local and state-owned equipment. These gaps are not identified or mapped in a systematic way. It was noted that field work will be needed to verify coverage and gaps. Regional operating agencies along with NCTA and NCDOT Central Office and Division offices agree that there should be standardization of fiber, software, signal, and controller selection.

NEED #1: THE NEED FOR A COMMON, REGIONAL COMMUNICATION FIBER NETWORK

Lack of inter-operable signal systems.

Several regional stakeholders noted a lack of compatibility between the various signal systems currently being operated by other agencies (local and NCDOT) within their jurisdictions. In response to this, some regions plan to alter their software to create compatibility in the future. It was also noted that while there is sufficient signal system infrastructure, the connections aren't standardized which creates the lack of interoperability. One suggestion included creating regional / statewide signal systems with connected TMCs. One reason interoperability is needed is for data collection to enhance transportation planning and assessment in the region.

NEED #2: THE NEED FOR INTEROPERABLE SIGNAL SYSTEMS ACROSS JURISDICTIONAL BOUNDARIES

Gaps in dedicated funding for the operations and maintenance of ITS assets.

Several stakeholders noted the importance of life-cycle costs, specifically having dedicated funding for the operations and maintenance of ITS assets. It was noted that continued education of decision-makers is critical to ensuring buy-in and agreement when for funding ITS projects. When asked about current technology, one regional agency noted that some of its technology is a decade old and is currently "breaking down." In addition to the technology itself and the need for funding to maintain it, there is also a need for education – agencies are experiencing staff turnover, resulting in a loss of knowledge for ITS operations.

NEED #3: THE NEED FOR DEDICATED FUNDING FOR ITS OPERATIONS AND MAINTENANCE

Universal interest in advancing Connected and Automated Vehicles (CAV), but limited actions taken.

Several local agencies aren't currently focused on CAVs (the exception being Cary) which is currently participating in the National Operations Center of Excellence (NOCoE) Signal Phase and Timing (SPaT) challenge. Some agencies also noted that their leaders are innovative, understanding the need and being supportive of it. From a state perspective, NCTA coordinates with NCDOT to enhance CAV. New systems will be incorporating CAV communications technology and all new hardware will be CAV-ready. The exception is GoTriangle noting due to their funding mechanism, being "ahead in technology" is not a priority leading to a lack of interest in CAV.

NEED #4: THE NEED FOR CONTINUED ADVANCEMENT OF CAV ACROSS THE REGION

Discrepancies in Data Management capabilities.

Data management is considered a top priority in many areas of the Triangle Region. There are distinct efforts in the region to collect and manage data efficiently. For instance, Raleigh's vision is to have readily-available data that meets all transportation needs and Cary received a Smart Cities grant that focuses heavily on data integration; however, there are still caveats in the system. Chapel Hill-Carrboro's system of loop detectors collect data, but the data is not archived. Data collection and management is provided by consultant contract and currently there is no central repository for this data.

NEED #5: THE NEED FOR COORDINATED DATA MANAGEMENT ACROSS THE REGION

Gaps in regional incident and emergency response.

Each jurisdiction has significant interest in implementing and improving their incident and emergency management capabilities. For Cary, adaptive incident management is a top priority. Durham has flood prone areas, meaning emergency plans for prioritizing rail at-grade crossings for preemption of emergency vehicles in Durham. Taking into consideration their individual needs and agendas, each jurisdiction would benefit from coordinating incident and emergency response efforts regionally.

NEED #6: THE NEED FOR REGIONAL LEVEL PLANNING FOR MANAGING AND RESPONDING TO INCIDENTS AND EMERGENCIES

Lack of integrated and wide covering multimodality.

The region contains heavy commuter areas that would benefit from alternative modes of transportations (e.g., bikes and pedestrian), and better transit. Some areas in the region are focusing on (or considering) bus rapid transit (BRT) as an option, such as Raleigh and Chapel Hill-Carrboro. Other areas are assessing the need for unified fare box system and ongoing maintenance of transit assets and ridesharing incentives, as well as transit signal priority and how to improve pedestrian access and parking management.

NEED #7: THE NEED TO ENHANCE BUS RAPID TRANSIT, PARKING MANAGEMENT, AND BIKE/PEDESTRIAN MOBILITY ACROSS THE REGION

Lack of operation and management integration.

Integrated corridor management (ICM) is seen as a long-term need for the Triangle Region supported by data management and coordinated systems. ICM is needed to provide a full system of operational strategies that become part of long-range planning as "planning for operations." The vision for the future includes statewide software for corridor management, for both transit and roadway. In this manner, NCTA is currently evaluating various tools that can provide detection data as well as manage traffic.

NEED #8: THE NEED FOR INTEGRATED CORRDOR MANAGEMENT

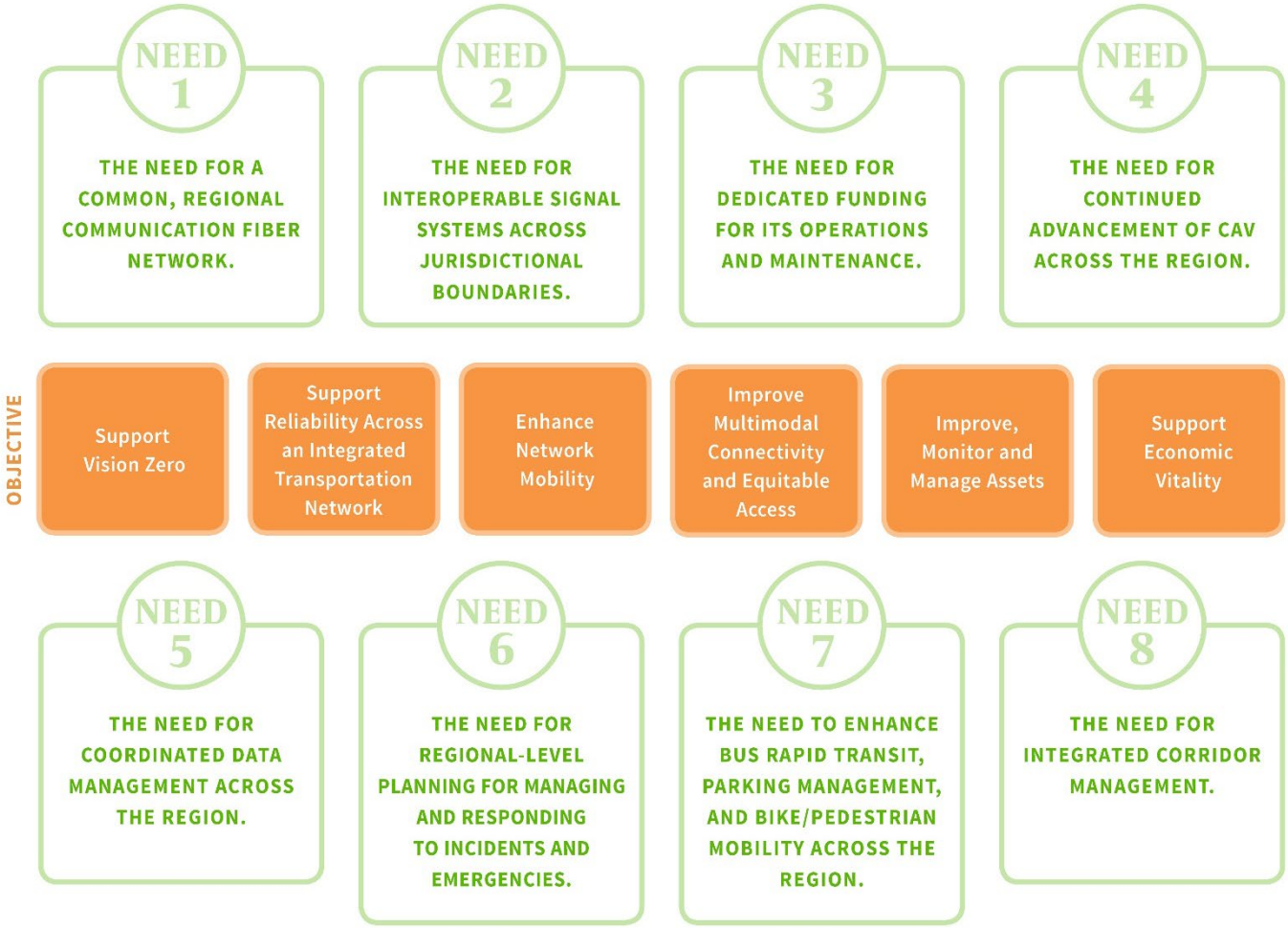


Figure 5 Objectives and Needs

3

ITS Strategic Direction

Strategic planning provides a vision, goals, objectives and strategies for building on existing organizational strengths, addressing needs, bridging the gaps and overcoming existing and anticipated challenges to reach the final success. Multiple regional stakeholders were involved in the strategic planning process to address and consider technical, operational and organizational concerns. Together, the identified vision, goals, gaps and needs laid out the foundation for the strategic deployment plan and guided the team to the next logical step: strategy development.

3.1 Developing Strategies

Developing strategies is the essential step between establishing the objectives and implementing actions to achieve them. Strategies should always be formed in advance of implementation of the action plan, to avoid duplicating efforts. In addition, strategies cannot be static and should be revised and updated to meet the needs of a changing environment, including new opportunities and emerging technologies.

To test the strategy, the following questions were addressed:

- Does the strategy give an overall direction?
- Does the strategy fit current resources and opportunities?
- Does the strategy address the identified needs?
- Does the strategy help to achieve the objective.

3.2 Strategic Development Process

Vision, goals, gaps, and objectives were developed in the previous project stages as a result of the strategic planning process that involved the stakeholders outreach activities including stakeholder workshops and group and individual stakeholder interviews.

While the identified objectives outline the purpose of the strategic deployment by describing what success would look like when the vision is achieved, the strategies define the path to reach the ultimate success.

Similar to going through the process of developing the regional vision and objectives, developing strategies requires brainstorming and involvement of the regional stakeholders. At the last stakeholder workshop, the participating stakeholders were divided into groups for a break-out session to identify critical action items and asked to present their results to all attendees. The summary of the last stakeholder workshop is presented in Appendix G and needs, and objectives are presented on Figure 5.

3.3 Recommended Strategies

Feedback that was gathered through several brainstorming sessions, discussions, and stakeholder workshops resulted in seven strategies which are presented herein. The action items identified in the final workshop are mapped to the proposed strategies and are presented in Appendix H.

Seven main strategies are recommended for implementation in the Triangle Region. The key points and benefits for each strategy are summarized in Table 3.

2 Business Dictionary http://www.businessdictionary.com/definition/strategy.html

Strategies	Objectives	Action Plan
Establish and develop partnerships for operations, communication and information dissemination	Support Vision Zero Support Reliability Across an Integrated Transportation Network Enhance Network Mobility Improve Multimodal Connectivity and Equitable Access Support Economic Vitality	- Establish ITS database - Develop network security plan - Establish partnership agreements between regional stakeholders - Develop policy and procedures to share data with public and third parties - Educate political leaders, senior management, and elected officials - Create and encourage regional partnership culture to eliminate silo mentality - Establish performance objectives and monitoring - Develop guidelines to evaluate projects for compliance with Regional Architecture - Establish procurement process for security and interoperability - Establish a regional task force/working group to: - Allocate funding for maintenance and operations - Partner up to pursue funding opportunities (i.e. STIP, HSIP, etc.)
Improve incident management and response, Freeway Management, Arterial Management, ICM	Support Vision Zero Support Economic Vitality	- Develop and implement a Traffic Incident Management (TIM) plan integrating freeways and arterials - Develop an ITS Resource Toolbox - Increase and improve roadway surveillance coverage - Integrate TMCs and computer aided dispatch - Integrate emergency vehicle preemption locally and regionally - Develop a protocol for Emergency Response Training - Partner up to pursue funding opportunities (i.e. STIP, HSIP, etc.)
Prioritize deployments to improve safety and provide accurate real time information	Support Vision Zero Support Reliability Across an Integrated Transportation Network Enhance Network Mobility Support Economic Vitality	- Identify high crash corridors - Develop project prioritization methodology - Identify potential deployments on high crash corridors - Create regional central clearing house database for lane closures (i.e. DriveNC.gov extended to local agencies) - Establish performance objectives and monitoring - Identify strategic corridors prioritizing projects - Develop best practices guidance document to manage regional mobility - Partner up to pursue funding opportunities (i.e. STIP, HSIP, etc.)

Table 3 Summary of Action Plan

Strategies	Objectives	Action Plan
Expand Integrated Corridor Management (ICM) Program-Interoperability between State and Local, Arterial Management, Freeway Management	Support Vision Zero Support Reliability Across an Integrated Transportation Network Enhance Network Mobility Support Economic Vitality	- Develop operational agreements - Identify applicable corridors - Involve all agencies and municipalities in the region in the planning development process - Develop decision support systems - Develop operational scenarios - Develop a regional plan for traffic signal system upgrades - Develop plan for Transit Signal Priority (TSP) - Develop plan for Emergency Vehicle Preemption (EVP) - Improve fiber/communications network - Establish partnerships for data integration and inventory compliance with Architecture - Establish procurement process for security and interoperability - Establish a regional task force/working group to: - Partner up to pursue funding opportunities (i.e. STIP, HSIP, etc.)
Improve system communications for interconnectivity and data sharing	Enhance Network Mobility Improve Multimodal Connectivity and Equitable Access	- Improve information dissemination at operations level - Develop operational agreements to share data between agencies - Determine and monitor performance measures and system evaluation - Provide quality ITS data to the public - Improve fiber/communications network - Develop regional fiber mapping plan along with protocols for software platforms - Create regional central clearing house database for lane closures (i.e. DriveNC.gov extended to local agencies) - Establish partnerships for data integration and inventory compliant with Architecture - Establish procurement process for security and interoperability - Establish agreements to leverage partners to acquire equipment

Table 3 Summary of Action Plan (Continued)

The proposed strategies were carefully aligned with regional goals and objectives. As presented in Table 3, most strategies address multiple objectives. For example: "Establish and develop partnerships for operations, communication, and information dissemination" addresses the following objectives:

› Improve Multimodal Connectivity and Equitable Access

› Support Reliability Across an Integrated Transportation Network

- Enhance Network Mobility
- Support Vision Zero
- Support Economic Vitality

Aligning each strategy with an objective the strategy addresses, can help in implementing the prioritization process, as some strategies that address multiple objectives may be more critical to implement and, therefore, the projects that would result from these strategies might receive higher prioritization.

4

ITS State of the Practice and Regional Project Roadmap

This section details ongoing and planned projects for the region (Capital Area Metropolitan Planning Organization - Durham-Chapel Hill- Carrboro Metropolitan Planning Organization). Projects are divided into infrastructure and non-infrastructure. Infrastructure projects include the construction of new roadway and transit, and expansion of existing ones. Whereas non-infrastructure projects include initiatives to reduce congestion through the deployment, operation and maintenance of different ITS and emerging technology systems and strategies. In addition, this section will discuss the emerging trends in traffic technology from a regional and national perspective.

4.1 Infrastructure Projects

4.1.1 Roadway

Regional trends show an increase in (1) commuter travel distance in single-occupant vehicles (SOVs), (2) non-commuter local travel in SOVs (e.g., school, business, shopping, social engagements), and (3) pass-through highway traffic. As a result, additional roadway capacity is needed as the region continues to grow. The Connect 2045 Metropolitan Transportation Plan, identified several priority roadway projects across the region. Table 4 provides a list of the major roadway investments. An exhaustive list of ITS-related projects is found in Table 6.

PROJECT	TIME PERIOD 2025*	2035**	2045**
DCHC MPO			
East End Conn. link US 70 to NC 147 (Durham Freeway) to from I-885	✓		
NC 147 (Durham Freeway) widened (East End Connector to I-40)	✓		
US 70 lane add and freeway conversion (East End Conn. to Miami Blvd)	✓		
I-40 managed lanes (Wade Ave in Wake County to NC 147)		✓	
I-40 widening (US 15-501 to I-85)		✓	
US 70 lane add and freeway conversion (Miami Blvd to Wake County)		✓	
US 15-501 (Fordham Blvd) capacity improvements (Columbia St to I-40)		✓	
I-40 managed lanes (NC 147-US 15-501)			✓
I-85 widened (I-40 to Durham County)			✓
I-85 widened (US 70 to Red Mill Road)			✓
US 15-501 freeway conversion (I-40 to US 15-501 bypass)			✓
CAMPO			
I-40 widened from Wade Avenue to Lake Wheeler Road		✓	
I-440 widened from Wade Avenue to Crossroads	✓		
US 64 W corridor improvements from US 1 to Lauran Duncan Rd		✓	
NC 540 toll road extended from Holly Springs to I-40 south of Garner	✓		
NC 50 widened and access management from I-540 to NC 98	✓		
I-40 widened from I-440 to NC 42 in Johnston County	✓		
I-87 widened from I-440 to US 264		✓	
US 1 widened south from US 64 to NC 540		✓	
Managed lanes added to I-540 (N. Wake Expressway) from I-40 to I-87		✓	
NC 540 completed as a toll road from I-40 to I-87/US 64 bypass		✓	
Managed lanes added to I-40 from Durham County to MPO boundary in Johnston County		✓	
I-87 widened from US 64 Bus to US 264			✓
NC 210 widened from Angier to Lassiter Pond Rd			✓
NC 50 widened from NC 98 to Creedmoor			✓
US 401 widened from Fuquay-Varina to MPO boundary in Harnett County			✓
NC 96 widened from US 1 to NC 98			✓
NC 56 widened from I-85 to MPO boundary in Franklin County			✓

** 2025 includes projects currently underway with full funding and an expected completion date by 2025.*

*** 2035 and 2045 includes projects selected through an alternatives analysis process that can be funded with existing revenue streams or reasonably foreseeable new revenue streams.*

Table 4 Projects by MPO and Time Period (Source. Connect 2045)

4.1.1.1 TRANSIT PROJECTS

Based on prior planning efforts and dedicated revenue sources for transit improvements, several transit investments were identified in Connect 2045 to provide dedicated transit corridors in order to reduce transit time, improve reliability, and enhance customer experience. These investments fall under three major categories: light rail transit (LRT)[1] bus rapid transit (BRT), and commuter rail (CR).

It should be noted that the Durham-Orange LRT project was halted during 2019; however, BRT projects in the region continue.

** 2025 includes projects currently underway with full funding and an expected completion date by 2025.*

*** 2035 and 2045 includes projects selected through an alternatives analysis process that can be funded with existing revenue streams or reasonably foreseeable new revenue streams.*

PROJECT	DESCRIPTION	TIME PERIOD		
		2025*	2035**	2045**
Chapel Hill Transit's North-South Corridor BRT	8-mile, 16-station project along the primary north-south corridor in Chapel Hill, Martin Luther King Jr. Blvd. and Columbia Street	✓		
Rapid rail system	Linking, Garner, Raleigh, and Cary in Wake County with the Research Triangle Park downtown Durham and West Durham		✓	
Extension of the rapid rail system	From west Durham to Hillsborough, where new Amtrak intercity rail station is being developed by NCDOT, and an eastward extension from Garner to Clayton			✓
Rapid rail extension	Apex and Wake Forest/Youngsville via Cary and Raleigh			✓
BRT system	Connecting Raleigh, Cary, Morrisville, Research Triangle Park, Garner, and Clayton. Includes portions of dedicated fixed guideway as well as mixed traffic BRT service		✓	
Extension of dedicated fixed guideway and additional BRT service	An extension of dedicated fixed guideway for the initial BRT corridors in Wake County as well as the addition of BRT service to Midtown in Raleigh		✓	
Extension of dedicated fixed guideway and BRT service	An extension of dedicated fixed guideway and BRT service to New Hope Rd. in the New Bern BRT corridor in Raleigh			✓
North-south BRT corridor in Cary	North-south BRT corridor in Cary along the Harrison-Kildaire Farm-Tryon Rd. Connects SAS/Weston area to Regency business park via downtown Cary			✓

Table 5 Transit Investments (Source: Connect 2045)

1 No longer being considered as a Connect 245 Project

4.1.2 Non-Infrastructure Regional Initiatives

In addition to roadway and transit investments, the region deploys numerous transportation-related programs to support reductions in congestion and increased travel reliability. These incentives-based programs are operated by various agencies for a multitude of regional transportation users. Information is summarized by category below.

4.1.2.1 TRANSPORTATION DEMAND MANAGEMENT

Transportation Demand Management (TDM) strategies are used to effectively and successfully manage traffic and control roadways. North Carolina has identified and deployed several of such strategies. The FY2017 TDM Impact Report highlights the following TDM programs (Triangle J Council of Government, 2018):

EFFORT	DESCRIPTION
CommuteSmart Raleigh	Goal to reduce use of SOVs through strategies such as biking, walking, car/vanpooling, transit, flex hours and teleworking.
Duke University's Unpark Yourself Program	Offers TDM services to employees and students on main campus and worksite locations between Duke and downtown Durham. Services include vanpool, carpool, carshare, bikeshare, and transit options.
Emergency Ride Home (ERH)	Voucher for taxi cab or rental car in event on an emergency. STRNC registrants are also included.
GoChapel Hill	Free membership to its Commute Club, promotes use of alternative transportation and encourages members to pledge to use alternative commutes.
GoTriangle Vanpool Service	Between 7-15 commuters included in each automobile. Vehicle, insurance, and maintenance provided by GoTriangle with riders paying monthly fare.
NCSU WolfTrails Program	Assists students, faculty and staff in accessing services such as carpooling, employee vanpooling, bicycling, walking and transit.
Share the Ride NC (STRNC)	Rideshare database that matches commuters interested in carpooling or vanpooling together.
UNC-Chapel Hill Commuter Alternative Program (CAP)	Program is free to employees of the University and UNC Health Care, and to commuter students living off campus. Alternative modes and services promoted through the University include free bus service through Chapel Hill Transit, numerous regional transit

	systems, Share the Ride NC ride matching service, carsharing program, carpooling, vanpooling, bicycling, and walking.
Wake Tech Community College ZOOM Program	Zeroing Ozone Output Measures (ZOOM) Program encourages use of alternative commute modes sych as transit, carpool, bicycling, and walking.
Bicycle and Pedestrian Related Projects	Connect 2045 prioritizes integration of transit and roadway projects with bike and ped needs. As a result, the document noted an expected investment on bike and ped projects of roughly $1.2 billion during its planning horizon (2018-2045).
Bus on Should System (BOSS)	Pilot project on Triangle Region's I-40. Program allows authorized transit buses to operate on freeway shoulders during periods of congestion.

4.1.2.2 FARE INCENTIVES

Fare incentive programs are a type of incentive strategy that seeks to encourage the use of alternate modes of transportation—usually transit or other sustainable modes (e.g., carpool). Currently, the following fare incentive programs exist in the Triangle Region:

EFFORT	DESCRIPTION
GoPass	Regional discounted transit pass for employees and students to ride for free when employers, universities, or property managers cover cost of ridership.
GoPerks	STRNC incentive program for commuters to track trips and earn point. Points are redeemed for monthly prize drawings.
NC Quick Pass	N.C. Turnpike Authority's all-electronic toll-collection program allows for discounted toll rates on the Triangle Expressway, Monroe Expressway, and future I-77 Express lanes

4.1.2.3 TRAVELER INFORMATION

Informed travelers making wise transportation choices are essential for reaching any safety and mobility goals. As such, the Triangle Region seeks to maximize the distribution of its travel information to improve mobility across the region. Below are examples of the initiatives for traveler information currently implemented by NCDOT (NCDOT, 2018):

EFFORT	DESCRIPTION
GoLive Transit	Real-time information system allows users to access real-time bus route information through website, app, and text messaging.
NCDOT 511	Includes Interactive Voice Response (IVR) system with links to the ATMS and TIMS incident databases.
NCDOT Traveler Information Management System Website	Website (https://tims.ncdot.gov/tims/) to access real-time traffic conditions on highways, camera images, planned events, (construction or major events), and emergency information (adverse weather or evacuations). The site links to neighboring states' 511/traveler information services.
ReadyNC	Mobile application that allows users to access real-time traffic conditions including alerts.
NCDOT Social Media (Facebook, Instagram, Twitter, Youtube)	Individual Twitter feeds for different NCDOT regions and for key corridors (I-26, I-40, I-77, I-85, and I-95). North Carolina State Highway Patrol (NCSHP) also uses the information provided by NCDOT's social media feeds within the NCSHP's social tools.
Work Zone and Construction Websites	For major construction projects, NCDOT maintains individual project web pages that typically include background materials, notices and bulletins about pending lane or roadway restrictions, links to documents and project newsletters.

4.1.2.4 CONNECTED AND AUTOMATED VEHICLES

Connected and Automated Vehicles (CAV) are expected to become part of the transportation environment. While the timeline to reach a significant level of market penetration is still unknown, it is important that agencies start considering a future where CAVs are part of their network. NCDOT and the Division of Motor Vehicles (NCDMV) took a

lead in the assessment of the North Carolina readiness for CAVs, determining how the State of North Carolina should be positioning to prepare for CAV technology and defining an approach, or activities roadmap, for the next 10 years[1]. NC 540 was been selected by USDOT for demonstrating and testing autonomous vehicles and the was selected to participate in the Spat challenge

EFFORT	DESCRIPTION
Town of Cary SPaT Challenge	Deployment of DSRC-enabled traffic signal infrastructure as part of the Signal Phasing and Timing (SPaT) challenge. The challenge is for each state to broadcast SPaT messaged (i.e. phase information) on one corridor including at least 20 traffic signals. The Town of Cary has funding approved for town-wide implementation in 2020.
NC 540 Truck Platooning	NC 540 has been selected by USDOT as a site for demonstrating tractor trailer truck platooning.

1 NC Readiness for Connected and Autonomous Vehicles (CAV), NDOT CAV Roadmap Development Project, Final Report: http://www.ncav.org/wp-content/uploads/2016/03/NC-Roadmap-for-CAV_Final_ALL.pdf

4.1.2.5 INCIDENT MANAGEMENT

Traffic incident management consists of a planned and coordinated multi-disciplinary process to detect, respond to, and clear traffic incidents in a way that reduces the duration and impacts of traffic incidents and improves the safety of motorists, crash victims and emergency responders (FHWA, 2017).

The Triangle Region seeks to improve transportation network efficiency and public/responder safety when a non-recurring event either interrupts or overwhelms transportation operations (i.e., when emergency/ disaster occurs). The following table describes NC's effort in this area.

EFFORT	DESCRIPTION
Incident Management Assistance Patrol (IMAP)	NCDOT safety service patrols the freeways, detects incidents, and responds to traffic related events. Vehicles are equipped to provide services such as pushing disabled vehicles off the roadway, traffic control for events, on-site coordination with emergency responders, and providing gasoline to stranded drivers.
Quick Clearance	After a five-year study of abandoned vehicles crash involvement concluded in 2005, North Carolina passed a quick clearance law. The law provided NCDOT and law enforcement the right to move a vehicle "by any means necessary facing any liability" if safety is a concern if the vehicle remains. The law typically is initiated during weather events, as NCDOT need to clear the roadway safely and efficiently for snow removal.

4.1.2.6 ACTIVE MANAGEMENT

NCDOT recognizes the potential benefits of using Active Traffic Management (ATM) on certain corridors that experience higher levels of congestion. ATM implementations can include a customized collection of strategies based on the physical characteristics and performance of a corridor. Some initial ATM elements that NCDOT is investigating include Bus on Shoulder on I-40 in the Triangle, variable speed limits in work zones, and ramp meters in the Triangle and Metrolina regions. The following table describes NCDOT's effort in this area.

EFFORT	DESCRIPTION
Ramp Meters	NCDOT conducted feasibility study for ramp meter deployment in the Triangle Region. As a result, a ramp meter in infrastructure was installed at four locations projects on the I-540 corridor.
Dynamic Message Signs	Widely used across the state. Some information includes adverse weather conditions, detours, closures, and travel times.
Inter-agency Communication	NCDOT has access to view CCTV cameras from multiple local agencies. Multiple municipalities coordinate directly with NCDOT either for their signal operations or for video sharing (e.g. cities of Fayetteville, Raleigh, Winston-Salem, Greensboro, Charlotte, Gastonia, and the Town of Cary.

4.1.2.7 TRANSPORTATION SUPPORT INFRASTRUCTURE

The advent of new, emergent transportation technologies brings a need of supporting infrastructure, both physical and digital. The following are examples of NCDOT and other agency's projects in this field.

EFFORT	DESCRIPTION
Underground Fiber Inventory (Regional)	NCDOT is completing a detailed communications inventory of its underground fiber network. Includes GPS locating junction boxes and importing the information to GIS. The next phase will be expanded to include more detailed information regarding field devices and equipment cabinets.
Fiber Management Tool (Statewide)	NCDOT is investigating solutions to management the inventory of the state's fiber-optic communications infrastructure.
Statewide ITS Device Map	NCDOT completed a review of ITS deployed devices across the state. The locations were placed on a Google map to be shared with consultant and partner agencies to support collaboration efforts.
Signal System Database	NCDOT maintains a database of over 14,000 traffic signals across the state including physical characteristics and historical information. The map is viewable online at https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=cd1fe92936ec44f8a3dbc002be2f68a3
Transit System Maintenance	CAMPO and DCHC MPO approved asset performance measure and targets address State of Good Repair in June 2017.
Transit Hub (Public-Private Partnerships	Local public transit systems coordinate and share facilities with private intercity bus operation; for example, the Durham Central Transit Station serves both the Greyhound and MegaBus along with local/regional public routes.
Transit Infrastructure Enhancements	Counties and transit agencies are investing in infrastructure such as improved customer bus stops and shelters, park-and-ride logs, and new vehicles.

4.1.2.8 DATA MANAGEMENT

Data management strategies relate to the equipment, systems and agreements with partners put in place by the Triangle Region to collect information on the conditions on its roads. The TSMO Strategic Plan defines the following current initiatives for this strategy (NCDOT, 2018):

EFFORT	DESCRIPTION
I-95 Corridor Coalition traffic data mart	NCDOT participates in the coalitions' traffic mart. The data is used for work zone travel times, monthly statewide bottleneck ratings, signal system timing analysis, and system performance reporting.
IMAP data assessment	NCDOT collects data of each stop made by vehicles that are part of the IMAP program. The intent is to enhance data to emphasize the benefits and impacts of IMAP by calculating a return on investment (ROI) for the program.
3rd Party Data	NCDOT acquires granular travel time data from HERE to identify congestion in small localized areas of roadways that may not have been detected otherwise using traditional methods.
High Resolution Data Collection (HRDC)	NCDOT and some Triangle municipalities (Town of Cary) are collecting high resolution data on specific corridors. The data will be incorporated into performance measures and used to monitor arterial performance and assist in project prioritization.
NCDOT Performance Dashboard	NCDOT provides a dashboard of metrics on incident clearance times, travel time index, and yearly fatal crash numbers. Measures are divided into mission goals, internal goals, division goals, group goals, and individual goals. Each metric includes some for of data collected.

4.1.2.9 INTERMODAL FREIGHT

Around 80% of both freight tonnage and freight value in the region moves by truck—with the amount of freight moved by truck expected to grow by a third by 2045. Furthermore, tonnages to, from and within the Raleigh-Durham region are expected to increase over the following decades at an average rate of 0.82 percent per year (WSP, 2018). The following table describes NC's effort in this area.

EFFORT	DESCRIPTION
Intermodal Terminal	Plans to develop an intermodal terminal near the Triangle Region. CSX's plans for this intermodal terminal to be used as a hub for consolidating and rerouting containers form all over the country.

4.2 Traffic Technology and Engineering Trends

Technological improvements and advancements continue to make transportation more accessible. These same technological improvements can also serve to improve safety and reduce traffic congestion, and its negative social, economic, and environmental impacts. Big data enables better estimation of travel behavior through trends analysis and forecasting to better identify patterns and inform decisions as connectivity is being captured at the individual level and data exchange occurs in (near) real-time. A key driver for this is that users of the transportation network are more virtually connected (i.e., online) than ever, which is the foundation of incentive-based applications and the new shared mobility transportation alternatives, particularly vehicle- and bike-share services. Many cities are developing and deploying smart city technologies, using Internet of Things (IoT) that allows the extension of Internet connectivity into physical devices and provides users with real-time information and available options. Figure 6 illustrates how data and connectivity set the stage for how planning entities and infrastructure owners and operators (IOO) can prepare for the future of transportation safety and mobility.

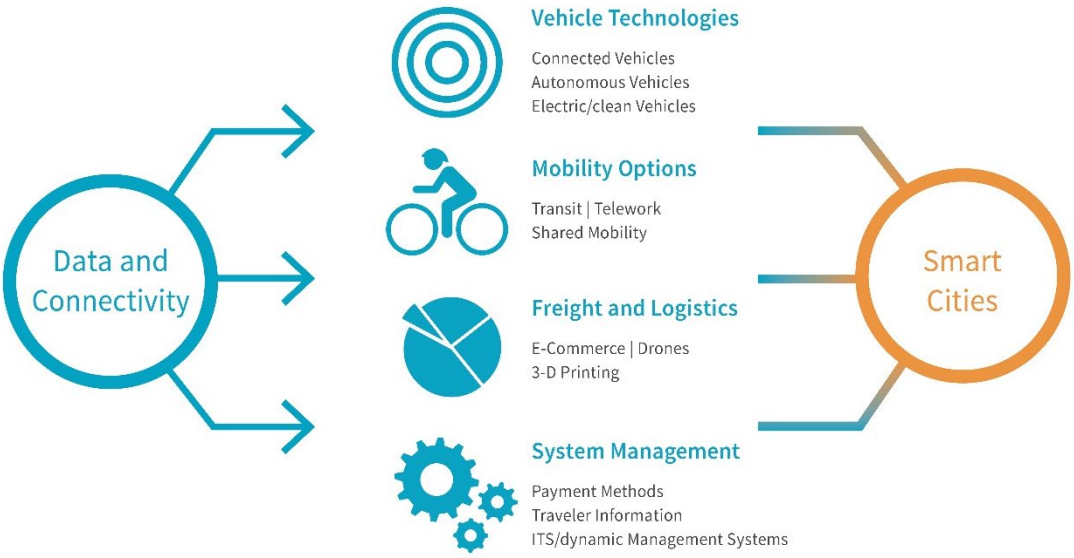


Figure 6 Comprehensive Picture of ITS

Major investments are being made in the smart infrastructure that allows implementation of the following systems:

- Smart signals networks;
- Integrated payment methods systems;
- New traveler information and incentives systems;
- Integrated corridor management systems
- Active Transportation Demand Management (ATDM) systems

Advancements in these technologies give CAMPO, DCHC MPO and NCDOT an opportunity to seek out potential partnerships and projects with local municipalities to embrace these technologies for the betterment of the traveling public. Improved mobility and safety are the key drivers behind these investments for the Triangle Region. Although, the time frame for implementation of many of these technologies may be uncertain, there are investments that can be made now that will support future mobility solutions. For example, investments in a communications network infrastructure and system operations will always have value even as the technology evolves.

Emerging trends in transportation technology can be summed up in three categories:

INSTRUMENTED

- The Internet of Things (IoT) brings sensory and hybrid communications technologies to:
  - Transit and specialty vehicle fleets
  - Roadside Infrastructure

- Traffic Signals
- Lighting
- Parking
- Personal Information Devices

INTERCONNECTED

› New traffic and transit operations models building ICM, shared use mobility and regional movement of freight and goods

› New management strategies that achieve shared outcomes of safety, mobility and reliability at corridor and network levels

INTELLIGENT

› New analysis tools, dashboards and decision support systems enabling new insights and agency resource optimization

› New modes of travel and customization of mobility is possible

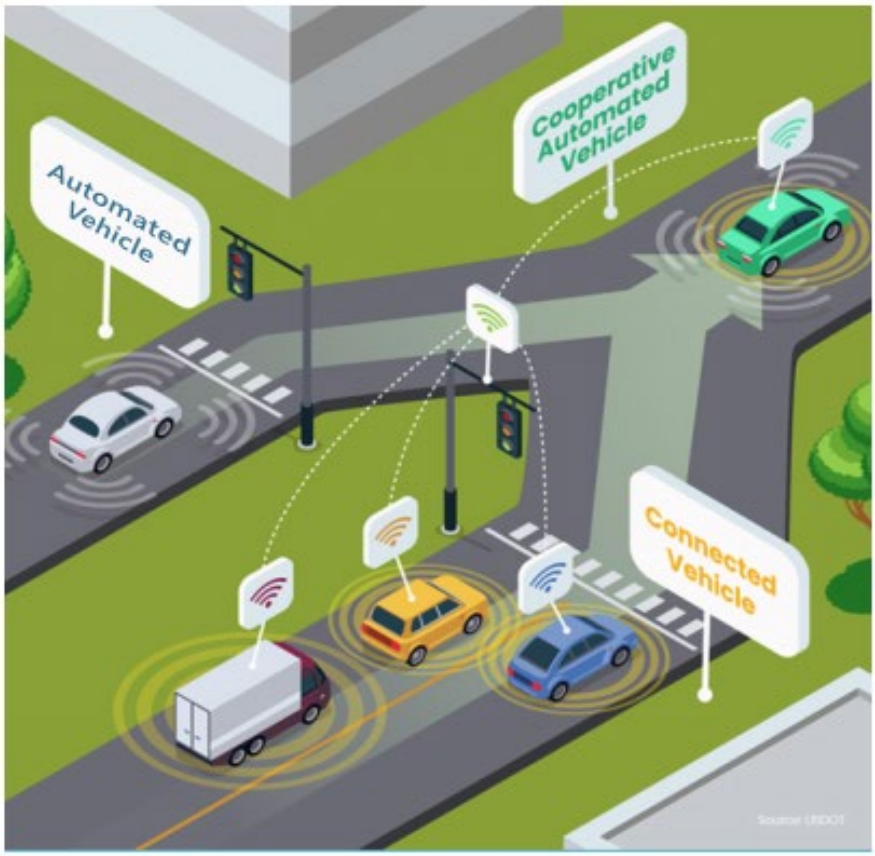
Emerging technologies associated with connected and automated vehicles (CAVs) may significantly affect travel, but the nature and scale of these impacts remains highly uncertain and may achieve substantial market penetration only in the long-term.

However, as advanced computing, sensors and telecommunications technology are changing and enhancing surface transportation networks, NCDOT and the NCDMV took a lead in assessment of the NC readiness for CAVs. Those agencies are determining how the State of North Carolina should be positioning to prepare for CAV technology and identifying an activities roadmap over the next 10 years[1]. These technologies are transforming transportation systems by combining connectivity with the self-driving features and by allowing vehicles to share information with other vehicles, the infrastructure, and devices.

Near term market penetration through research and pilot testing provides opportunities for regions to determine what may or may not work well in their region.

Improved safety and mobility are expected to some of the primary benefits of increased connectivity. Vehicles communicating with each other, and the surrounding infrastructure, as illustrated in Figure 7, provide warning information and critical data to drivers allowing them to proactively respond to potentially unsafe or congested conditions.

[1] NC Readiness for Connected and Autonomous Vehicles (CAV), NDOT CAV Roadmap Development Project, Final Report: http://www.ncav.org/wp-content/uploads/2016/03/NC-Roadmap-for-CAV_Final_ALL.pdf



Connected and Automated Vehicles (CAVs) are expected to provide **increased safety** while also **supporting economic vitality**. CAVs are expected to be a significant component of future automotive industry.

Figure 7 Connected and Automated Vehicles (CAVs)

As CVs and AVs begin to appear on roadways, many state and municipal governments have begun to enact legislation to address potential impacts of these vehicles on the transportation network. Issues such as types of vehicles allowed on a public highway, the requirements of an operator of a vehicle and different levels of operator control are all regulated. In order to allow AVs to be tested on public roadways, states had to modify these regulations in different ways to accommodate these situations. Should a vehicle operating in an automated mode on a public roadway be involved in an incident, there are many questions to be answered about the operation of the vehicle and the attentiveness of the driver/operator. States with autonomous vehicles enacted legislations and executive orders are presented on Figure 8.[1]

1 http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx#Enacted%20Autonomous%20Vehicle%20Legislation

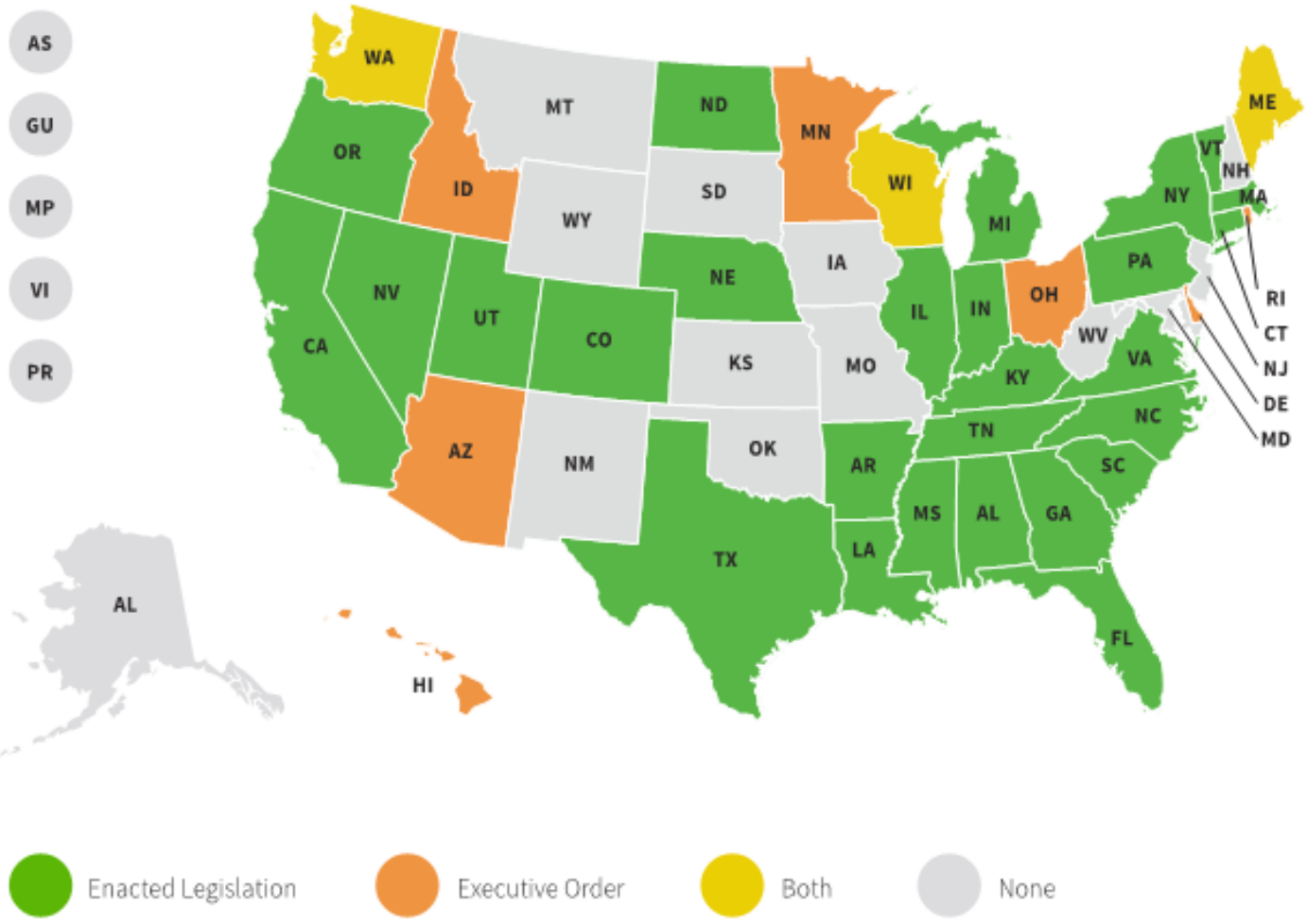


Figure 8 **States with autonomous vehicles enacted legislation and executive orders**

North Carolina has already enacted legislation that addresses autonomous vehicle operation allowing AVs to be tested on public highways within the state. Under the House Bill 469, The General assembly of North Carolina defined what constitutes a "fully autonomous vehicle" and established regulation stating the requirements necessary to operate fully autonomous motor vehicles on public highways of this state. In addition, House Bill 716, modified the follow-too-closely law to allow platooning.

As AV and CV advancements expand, arguments against deploying these technologies or at least slowing down implementations remain. Concerns include the safety of vulnerable road users (i.e., bicyclists, pedestrians), impacts of increased vehicle ownership on traffic capacity, and impacts on transit ridership.

4.3 Review of Current Deployments

The Triangle Region has made a significant investment in ITS programs in an effort to optimize efficiencies and increase mobility of the regional transportation system. The larger municipalities in the region (Raleigh, Durham, Cary, and Chapel Hill) have already implemented city-wide or town-wide traffic signal systems including fiber communication networks.

The Town of Cary system is also connected to the traffic signals in Morrisville and Holly Springs. Those municipalities have a municipal agreement which enables the Town of Cary to maintain and operate the traffic signals in Morrisville and in Holly Springs. Chapel Hill has a similar arrangement with their close neighbor, the Town of Carrboro. Other municipalities in the region feature closed loop systems even though they do not have a systemwide fiber network. Some municipalities in the region that do not already have traffic signal systems, are in the process of developing requests for funding for the design and construction of traffic signal systems.

The municipalities with existing signal systems have supplemented their systems with the addition of CCTV cameras, DMS, and emergency vehicle preemption.

Five traffic management centers (TMC) operate in the region – the NCDOT Statewide Traffic Operations Center (STOC), City of Raleigh TMC, the Town of Cary TMC, the Town of Chapel Hill TMC, and the City of Durham TMC. Discussions with regional stakeholders have indicated a desire to expand the reach of one of the existing TMCs or establish an additional TMC in the southeast part of the Triangle Region. A proposed process for determining a recommended plan of action is included in Appendix J.

In addition to the implementation of ITS devices for operations and monitoring of passenger vehicles, the region's transit operators have implemented AVL technologies to gather real-time locations of buses. The data is shared with users in real-time through internet webpages, smartphone applications, and text messaging services.

Not only has the region deployed ITS programs to maximize efficiencies of daily traffic, NCDOT successfully implemented an integrated corridor management (ICM) program for a project to reconstruct a significant portion of I-440 in Raleigh (Fortify I-40/I-440 Rebuild Project). The ICM program helped to minimize delays through gathering and distribution of real-time information in the corridor and reduce incident response times and recovery times following incidents in the work zone. A summary of ITS deployments by state and regional, municipal, and transit agencies is included in the regional architecture.

4.4 Proposed Project List and ITS Roadmap

The objectives and strategies will guide the identification of ITS deployments in the near-term (0-5 years), mid-term (5-10 years), and long-term (10+ years) outlooks; however, it is also important to recognize projects that have already been identified, some of which are already being considered for funding and implementation. This section lists ITS deployment projects and supporting programs that have been identified through feedback during the workshops and stakeholder interviews and through review of current regional transportation planning documents. The relative project costs and schedule for implementation have been identified for the current and potential list of projects and are illustrated in the project roadmap below. The projects that have been identified satisfy multiple objectives and are key to addressing many of the needs that were expressed by stakeholders.

Estimated costs for the signal system projects will vary based on the requirements to upgrade existing systems or to install brand new systems. The costs will be driven by the number of traffic signals that require upgrades, the number of new signals, the length of new fiber communication cable required, and the extent of the upgrades of existing infrastructure, i.e. new cabinets instead of reusing existing cabinets. Table 6 shows the proposed list of ITS projects with designations for anticipated costs and timeline for implementation.

LOW = ($) UP TO $3M, MEDIUM = ($$) $3M TO 10M, HIGH = ($$$) OVER $10M

PROJECT TYPE	NEAR-TERM (0-5 YEARS)	MID-TERM (5-10 YEARS)	LONG-TERM (10+ YEARS)
Transit Signal Priority/Bus Rapid Transit	$$		
Unified Transit Farebox System	$		
Implement AVL technology for Transit	$$		
New Municipal Traffic Signal System - Fuquay-Varina (U-6022)	$$		
New Municipal Traffic Signal System - Knightdale (U-6026)	$		
New Municipal Traffic Signal System - Morrisville (U-5967)	$		
New Municipal Traffic Signal System - Wake Forest (U-6023)	$$		
New Municipal Traffic Signal System - Clayton (U-5943)[5]	$		
Upgrade Municipal Traffic Signal System - Apex (U-6117)		$	
New Municipal Traffic Signal System - Garner (U-6194)		$	
Upgrade Municipal Traffic Signal System- Raleigh (U-6119)		$$	
New Municipal Traffic Signal System - Holly Springs			$$
Traffic Signal System Upgrade City of Durham (U-5968)	$$$		
Traffic Signal System Upgrade - Town of Cary		$$	
Complete Regional Fiber Network - NCDOT[6]			$$
Consolidate Municipal Signal Systems Management[6]			$
Establish Agreements for System Consolidation and Management	$		
Assess New Sub-Regional TMC		$	
Centralize Data Warehousing and Distribution		$	
Coordinated Corridor Traffic Signal Timing	$$		
Establish software and hardware platforms to serve connected vehicles and automated vehicles	$		
Regional standards for software, hardware, and communication platforms	$		
Inventory current deployments	$$		
Replace/upgrade outdated devices	$		
Integrated Corridor Management[6]			$$
Managed Motorways	$$$		
Training for Incident Response	$		
Emergency Pre-emption	$		
Adaptive Traffic Signal Systems		$$	
Occupancy Detection in Parking Decks		$	
Staff Training for Operation and Maintenance of ITS Equipment	$		
Expand Travel Information Coverage	$		

Table 6 Proposed Project List and ITS Roadmap

5 Project will go into implementation in near-term period and continue through mid-term, might continue through the long-term period.

6 Project may go into implementation in near-term or mid-term period, but could continue through the long-term period.

5

Triangle Regional ITS Architecture

The Triangle Regional ITS Architecture Update is part of the overall effort to update the Triangle Region ITS SDP, last updated in 2010. The updated Architecture is now based on the USDOT's Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) Version 8.2.

5.1 Introduction

The Triangle Regional ITS Architecture Update is part of the overall effort to update the Triangle Region ITS SDP, last updated in 2010. The updated Architecture is now based on the USDOT's Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) Version 8.2. https://local.iteris.com/arc-it/

Intelligent Transportation Systems (ITS) has evolved since the Triangle Regional ITS Architecture was previously published. Advances in communications, mobile electronics, and vehicle technology are changing the capabilities of infrastructure equipment and mobile platforms making possible the emergence of connected and automated vehicles.

The Triangle region has evolved as well since 2010. The North Carolina Turnpike Authority now has several tolled freeways. The North Carolina Department of Transportation (NCDOT) has increased its coverage of ITS field devices used to monitor the areas roadways. NCDOT has also begun to implement a Managed Motorways program that will provide new tools for NCDOT to manage the freeways, including dynamic lane assignment, speed monitoring, and shoulder running.

In transit, the region has changed with the branding of "GoTriangle" and the other "Go" partner agencies to bring an integrated brand to the region's travelers.

The Triangle Regional ITS Architecture includes all of the components that make up a regional ITS architecture per the Federal Highway Administration (FHWA) regulation 23CFR940 for ITS Architecture & Standards. The software tool, Regional Architecture Development for Intelligent Transportation (RAD-IT) was used to convert the original 2010 architecture and update it to be compatible with the current version of ARC-IT.

Detailed tables and data provided in the architecture are not intended to be printed out in their entirety and are too extensive to include in the body of this document. The detailed information can be found at the following website: https://local.iteris.com/ncarch/ and the landing page is illustrated in Figure 9.

Figure 9 RAD-IT

Definitions for each of the navigation sites are as follows:

- **Scope**: the geographic scope, time frame, and services included in the architecture
- **Planning**: this section will link the Objectives for the region from the ITS Plan update to the services in the architecture
- **Stakeholders**: lists the agencies and private sector organizations that play a role in the implementation, management, or operation of ITS systems and contributing systems in the region. CAMPO and DCHC MPO will update the list of stakeholders, once the access is granted to Triangle J Council of Governments (TJCOG).
- **Inventory**: lists the things – the systems and devices that make up ITS in the region as well as non-ITS systems that have data needed by the ITS systems or that take data from ITS
- **Services**: based on Service Packages in the national reference architecture (ARC-IT), this section shows the portions of the overall ITS architecture that combine to deliver a particular service
- **Needs**: lists the user needs that are derived from the services and define the overall needs for the stakeholders in the region pertaining to the intelligent transportation system
- **Roles & Responsibilities:** lists the roles & responsibilities for the stakeholders based on their participation (owner/operator) with elements that are assigned to the service packages
- **Functionality**: lists the functions for each element in the architecture; this is based on the elements assigned to 'subsystems' of the ARC-IT model – the elements that have ITS functionality and not the elements (devices/systems) on the fringe of ITS
- **Interfaces**: lists the interfaces between elements built from the element assignment and their mapping to the service packages
- **Standards**: lists the ITS and Communications standards that are related to the interfaces in the previous section
- **Agreements**: lists the inter-agency agreements that will be needed (some may already be in place) to carry out the services and interfaces called for by this architecture. Some examples of these agreements are already in place in the region. The Town of Morrisville and the Town of Cary have an agreement in place that enables the Town of Cary to operate and maintain traffic signals in the Town of Morrisville. The Town of Carrboro and the Town of Chapel Hill have a similar agreement that allows the Town of Chapel Hill to operate and maintain traffic signals in the Town of Carrboro. Additionally, NCDOT and municipalities have agreements in place that provides reimbursement of costs to municipalities to operate and maintain traffic signals that are part of the NCDOT traffic signal systems.
- **ITS Projects**: will list projects from the architecture needed to implement the vision in the ITS architecture.

5.2 Architecture Scope

The Triangle Regional ITS Architecture is a roadmap for transportation systems integration. The architecture was developed through a cooperative effort by the region's transportation agencies, covering all modes and all roads in the region. It represents a shared vision of how each agency's systems will work together in the future, sharing information and resources to provide a safer, more efficient, and more effective transportation system for travelers in the region.

The architecture provides an overarching framework that spans all of the region's transportation organizations and individual transportation projects. Using the architecture, each transportation project can be viewed as an element of the overall transportation system, providing visibility into the relationship between individual transportation projects and ways to cost-effectively build an integrated transportation system over time. This chapter establishes the scope of the architecture in terms of its geographic breadth, the scope of services that are covered, and the time horizon that is addressed.

Description

This is the regional ITS architecture for the North Carolina Triangle Region. The architecture is sponsored by the Triangle ITS Communications Partners, representing the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC- MPO), the Capital Area Metropolitan Planning Organization (CAMPO), the North Carolina Department of Transportation (NCDOT), the Federal Highways Administration (FHWA) and local governments within the region. Because no North Carolina Statewide ITS Architecture existed at the time when this version was developed, this architecture also includes some services and elements that would normally belong in a statewide ITS architecture, including Electronic Toll Collection and the NCDOT State Traffic Operations Center (STOC).

As the MTP undergoes formal updates on regular cycles, the Architecture should undergo simultaneous review and major modifications. This effort should include reviewing every aspect of the Architecture and working with the stakeholders to reprioritize the region’s needs. This should be a natural result of the Architecture being mainstreamed into the regional planning process and ensures that the Architecture continues to accurately represent the region. Regular updates of the regional ITS architecture should be performed by MPO staff using the use and maintenance manual and training materials as discussed sections 5.4 and 5.5.

Timeframe

The timeframe for the main focus of the architecture is on items to be implemented in the next 10 years. DCHC MPO and CAMPO update the Metropolitan Transportation Plan every 4 years with a 25-year horizon. Looking at the 10-year to 25-year range there are some longer-term initiatives like Automated Vehicle and Integrated Corridor Management that will be included in the architecture to support longer range planning.

Geographic Scope

The Triangle Regional ITS Architecture encompasses the combined membership of the Durham-Chapel Hill MPO (DCHC MPO) and the Capital Area MPO (CAMPO) – Town of Angier, Town of Apex, Town of Archer Lodge, Town of Bunn, Town of Carrboro, Town of Cary, Town of Chapel Hill, Chatham County, Town of Clayton, Town of Creedmoor, City of Durham, Durham County, Franklin County, Town of Franklinton, Town of Fuquay-Varina, Town of Garner, Granville County, Harnett County, Town of Hillsborough, Town of Holly Springs, Johnston County, Town of Knightdale, Town of Morrisville, Orange County City of Raleigh, Town of Rolesville, Wake County, Town of Wake Forest, Town of Wendell, Town of Youngsville, Town of Zebulon. From NCDOT's perspective this region covers mostly Division 5 with portions of Division 7 to the west, Division 8 to the southwest, Division 6 to the south, and Division 4 to the southeast.

Service Scope

The Triangle Regional ITS Architecture includes the following functional areas: Traffic, Transit, Data Management, Traveler Information, Commercial Vehicle (HAZMAT response only), Emergency Management / Public Safety, as well as Weather Data and Maintenance & Construction Management. Although it is recommended that all traffic signals maintained by NCDOT should operate with compatible hardware and software platforms, NCDOT Highway Divisions 4, 5, 6, 7 and 8 manage additional local signal systems beyond the regional boundaries but those systems don't factor into this architecture. There are also some commute sheds outside the regional boundaries.

5.3 Relationship to Regional Planning

The Triangle Regional ITS Architecture is an integral part of planning for the operations and maintenance strategies that are addressed by the regional transportation planning process.

The architecture provides a framework that connects operations and maintenance objectives and strategies with the integrated transportation system improvements that are implemented as a progressive series of ITS projects. The architecture also is used to define the data needs associated with performance monitoring that supports an informed planning process. This section identifies the planning objectives, strategies, and associated performance measures from the regional plan. These planning elements are connected with ITS services in the RAD-IT database.

5.4 Triangle Regional ITS Architecture Use and Maintenance

The Triangle Regional ITS Architecture Use and Maintenance Manual provides a plan for the use and maintenance of the ITS Architecture. This document serves a guide for how Triangle Region ITS Architecture will be maintained to support planning, design and implementation

processes in the future. The manual is provided as a separate document and can be provided in digital format to simplify distribution.

5.5 Triangle Regional ITS Architecture Training Material

The Triangle Regional ITS Architecture Training Material provides training on how the Architecture is organized and how it can be used. The manual is provided as a separate appendix and is available digitally as an annotated Microsoft PowerPoint file.

Iteris worked with FHWA to develop the ARC-IT program and provides access to additional training on the use of the program on their website (https://local.iteris.com/arc-it/html/resources/training.html). Both web-based training on on-site training, including facilitated workshops, are available for no costs. The matrix below illustrates the available training opportunities.

Topic Area	Web-Based Training	On-Site Training	Workshops
ITS Architecture	• ARC-IT Web Training • Use & Maintenance	• ARC-IT Refresher	• Quick-Starting Your Update Workshop • Architecture Development Workshop • Use & Maintenance Workshop
Software Tools	• RAD-IT • SET-IT	• RAD-IT • SET-IT	-
Systems Engineering	-	• Systems Engineering Training	• Systems Engineering for ITS Workshop

The web-based training offerings are self-paced which offer the most flexibility to individuals, but the on-site training and facilitated workshops both offer professional development hours (PDHs) for participants.

6

Plan Implementation

Stakeholders have identified ITS deployment strategies and developed necessary action items to move forward in developing a roadmap for potential ITS deployments. This chapter presents a summary of action items and a path for implementing the plan.

Translating the ITS Strategic Plan into implementation is key to aligning strategic investments and key resources to identify a clear path forward. A consistent process for plan implementation is critical to the success of the program.

6.1 Identify Lead

CAMPO and DCHC MPO, as administrators of the ITS Strategic Plan, should identify appropriate leads or owners for high priority actions that corelate to the project list that has been developed by the region. Lead for lower priority items can be determined when resources are made available. Stakeholders identified existing task forces and committees already established that provide good starting points for implementing action items that fall within their purview. Additional groups can be formed based on priority and need to meet the goals established in the strategic plan.

An important consideration for organizing efforts to develop and construct projects is to form a regional ITS task force/working group. Establishing a regional ITS task force/working group will provide opportunities for stakeholders in the region to have a common focus on the future of ITS deployments in the region.

6.2 Verify Proposed Action Items

Even though ITS has been actively deployed through the region in the past ten years, during each workshop, stakeholders put emphasis on the importance of aligning actions with regional objectives and needs.

Table 7 provides a summary of action items aligned with identified objectives and relevant ITS Architecture service packages in a series of tables. Also, recommendations on roles and responsibilities of regional stakeholders are assigned to action items that cover a wide range of services.

One action that was mentioned by stakeholders repeatedly throughout the development of the strategic plan included addressing interagency agreements and several actions were developed to address the need.

Given the desire to establish a regionally connected transportation system, developing agreements between municipalities and other agencies will be vital to the success of establishing a regionally connected system. Some examples of these agreements are already in place in the region. The Town of Cary has agreements with the Town of Morrisville and with the Town of Holly Springs that enables the Town of Cary to operate and maintain traffic signals in the Town of Morrisville and in the Town of Holly Springs. The Town of Carrboro and the Town of Chapel Hill have a similar agreement that allows the Town of Chapel Hill to operate and maintain traffic signals in the Town of Carrboro. The agreements between the Town of Morrisville and the Town of Cary and between the Town of Carrboro and the Town of Chapel Hill are included in Appendix. i. Additionally, NCDOT and municipalities have agreements in place that provides reimbursement of costs to municipalities to operate and maintain traffic signals that are part of the NCDOT traffic signal systems.

Important considerations when developing agreements include the following:

- The level and type of service to be provided such as installation, operation, and maintenance typically in accordance with NCDOT Schedule C and D agreements.
    - Insurance requirements
    - Reporting requirements (typically telephone and writing).
- Description of all costs to be incurred by the service provided, with a consideration for unanticipated incidents and expenses and annual increases in costs.
- Processes for expanding the scope of services and geographic area as systems grow.
- Details on operation of system components during events that disrupt normal operations – special planned events, weather events, etc.
- Identification of equipment storage in locations in proximity to where services are to be provided.
    - Term of the agreement.
    - Agreement termination requirements.

Agreements will involve cooperation between the agencies at both the staff level and administrative level. Involvement at all levels should be a significant component of the early efforts to establish the agreement to ensure a more timely execution of the desired agreements.

In addition to agreements between municipalities for the purposes of maintaining traffic signal systems, other examples of agreements that should be developed include:

- Data sharing
- Sharing travel data for public distribution through a common portal
- Sharing resources
- Establishing uniform asset management practices
- Agreements for managing responses to incidents affecting multiple municipalities
- Setting common equipment specifications to help ensure interoperability across system and municipal boundaries.

Examples of existing municipal agreements can be found in Appendix I.

1. OBJECTIVE: SUPPORT VISION ZERO		
ACTION ITEMS	**RESPONSIBILITY**	**ARCHITECTURE RELATIONSHIP**
Develop policy and procedures to share data with public and third parties	CAMPO and DCHC MPO	Traffic Information Dissemination (TMO6) Integrated Decision Traffic Incident Management System (TM08) Emergency Vehicle Preemption (PS03)
Establish performance objectives and monitoring	CAMPO and DCHC MPO	
Establish a regional task force/working group	CAMPO and DCHC MPO	
Establish partnership agreements between regional stakeholders	Individual municipalities, CAMPO and DCHC MPO	
Create and encourage regional partnership culture to eliminate silo mentality	Individual Municipalities, CAMPO and DCHC MPO	
Develop for Emergency Vehicle Preemption (EVP)	Individual Municipalities, CAMPO and DCHC MPO	
Develop and implement a TIM plan integrating freeways and arterials	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Increase and improve roadway surveillance coverage	Individual Municipalities, CAMPO and DCHC MPO	
Integrate CV Technologies	Individual Municipalities, CAMPO and DCHC MPO	
Integrate TMC's and computer aided dispatch	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Identify high crash corridors	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop operational scenarios	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Integrate emergency vehicle preemption	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop a protocol for emergency response training	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop an ITS Research Toolbox	NCDOT, CAMPO, DCHC MPO	

Table 7 Action Items Aligned with Objectives and Architecture Service Packages.

2. OBJECTIVE: SUPPORT RELIABILITY ACROSS AN INTEGRATED TRANSPORTATION NETWORK		
ACTION ITEMS	**RESPONSIBILITY**	**ARCHITECTURE RELATIONSHIP**
Establish performance objectives and monitoring	CAMPO and DCHC MPO	ITS Data Warehouse (DM01) Infrastructure-Based Traffic Surveillance (TM01) Traffic Information Dissemination (TMO6) Regional Traffic Management (TM07) Traffic Incident Management System (TM08) Integrated Decision Support and Demand Management (TM09) Emergency Vehicle Preemption (PS03) Transportation Infrastructure Protection (PS09) Transit Signal Priority (PT09)
Identify strategic corridors prioritizing projects	CAMPO and DCHC MPO	
Develop guidelines to evaluate projects for compliance with Regional Architecture	CAMPO and DCHC MPO	
Develop project prioritization methodology	CAMPO and DCHC MPO	
Involve agencies and municipalities in planning development process	CAMPO and DCHC MPO	
Develop a plan for traffic signal system upgrade	CAMPO and DCHC MPO	
Develop plan for Transit Signal Priority(TSP)	CAMPO and DCHC MPO	
Develop for Emergency Vehicle Preemption (EVP)	CAMPO and DCHC MPO	
Establish ITS Database	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop network security plan	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Establish partnership agreements between regional stakeholders	Regional Task Force (develop) CAMPO, DCHC MPO (approval)	
Identify potential deployments on high crash corridors	Regional Task Force (develop) CAMPO, DCHC MPO (approval)	
Create regional central clearing house database for lane closures (i.e. DriveNC.gov extended to local agencies)	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	

Table 7. Action Items Aligned with Objectives and Architecture Service Packages. (Continued)

2. OBJECTIVE: SUPPORT RELIABILITY ACROSS AN INTEGRATED TRANSPORTATION NETWORK (Cont…)		
Develop operational agreements	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop decision support systems	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop operational scenarios	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Improve fiber/communications network	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Establish partnerships for data integration and inventory compliance with Architecture	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	

Table 7 Action Items Aligned with Objectives and Architecture Service Packages. (Continued)

3. OBJECTIVE: ENHANCE NETWORK MOBILITY		
ACTION ITEMS	**RESPONSIBILITY**	**ARCHITECTURE RELATIONSHIP**
Create regional central clearing house database for lane closures (i.e. DriveNC.gov extended to local agencies	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	ITS Data Warehouse (DM01) Maintenance and Construction Vehicle Maintenance (MC02) Roadway Maintenance and Construction (MC05) Work Zone Management (MC06) Traffic Information Dissemination (TMO6) Regional Traffic Management (TM07) Traffic Incident Management System (TM08) Integrated Decision Support and Demand Management (TM09) Transit Signal Priority (PT09) Reduced Speed Zone Warning/ Lane Closure (VS09) Multi-modal Coordination (PT14) Dynamic Lane Management and Shoulder Use (TM22) Reversible Lane Management (TM16)
Establish performance objectives and monitoring	CAMPO and DCHC MPO	
Identify strategic corridors prioritizing projects	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Develop best practices guidance document to manage regional mobility	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Educate political leaders, senior management, and elected officials	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Create and encourage regional partnership culture to eliminate silo mentality	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Develop guidelines to evaluate projects for compliance with Regional Architecture	CAMPO and DCHC MPO	
Establish a regional ITS Task Force force/working group	CAMPO and DCHC MPO	
Identify critical corridors	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Develop operational agreements	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop decision support systems	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop operational scenarios	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	

Table 7 Action Items Aligned with Objectives and Architecture Service Packages. (Continued)

3. OBJECTIVE: ENHANCE NETWORK MOBILITY (Cont...)		
Develop plan for Transit Signal Priority(TSP)	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Improve information dissemination at operations level	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Develop operational agreements to share data between agencies	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Determine and monitor performance measures and system evaluation	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Provide quality ITS data to the public	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Improve fiber/communications network	NCDOT, C MPO, DCHC MPO and Individual Municipalities	
Develop regional fiber mapping plan	Regional Task Force (develop) CAMPO DCHC MPO and NCDOT (approval)	
Establish procurement process for security and interoperability	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Establish agreements to leverage partners to acquire equipment	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Establish partnership for data integration and inventory compliance with Architecture	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	

Table 7 Action Items Aligned with Objectives and Architecture Service Packages. (Continued).

4. OBJECTIVE: IMPROVE MULTIMODAL CONNECTIVITY AND EQUITABLE ACCESS		
ACTION ITEMS	**RESPONSIBILITY**	**ARCHITECTURE RELATIONSHIP**
Develop policy and procedures to share data with public and third parties	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	Transit Traveler Information (PT08) Multi-Modal Coordination (PT14)
Educate political leaders, senior management, and elected officials	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Create and encourage regional partnership culture to eliminate silo mentality	Regional Task Force (develop) CAMPO and DCHC MPO (approval)	
Establish procurement process for security and interoperability	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	
Establish a regional task force/working group	CAMPO and DCHC MPO	
Allocate funding for maintenance and operations	NCDOT, CAMPO, DCHC MPO and Individual Municipalities	

5. OBJECTIVE: IMPROVE, MONITOR AND MANAGE ASSETS	
ACTION ITEMS	**RESPONSIBILITY**
Allocate funding for maintenance and operations	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Develop a complete regional ITS infrastructure inventory	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Identify data driven tools and resources	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Allocate appropriate recourses and funds for asset replacements or system expansions	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Continue to assess stakeholders needs and resource availability	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Develop program management process for system utilization after maintenance and replacement	NCDOT, CAMPO, DCHC MPO and Individual Municipalities

Table 7 Action Items Aligned with Objectives and Architecture Service Packages. (Continued)

Identify and maximize potential of key ITS assets	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Proactive replacement of critical ITS infrastructure	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Improve fiber/communications network	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Develop regional fiber mapping plan	Regional Task Force (develop); CAMPO and DCHC MPO (approval)
Partner up to pursue funding opportunities (i.e. STIP, HSIP, etc.)	Regional Task Force (develop); CAMPO, NCDOT and DCHC MPO (approval)
Action Items	Responsibility
Allocate funding for maintenance and operations	NCDOT, CAMPO, DCHC MPO and Individual Municipalities
Develop a complete regional ITS infrastructure inventory	NCDOT, CAMPO, DCHC MPO and Individual Municipalities

6.OBJECTIVE: SUPPORT ECONOMIC VITALITY	
ACTION ITEMS	**RESPONSIBILITY**
Perform benefit cost analysis	CAMPO, NCDOT and DCHC MPO
Evaluate best practices and lessons learned	Regional Task Force (develop); CAMPO, NCDOT and DCHC MPO (approval)
Project prioritization methodology	CAMPO, NCDOT and DCHC MPO
Identify alternative funding sources and project criteria	Regional Task Force (develop); CAMPO, NCDOT and DCHC MPO (approval)
Develop performance metrics	CAMPO and DCHC MPO
Quantify ITS benefits	CAMPO and DCHC MPO
Achieve the highest ROI	Regional Task Force (develop); CAMPO and DCHC MPO (approval)
Partner up to pursue funding opportunities (i.e. STIP, HSIP, etc.)	CAMPO, DCHC MPO and Individual Municipalities

Table 7 Action Items Aligned with Objectives and Architecture Service Packages. (Continued)

6.3 Identify Resources

The lead will need to identify partnerships with other programs, agencies and individuals that have a stake in the actions required to move projects from planning and funding to deployment. Some of these relationships were identified while developing the action plan; however, requirements for additional resources may be identified as the development of each action item is fine-tuned, verified, and pursued.

6.4 Establish Timeframe

The projects were identified through input from stakeholders during workshops and group interviews. While the implementation timeline for each project will vary, the projects have been categorized as short-term, mid-term and long-term implementations based on current status of funding and study, anticipated lead time to obtain funding, and anticipated level of effort to complete the project given each project's complexities. Some common critical path items for many projects on the list include the following:

- Development of agreements where projects require cooperation between agencies and municipalities for exchanging services, sharing costs, and reimbursing costs for services. An example is an agreement between municipalities that intend to consolidate traffic signal systems for the purpose of monitoring, maintaining, and operating the systems.
- Establishing specifications for software and equipment platforms intended to be implemented across the region to ensure interoperability of systems. Examples include specifications for hardware and software platforms.
- Feasibility studies to identify recommended project scopes and application. An example would be a feasibility study for bus rapid transit (BRT).
- Securing and maintain funding. Funding must be obtained for projects that are not in the current NCDOT 2020-2029 STIP or already designated for funding by the DCHC MPO or by CAMPO.

Most of the projects on the list, including those that area already designated for funding, are intended to be completed within a 10-year timeframe. Projects of substantial scope that do not have funding yet programmed are designated to be completed beyond a 10-year time frame.

6.5 Develop Performance Measures

In order to effectively implement the strategic plan, the performance of each objective must be measured against an established target to determine if the objectives have been met. The action items identified in the plan are intended to implement projects and strategies to maximize the performance of the transportation system. Performance measures will vary by objective but all must be quantifiable on a consistent basis in order to make reliable

assessment of performance over time. For example, measures of system reliability could include changes in travel time, changes in the time to identify, respond to, and clear incidents, and changes in the amount of secondary incidents.

6.6 Review Progress

The lead is responsible for keeping stakeholders engaged and committed to working through the action items. Regular stakeholder meetings established by the group need to be maintained to continue progress towards the objectives of the Triangle Region.

6.7 Update Strategic Plan

It is important to recognize that the SDP is a living document and needs to be revisited at least annually to identify new strategies, objectives and actions that may be necessary to address gaps or modify actions as progress is made. This is necessary to ensure the program focuses on project priorities as the region grows.

6.8 Example Project Implementation

The details of implementing projects will vary depending on the scope of the project, but all ITS projects should involve some level of coordination across all agencies and municipalities in the region that have a stake in the project type. For example, stakeholders repeatedly mentioned a desire to complete connectivity of the transportation communication fiber network throughout the region. Steps to complete a fiber network across the region will include the following steps:

- Utilize the regional task force/working group to manage the project.
- The regional task force/working group should develop the basis for an inventory of existing fiber network including the following data items: the location of existing fiber, the age and condition of the fiber, the remaining capacity of the fiber, identification of the type of installation (overhead or underground), and location of splice enclosures and junction boxes.

- The regional task force/working group should establish the preferred software platform for developing the inventory. Applicable software programs in use in the region include AutoCAD, Microstation, Microsoft Excel, and ArcGIS. The most consistent platform that might be the most appropriate for establishing an inventory would be ArcGIS. While some municipalities may only have digital files in AutoCAD or Microstation, data from those applications can be imported into ArcGIS and the data items for the fiber can be associated with the fiber by location.
- After the format of data items and the preferred software platform is identified, NCDOT and each municipality that maintains a fiber network should compile their individual inventories into the required format so that gaps in the network can be identified.
- The regional task force/working group should establish requirements and specifications for new fiber to be deployed.
- The regional task force/working group can then review the consolidate data and the identified gaps in the network and then overlay those gaps with upcoming projects that could be leveraged to help construct improvements to eliminate the gaps. The projects in the NCDOT 2020-2029 STIP should be considered candidate projects to help eliminate gaps in the fiber network.
- If overlaying the scope of programmed projects does not provide opportunities to eliminate the gaps, then other options must be considered such: standalone projects by NCDOT or by individual jurisdictions or joint projects between neighboring municipalities where the gaps may prevent consolidation of traffic signal systems.

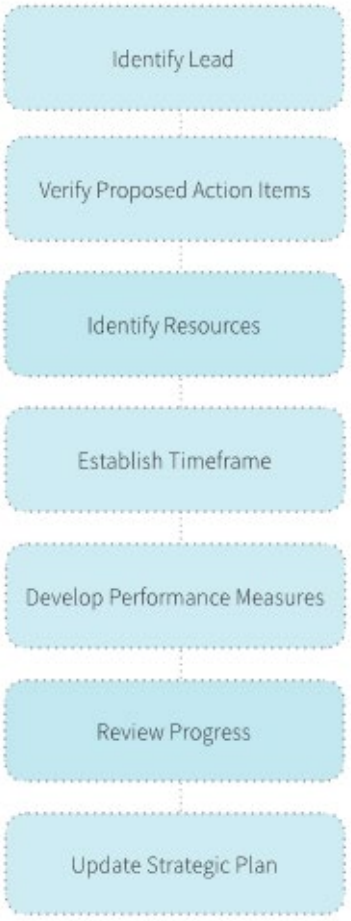


Figure 10 Steps to Implementation

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Appendices

Appendix A: Workshops Attendance and Interview Participation Summary

STAKEHOLDER	DESCRIPTION	PARTICIPATION				
		KICKOFF	WORKSHOP 1	WORKSHOP 2	WORKSHOP 3	INTERVIEWS
Town of Apex	Various government departments and agencies of the Town of Apex.	✓	✓			✓
CAMPO	MPO for the region and serves as coordinating agency between local governments, NCDOT, and FHWA.	✓	✓	✓	✓	✓
Town of Cary	Various government departments and agencies of the Town of Cary.	✓	✓	✓	✓	✓
Town of Carrboro	Various government departments and agencies of the Town of Carrboro.			✓		✓
Town of Chapel Hill	Various government departments and agencies of the Town of Chapel Hill.				✓	✓
Town of Clayton	Various government departments and agencies of the Town of Clayton.		✓			
DCHC MPO	Regional organization responsible for transportation planning for the western part of the Research Triangle area in North Carolina.	✓	✓	✓	✓	✓
City Durham	Various government departments and agencies of the City of Durham.	✓			✓	✓
FHWA	Federal agency that supports State and local governments.	✓	✓	✓	✓	
Fuquay-Varina	Various government departments and agencies of the Town of Fuquay. -Varina	✓		✓		
Town of Garner	Various government departments and agencies of the Town of Garner.			✓		✓
GoCary	Various government departments and agencies of the Town of Cary.				✓	
GoDurham	Bus service and Robertson Scholar Express (RSX) route for GoTriangle in the City of Durham.	✓	✓			
GoRaleigh	(this is shown in the pdf but not here in the Word?)	✓	✓	✓		✓
GoTriangle	Public transportation, ridesharing, bicycling, and telecommuting services, incentives, and resources (previously Triangle Transit).	✓			✓	
Town of Holly Springs	Various government departments and agencies of the Town of Holly Springs.	✓	✓	✓		✓
Town of Morrisville	Various government departments and agencies of the Town of Morrisville.	✓	✓	✓	✓	✓
NCDOT	Provides transportation for travelers throughout North Carolina, including highways, rail, aviation, ferries, bicycle and pedestrian facilities, and public transit.				✓	✓
NC Turnpike Authority	Authorized to study, plan, develop and undertake preliminary design work for toll roads in the state. At the conclusion of these activities, the NCTA is authorized to design, establish, purchase, construct, operate, and maintain the toll roads.	✓	✓			✓
City of Raleigh	Represents the various government departments and agencies of the City of Raleigh.	✓	✓		✓	✓
Wake County	Various government departments and agencies of Wake County.	✓	✓	✓		✓
Town of Wake Forest	Various government departments and agencies of the Town of Wake Forest.	✓				✓

Table 8 Participation by Agency

Appendix B: Stakeholder Workshops and Interview Attendees and Participants Information

FIRST	LAST	AGENCY	KICKOFF SIGN IN SHEET 5/18/2018	WORKSHOP 1 SIGN IN SHEET 7/10/2018	WORKSHOP 2 SIGN IN SHEET 3/14/2019	WORKSHOP 3 SIGN IN SHEET 5/30/2019	STAKEHOLDER INTERVIEW
Russell	Dalton	Town of Apex	✓	✓			✓
Paul	Black	CAMPO	✓	✓			
Alex	Rickard	CAMPO			✓	✓	✓
Brandon	Watson	CAMPO			✓		
Chris	Lukasina	CAMPO		✓	✓		✓
Shelby	Powell	CAMPO	✓				
Zach	Hallock	Town of Carrboro			✓		✓
Walter	Horton	Town of Carrboro					
Tina	Moon	Town of Carrboro					✓
Luana	Deans	Town of Cary	✓				
David	Spencer	Town of Cary	✓	✓	✓	✓	✓
Kevin	Wyrauch	Town of Cary	✓				
Kumar	Neppalli	Town of Chapel Hill					✓
Matt	Sullivan	Town of Chapel Hill					
Mila	Vega	Town of Chapel Hill					
Bergen	Watterson	Town of Chapel Hill					
Kayla	Seibel	Town of Chapel Hill					✓
Scott	Clark	Town of Chapel Hill				✓	✓
Sajid	Hassan	Town of Chapel Hill					✓
Samantha	Wullenwaber	Town of Clayton		✓			
KC	Chae	DCHC MPO		✓	✓	✓	✓
Felix	Nwoko	DCHC MPO	✓	✓	✓		
Peter	Nicholas	City of Durham			✓	✓	✓
Mohammad	Islam	City of Durham					✓
Anthony	Wambui	City of Durham					✓

✓ = in attendance

Table 9 Participation Information

FIRST	LAST	AGENCY	KICKOFF SIGN IN SHEET 5/18/2018	WORKSHOP 1 SIGN IN SHEET 7/10/2018	WORKSHOP 2 SIGN IN SHEET 3/14/2019	WORKSHOP 3 SIGN IN SHEET 5/30/2019	STAKEHOLDER INTERVIEW
Joe	Geigle	FHWA	✓	✓	✓	✓	
Tracy	Stephenson	Town of Fuquay-Varina	✓		✓		
Het	Patel	Town of Garner			✓		✓
Steve	Vargas	Go Durham		✓			
Earl	Bumphus	Go Durham					✓
Matthew	Frazier	GO TRIANGLE			✓	✓	✓
Patrick	Stephens	GO TRIANGLE			✓	✓	✓
Geoff	Green	GO TRIANGLE					✓
Bryan	Fainey	GO TRIANGLE					✓
John	Tallmadge	GO TRIANGLE	✓	✓			
Bret	Martin	GoCary				✓	
Mary	DePina	Town of Holly Springs	✓				
Benjamin	Howell	Town of Morrisville		✓	✓	✓	✓
Kent	Jackson	Town of Morrisville					✓
Mohd	Aslami	NCDOT					✓
Neil	Avery	NCDOT	✓	✓	✓		✓
A Cliff	Braam	NCDOT					✓
Andy	Brown	NCDOT					✓
Mike	Boahn	NCDOT					✓
Mark	Eatman	NCDOT	✓	✓			
Jimmy	Eatmon	NCDOT	✓				
James	Flowers	NCDOT					✓
Heather	Hildebrandt	NCDOT		✓			
Doumit	Ishak	NCDOT	✓				✓
Dennis	Jernigan	NCDOT					✓
David	Keilson	NCDOT	✓			✓	✓
Kent	Langdon	NCDOT	✓				

✓ = in attendance

Table 9. Participation Information. (Continued).

FIRST	LAST	AGENCY	KICKOFF SIGN IN SHEET 5/18/2018	WORKSHOP 1 SIGN IN SHEET 7/10/2018	WORKSHOP 2 SIGN IN SHEET 3/14/2019	WORKSHOP 3 SIGN IN SHEET 5/30/2019	STAKEHOLDER INTERVIEW
Todd	Lewis	NCDOT					✓
Paul	Marak	NCDOT		✓			
Meredith	McDiarmid	NCDOT	✓	✓			✓
Evan	McKinnon	NCDOT		✓			
Jennifer	Portanova	NCDOT	✓	✓	✓	✓	✓
John	Sandor	NCDOT					✓
Kelly	Wells	NCDOT	✓				
Frank	West	NCDOT					✓
Richard	Dayhuff	NCDOT		✓			✓
Dave	Jones	NCTA/ Consultant					✓
Sravya	Suryadevara	NCTA/ Consultant/ NHTB	✓	✓			
Tim	Bender	Raleigh				✓	
Matt	Pollack	NCTA/ Consultant/ NHTB					✓
Jed	Niffenegger	City of Raleigh	✓	✓			✓
Brandon	Watson	Raleigh Transit/Go Raleigh	✓		✓		
Tim	Gardiner	Wake County	✓	✓	✓		
Suzette	Morales	Wake Forest	✓				✓

✓ = in attendance

Table 9. Participation Information. (Continued).

Appendix C: Kickoff Meeting Notes

Meeting Agenda

Date: May 18, 2018 **Agenda Prepared By:** J Lewis

Place: CAMPO offices, Raleigh, NC

Project No.: 38813.00 **Project Name:** Triangle Region ITS Plan Update

1. Welcome and Introductions
2. Study expectations
    a. Study purpose
    b. Schedule, objectives, work products, project management, and reporting procedures 3. Stakeholder and core team participation
5. Technical team data needs
    a. Prior plans and studies
    b. Project updates
6. Local issues and sensitivities
7. Immediate next steps, upcoming meetings, and deliverables

\\vhb\gbl\proj\Raleigh\38813.00 CAMPO ITS Update 2018\docs\VARIOUS\Meetings\Stakeholder Meetings\May 18, 2018\May 18, 2018 Stakeholder Agenda.docx

Meeting Notes

Place: CAMPO Offices,
421 Fayetteville St., Ste 203,
Raleigh, NC
Conf Room A

Date: May 18, 2018 Notes Taken by: Cheryl Lowrance

Project #: 38813.00 Re: CAMPO ITS Deployment Plan Update
Stakeholder Kick-Off

ATTENDEES

See sign in sheet

The following is a summary of the Stakeholder Kickoff Meeting for the CAMPO ITS Deployment Plan Update Study.

Paul Black gave an introduction to the study and the purpose for the meeting and Jody Lewis (PM) gave an overview of the team and what the expectations of the Stakeholders would be throughout the project. NCDOT, the Transit agencies, the jurisdictional traffic signal systems and other traffic signal owners and the turnpike authority were all represented at the meeting. The sign in sheet is attached.

The Core Team consists of:

- Paul Black – CAMPO
- Kosok (KC) Chae – DCHC
- Mark Eatmon – NCDOT-TPD
- John Sandor – NCDOT
- Meredith McDiarmid – NCDOT ITS & Signals
- Jennifer Portanova – NCDOT Traffic Systems Ops
- TBD - Raleigh Traffic Signal System
- TBD - Durham Traffic Signal System
- TBD - Chapel Hill Traffic Signal System
- TBD - Cary Traffic Signal System
- TBD - GoTriangle - Transit reps TBD
- TBD - NC Toll Authority – TBD
- TBD - Incident Response (Question on how to cover this group geographically)

There will be monthly meetings with the Core team and 3 project workshops that will engage the larger stakeholder group.

The rest of the meeting centered around getting feedback from the stakeholders. Highlights included:

There is an expectation (from CAMPO) that this project will develop a prioritization for projects as they are determined, that they will be accounted for in the Locally Administered Projects Program (LAPP) and prioritized for the Master Transportation Plan (MTP).

  - Purpose would be to incorporate ITS projects into other projects if they are already in the MTP

- Suggestion was for the project team to engage the Signal Systems Users Group
  - There is some overlap with stakeholders for this project and the users' group. ○ We could use their meeting as a way to obtain user feedback. ○ Helps with overcoming jurisdictional boundaries and improving interoperability.
  - Communicates the need for regional compatibility.
    - Discussion on controller types and interoperability.
    - Do they all have to have the same controller to build an interoperable network?
    - Some agencies use Econolite – others do not – do they need to switch for interoperability?
    - Maintaining multiple types of equipment.
  - Region has a major project incorporating BRT. What will be needed/required from a traffic signal/arterial perspective.
- NCDOT
  - The State wants strategies for regional operations, not just devices.
  - Look at a Systematic approach – freeways and arterials working together, is there a need for a new TMC to manage a regional network, can we use what we already have.
  - How do we look at this regionwide and not just at the project specific level?
  - This team and this study has to remain balanced – taking the future into consideration – planning and engineering for the future while considering the operations and maintenance of the system long term.
  - The future needs to look at land use and how it will affect operations regionally. Balancing building with operations/maintenance.
- The future of transportation needs to be considered
  - Using active transportation tools. ○ Connected/automated vehicles.
  - Mobility services - parking, infrastructure, multi-modal services - look to include in architecture -have a discussion on how to prioritize these projects.

- Multi-modal opportunities need to be addressed.

- How does this study overlap with the Statewide TSMO Plan?
- How do we create a platform to get private entities to the table?
    - It is the public sectors role to bring all stakeholders together to meet regional objectives.
- The regional architecture has to be open – avoiding anything proprietary if at all possible. Standards and interoperability will have to be required.
- Need to engage Emergency Responders – I-40 first responders use to have a working group, but they do not at this time.
- Durham has also been putting together team meetings to start sometime this year.

Action Items

- Set up Monthly Core Team Meetings.
- Plan first Stakeholder Workshop – scheduled for week of July 9.
- Project Team needs an inventory of what has been deployed since the last Strategic Plan in 2010. ○ Provide a template to Transit agencies (and others if so desired) to help identify projects that include transportation technology.
- Obtain TSMO Statewide Plan and other available documents. What are we still missing?

https://portal.vhb.com/clients/12200/38813.00/Shared Documents/Meetings/Stakeholder Meetings/May 18, 2018 - Stakeholder Kick-Off/CAMPO ITS - Stakeholder kick-off_05-18-18 meeting notes.docx

Appendix D: Stakeholder Workshop 1 Summary

July 10, 2018 CAMPO Office

Following welcoming remarks by Paul Black (CAMPO) and participant introductions, the VHB team facilitated the discussion during each session. The meeting summary is organized in the agenda topic headings. A full participant list follows the report.

Setting the Stage

Beverly Bowen (ICF) began the discussion explaining how the VHB team researched three main documents to understand the vision and goals of the region.

- Connect 2045: The Research Triangle Region's Metropolitan Transportation Plan – Serves as the metropolitan transportation plan for the Triangle region and provides a comprehensive view of the regions' plan for improving its transportations network and services.
- NCDOT's 2018 Mobility and Safety Transportation Systems Management and Operations (TSMO) Strategic Plan – Provides guidance to NCDOT on TSMO-focused strategies and activities that will expand or enhance programmatic and agency integrations.
- Intelligent Transportation Systems Strategic Deployment Plan (2010 Update) – Provides an overview of NC's ITS practices at the time, as well as planned ITS projects.

Beverly then guided the participants through an open discussion on how the team developed a series of five draft objectives for the workshop by aligning the goals and objectives for this project with the broader regional goals. See the associated handout at the end of this document that illustrates the alignment of regional objectives among the multiple planning documents.

The participants were asked to provide feedback by answering questions including: "How can the ITS SDP support the goal?"; "What key words do you associate with this goal?"; and What role does ITS play in the overall regional goals and objectives? Participants provided significant feedback through the discussions of each objective and changes were made to the proposed objectives accordingly. For example, the first objective introduced was "Support safe travel for all users" based on the goal "Promote Health and Safety" from the Connect 2045 MTP and key words such as crashes, incident management and hot spots. The discussion lead to additional key words including bottlenecks, information, data, air quality, bikes and peds. A collective response among the participants was "Where are we going with performance measures?" They felt that safety should be an overarching theme for all the objectives and a broader objective was proposed: Support Vision Zero Policy in the Region.

The final results of the discussion led to the five objectives outlined below These were then used to frame the breakout group discussions later in the day.

- Support Vision Zero policy in the region
- Support reliability across an integrated transportation network
- Improve multimodal connectivity and equitable access
- Improve, monitor, and manage assets
- Support economic vitality

Big Picture of the Region: Successes, Challenges, and Desires

Continuing the full group session, the VHB team facilitated a brainstorming discussion of the region's successes and challenges. In addressing these successes and challenges, the following feedback was provided by stakeholders:

Successes:

- Integrated Traffic Signal Systems
    - Strategic Prioritization Office of Transportation (SPOT) process and Strategic Transportation Investments (STI) process provides a way to prioritize project requests in CAMPO. In the near future, more funds will be allocated in the budget for integrating traffic signal systems between cities. By providing interjurisdictional signal operations, the region benefits from opportunities to provide network wide coordination, speed management, and emergency vehicle response preemption and transit priority.
- Transit agencies are providing real-time transit information.
- Town of Cary is testing infrastructure to vehicle technology at traffic signals providing Signal Phase and Timing (SPaT) data. This project supports the national SPaT Challenge initiative sponsored by American Association of State Highway Transportation Officials (AASHTO).
- NCDOT has multiple traffic management centers, including one that is co-located with emergency operations.
- Transit agencies that have AVL data, provide an open platform for data exchange and traveler information.
- NCDOTs Transportation System Management and Operations (TSMO) program provides reliable traveler information on state owned and operated facilities.
- NCDOT operates a Traffic Incident Management (TIM) Program that has performance metrics to clear incidents within a specific time frame. Successful TIM programs reduce the chances of secondary crashes and reduces overall system delay.
- NCDOT has a certification and training program for their Incident Management Assistance Patrol (IMAP).

Challenges:

- Outdated fiber and network communications and gaps in fiber infrastructure
- Aging equipment and the interoperability between legacy traffic systems
- Better coordination and communications between agencies when responding to incidents.
- Need for funding operations and maintenance of ITS devices and infrastructure. Capital funding is available for building systems, but operations and maintenance has to be absorbed in current budgets.
- Coordination of traffic systems across jurisdictions along the same corridors. Some agencies have agreements for operations, but not all.

› Turnover in workforce and leadership. Leads to lack of regional vision and difficulties finding qualified staff.

The full group had many ideas on things they would like to see in the region. A discussion of desires included the list below.

Desires

› Coordination of ITS across communities (TMC, IMAP, etc.)
› Parking decisions and technology
› Operations agreements
› Integrated fare systems
› Funding for maintenance and operations costs
› Better real-time information on lower classified roads
› Downstream detectors at intersections
› Consideration of mobility as a service
› Automated management system to manage arterials diversions and detours (ICM)
› Better connection with planning and programming
› Integrated data infrastructure
› Decision support tools for reliability
› Bicycle and pedestrian considerations with traffic signal systems
› Management of parking spaces (interface with transit)
› First mile/last mile pilots/systems
› Explore school as a “community”/context for ITS

Lunch Break

During the lunch break, the VHB team presented strategies and ideas for participants to consider. Slides are provided at the end of this document.

Breakout Sessions

The full group was pre-assigned to breakout topics based on the five goal areas identified earlier in the day. The asset and economic vitality groups combined for a single discussion. The purpose of the breakout was to begin identifying some strategies to meet these objectives. The following information summarizes the major discussion items in each breakout group. Note: the Vision Zero candidate objective was not discussed in a specific breakout group. Safety was considered throughout the discussions.

Support Reliability Across An Integrated Transportation Network

- Considering strategies to manage congestion and to support travel time reliability it is important to look ahead and identify potential future needs of all different transportation modes. Examples include:
    - Active traffic management,
    - Bus lanes on shoulder
    - Smart Work Zones
    - Variable speed limits
    - Lane reduction and lower speed limits in Work Zones
- Some practices that are currently in place include the above initiatives and responsive ramp metering; however, bus lane management is done manually by the operator.
- Most vulnerable users (pedestrians and bicyclist) along with transit should be given priority in future planning and development.
- When the transportation network is built to be used efficiently, the decision support system needs a policy to manage the traffic.
- Currently used technologies and advancements include:
    - Automated vehicle location (AVL) system - data is pushed to the public. This is mostly used as a dispatch tool and very is limited. ▷ Limited pilot program with city of Durham
- In planning stages:
    - BRT and light rail - looking at how to use a combination of dedicated lane uses, onboard fair collection, and mobile fair payment.
    - AVL System
    - Create data warehouse and interface tools
    - Collect and use speed data
    - Collect and use computer dispatch data from freeway patrol

- Create real time information sharing with Emergency Response team and include transportation agencies in the response plan.
- Develop signal system strategies by improving coordination across jurisdictions.

Improve Multimodal Connectivity And Equitable Access

- Land use decisions impact how individual communities manage their systems. Land use and zoning is an overall strategy.
- Transit and parking management with communities more involved in transit hubs. How will public parking be funded is a consistent question.
- Improvement and implementation of the NC Complete Streets policy. Pedestrian and bicycle infrastructure and protection. Exploring technology to address more road users. Pedestrian implementation plan for crossings on signalized intersections and at midblock crossings.
- Get private sector involvement for parking decisions. Public-private partnerships for park and ride for transit use would be beneficial. There is no region wide policy for parking standard.
- Use transit plans to inform future decisions. Wake County Transit Plan is looking at ITS solutions to become a standard. Ten-year vision plan includes BRT, Light Rail, and Commuter Rail. Specific studies within the plan identify the transit needs with respect to ITS. Durham and Orange County are closer to implementation and are in the engineering phases.
- Better agreements need to be set into place to make things more productive with community policies matching up with bordering communities. Generally, NCDOT owns the roadways, and the communities are not prepared to take over ownership.
- Ride sharing to use as an incentive for transit with a reduced fare. Transit is partnering up with ride sharing for this as part of the Wake County Transit Plan. Also looking into transit technologies to enhance ridership.

Improve, Monitor, and Manage Assets

- Not currently using ITS devices/systems to manage/monitor its infrastructure assets.
- DOT does some over-height detection systems in some parts of the state; they provide help with some weigh stations. Other divisions do icy bridge detection, wind detection, and tunnel management systems.
- Unclear whether DOT actively monitors work zones during construction; perhaps the construction companies do.
- Snowplows and maintenance trucks are managed by the Maintenance Division.
- Currently no Asset Management systems are used in the region.
- The Turnpike Authority may have more sophisticated system monitoring for their field devices and computer equipment.

Support Economic Vitality

- There are some indicators that there is an interest in new technologies in the region but mostly to address some of the other areas.
    - Signal Phase and Timing (SPaT) Challenge in Cary: A challenge to state and local public sector transportation infrastructure owners and operators to cooperate to achieve deployment of DSRC infrastructure with SPaT broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each of the 50 states by January 2020. SPaT broadcasts are expected to be accompanied by MAP and RTCM broadcasts. (National Operations Center of Excellence)
    - AV testbed using the turnpike
    - Adaptive Signal System for Cornelius (a pilot between the state, the town, and the vendor)
- It is not considered that ITS will necessarily drive Economic Vitality. Pilots and other testing are supported, but there is no desire to get ahead of the industry.
- More importantly, economic drivers can sometimes create challenges in terms of mobility and access to facilities.
- Follow-up with the State Traffic Engineer for more perspective on this topic.

Wrap up and Next Steps

The VHB team and Paul Black thanked everyone for participating. The next workshop will be to consider the ITS architecture more specifically. Meeting notes will be shared with the group.

CONNECT 20145 MTP GOALS	TSMO STRATEGIC PLAN FUNCTIONAL AREAS	DRAFT ITS PLAN OBJECTIVES	KEY WORDS	INPUT FROM KICKOFF MEETING
Promote Health and Safety	Freeway Management (TIM/Tactical)	**Support safe travel for all users**	Crashes (all types), incident management, incident clearance, hot spots	
Manage Congestion and System Reliability	Freeway Management (Ops/Strategic), Arterial Management	**Support mobility across an integrated transportation network**	Integration across jurisdictions, agencies, and functional classifications Freeway capacity during events, ICM, ATM, minimize congestion and delay, TDM, ITS and technology Operations along arterial network, mobility and safety strategies integration into the decision-making process	Freeways and arterials working together Mobility services Regional compatibility and inter-operability
Promote Multimodal and Affordable Travel Choices, Connect People, Ensure Equity and Participation	Arterial Management Traveler Information Partner Agencies	**Assist multimodal travel options**	Bicycle and pedestrian transportation, transit real-time data, signal operations, mobility and safety strategies Jobs, education, travel time, sidewalks, bike lanes All populations, public participation, EJ, transit, employment centers, zero-car households Technology solutions for collecting, sharing, and disseminating information so travelers can make informed decisions	Incorporating BRT Active transportation tools CV and AV Parking, multi-modal service and opportunities
Improve Infrastructure Condition	Asset Management Data and Performance Measures	**Manage and maintain ITS assets**	Infrastructure, DOT networks, asset condition, maintenance history, forecast resource needs, level of performance	Maintaining the system long term Balancing building with operations/ maintenance
Stimulate Economic Vitality	Return on Investment	**Support economic vitality**	People and goods, P3, freight movement and freight corridors, land use, cost-effective solutions, improve project delivery, truck delay, travel time reliability Benefit/ cost of potential project and built project, effective application of resources and funding	Land use and its regional effect

Appendix E: Stakeholder Workshop 2 Summary

Thursday, March 14, 2019: 8:00am– 12:00pm, CAMPO Office

Jody Lewis (VHB) gave welcoming remarks and Cheryl Lowrance (VHB) provided a project status update including discussion of objectives and strategies and key takeaways from the stakeholder interviews. David Binkley (Iteris) presented the draft regional ITS architecture. A full participant list follows the report.

Vision, Goals, and Objectives

Cheryl Lowrance (VHB) and Beverly Bowen (ICF) lead discussions focusing on vision, goals, and objectives of the regional ITS deployment plan and how the vision is to be aligned with vision and objectives from other key regional planning studies such as the Connect 2045 Metropolitan Transportation Plan, the 2015 North Carolina Highway Strategic Safety Plan, and the NCDOT Mobility and Safety TSMO Plan. The following goals were presented to the workshop group:

- Support Vision Zero policy in the region
- Support reliability across an integrated transportation network
- Improve multimodal connectivity and equitable access
- Improve, monitor, and manage assets
- Support economic vitality

Discussion focused on identifying components that participants felt were overlooked and strategies and could align with some of the objectives.

Jennifer Portanova (NCDOT) commented that mobility was not specifically addressed by the presented objectives and recommended it should be on the list of objectives. Some strategies mentioned to align with the objectives included interoperability and integration, connected and autonomous vehicle technologies, traveler information systems, managed motorways, integrated corridor management, and a one-stop shop for travel information for visitors to the region. It was suggested that until connected vehicle technologies are widely implemented, travel information can be shared with drivers using existing technologies such as cell phone applications. GoTriangle staff suggested that transit operators should be better integrated in emergency management communications. NCDOT staff indicated more concern for the human communication process in emergency management. NCDOT staff also commented that removal of dynamic message signs may eventually occur, but removal will be organic, and they will remain in use until other options are more fully deployed to provide travel information to drivers.

Assessment of Needs

The consultant team lead discussions of the findings of the stakeholder group interviews. The group interviews included staff from all the regional municipalities, staff of both MPOs, NCDOT, the NC Turnpike Authority, and regional transit providers. The group interviews provided to be very valuable. They provided a great opportunity to gain deeper insight into each stakeholder's needs. The needs/initiatives that were most commonly identified by each

stakeholder group included improving coordination across agency and municipal boundaries, multimodal connectivity, asset management, innovation, emergency management, a complete regional fiber network, continued deployment of signal systems and coordinated corridor signal timings, funding, emerging technologies for connected and autonomous vehicles, and data collection and distribution.

Architecture Update

David Binkley (Iteris) presented the draft update of the regional architecture. The major topics included providing the definition of a regional ITS architecture, the benefits of preparing and following a regional ITS architecture, and the major components of the architecture – stakeholders, inventory of elements, ITS services, and the key interfaces of the architecture.

David explained that the major benefits of preparing and following the architecture when planning ITS deployment and ITS activities include an orderly and efficient deployment of ITS elements over time and improved communication between people and systems across the region.

Given the time that has elapsed since the last update of the regional ITS architecture, David led a discussion of the data in the architecture and gathered feedback from the stakeholders to update the list of stakeholders and project elements to include in the architecture update. The changes requested by the stakeholders were noted by David and the rest of the consultant team for inclusion in the updated architecture.

The stakeholders also provide comments on the geographic boundaries to be covered by the regional ITS architecture. Some areas outside of the regional boundaries are being maintained by various NCDOT divisions but this will not affect the architecture. Lillington, NC was mentioned as a potential addition to the coverage area due to increase commuter traffic since 2010.

Stakeholders provided comments on the time horizon of the regional ITS architecture and deployment plan. It was recommended that the architecture be formally updated on the same schedule of the regional metropolitan transportation plan (MTP) which is every four to five years. It was further suggested that projects be identified for near term (within the next five years), mid-term (five to ten years), and long term (beyond 10 years).

During open discussions, stakeholders made several general comments concerning elements to include in the architecture. There were multiple statements to not focus on detailed projects in the architecture and to instead focus on higher level descriptions such as stating a strategy to connect corridors to adjacent traffic signal systems instead of specifying corridors and attempting to provide specific details on the

ITS elements to deploy. Emergency management was mentioned by stakeholders as an important consideration. Specific strategies for emergency management included coordination/integration of responders into other regional systems, development of agreements between emergency service agencies and municipalities, acquiring compatible communication devices.

Project Prioritization

Discussions next focused on project prioritization. Alex Rickard (CAMPO) stated that he desires to a prioritization methodology that can be used by the MPOs to more efficiently assess various ITS deployment projects that are competing for funding. Discussion included trying to identify existing methodologies that could be used to identify ITS strategies for consideration. One current effort that was identified that could aid in this process was the NCDOT Hot Spot program. NCDOT has developed a Hot Spot map which includes key locations based on crash histories, congestion, and popular destinations. Stakeholders offered the following potential Hot Spots: I-40/I-540 interchange, NC 147 at NC 55, RDU Airport and accesses, ramp from SB I-440 to EB I-40, and Hillsboro Street at Enterprise St in Raleigh.

In additional GoTriangle staff mentioned a desire for transit signal priority on Hillsborough Street in Raleigh, bus rapid transit corridors across the region to improve reliability of transit services, improved/updated automated vehicle location systems, and education for transit agency staff.

Other Hot Spots might include communities that have experienced rapid growth in development and population and may benefit from increased investment in their transportation systems.

A potential Hot Spot strategy could be deployment of technologies to support connected and autonomous vehicles. Cary is operating a SPaT (signal phasing and timing) project and is planning to expand in other key corridors in the Town. The Town is leaning toward cellular data over dedicated short-range radio communication (DSRC) for now, primarily because data can be obtained now if drivers install the mobile applications on their smart phones. DSRC will be a long wait until there is meaningful prevalence. Some travel data types are already available by cellular data.

Wrap Up and Next Steps

The VHB team thanked everyone for participating. The next steps include stakeholders providing comments to assist in identification of gaps and needs, identifying emerging technologies, aligning strategies with other regional plans, and identifying potential projects.

Appendix F: Stakeholder Interview Summary

Overview

The stakeholder's interviews were performed to identify the gaps between current ITS state and the future vision. This Appendix contains a summary of these interviews for each group of participants.

Common interview questions were used as a starting point for each group interview to assist comparing needs and gaps across jurisdictions. Initial questions were:

- What are the upcoming ITS projects/investments in the next 5 years?
    - What changes do you see coming in terms of technology, communication, operations infrastructure and processes?
- What is the current position on emerging trends in ITS?
    - Connected Vehicles
    - Automated Vehicles
    - Shared mobility services
    - Big data/Analytics (including Decision-support systems)
- Are there gaps in managing and operating the current system that you see emerging technology solutions could fill?
- What risks do you see with respect to technology and ITS?
- Are there barriers to allocating (capital and O&M) funding for ITS projects? If so, what are they?
- Are there existing collaboration efforts and/or protocols in place? If so, what are the successes and/or barriers?
- Are there any legacy systems/ITS investments that should be discontinued in the next five years?
    - What other suggestions do you have for managing and operating the highway system to achieve the best outcomes over the next 5 years?

Local Perspective

Raleigh Group Interview Summary

The first stakeholder group interview was held on October 26, 2018 and included the City of Raleigh and adjacent communities in Wake County that are initially identified as those most likely to be connected to the Raleigh signal system (now and future). The Raleigh signal system uses a different software than NCDOT and Cary which is Centracs Econolite ATMS. Raleigh intends to make a software change from their Seimens system to be compatible with the other systems. Raleigh operates one of three traffic management centers (TMC) in the Region, with Cary and NCDOT operating the others. Time-of-day plans are used for individual corridors, and there is robust camera coverage across Wake County. There are gaps in fiber coverage and CAMPO has designated funding through 2026 to connect all communities, including the Town of Clayton in Johnston County. Currently, there is no connection to the NCDOT 511 system.

The Wake County Transit Plan identifies bus rapid transit (BRT) as the preferred transit system for the future. Transit service is provided by GoRaleigh, which is connected to other transit service across the Region including GoCary, GoDurham, and GoTriangle. The recent ½ cent sales tax for transit will provide funding to support technology changes including multi-jurisdictional BRT. Scooters have erupted recently without advance consideration, so options such as bike share and coordinated transit passes are an emerging interest. Docked/dockless bike share is available. Connected Vehicle (CV) technology is not currently available in Raleigh, but there is a strong interest.

The discussion of gaps focused on the lack of consistency across the Region and considering the regional needs over addressing individual jurisdictional issues. A "framework" was identified as the means to provide this consistency. This framework should include vendor requirements, prioritization of needs, and data support. Data management is a top priority for regionwide access of all available data, as needed. The vision for the region is for readily available data that meets all transportation needs. Camera/signal system data offers a strong opportunity to support other needs such as performance reporting, traffic counts, travel demand modeling.

ITS needs identified in this interview are based on best practices from across the country to inform how to improve connections with NCDOT and communities. Particularly important are operations and maintenance of technology and including life-cycle costs in funding. Integrated corridor management (ICM) is seen as a long-term need for the region supported by data management and coordinated systems.

Cary Group Interview Summary

The second local stakeholder group interview was held on October 26, 2018. This interview group included the Town of Cary and adjacent communities that are identified as those most likely to be connected to the Cary signal system (now and future). Cary operates a TMC and uses time-of-day plans for individual corridors. There is a second TMC in the Cary Public Works Department. There are internal plans for several incident/event types. Through local agreements, Cary supports signals in Morrisville and some in Apex. The signal systems are compatible across communities and with NCDOT. The Cary TMC is connected to the regional 911 system and the NCDOT Traffic Incident Management System (TIMS). Apex and Morrisville both depend on Cary 911. The Fire Department has requested signal pre-emption. The Town of Apex also uses emergency vehicle preemption (EVP) and a smart traffic beacon system in school zones to alert drivers.

Cary is a leader in connected vehicles within the Region; with support for vehicle to infrastructure connection at 27 intersections currently and recently approved funding to expand this to 100 intersections. Camera coverage is good and expanded by NCDOT cameras. Cary received a Smart Cities grant that will be applied to data integration.

As noted in the Raleigh interview, transit focus is on BRT in Wake County. A transit technology study pointed to the need for a unified fare box system and the need for ongoing maintenance of transit assets. Regional transportation demand management (TDM) is led by the Triangle J Council of Governments.

In addition to noting the gaps in fiber coverage, the group identified adaptive incident management and data management as top priorities. Information needs from FHWA/NCDOT can be addressed through coordinated signal systems. The need for maintenance and life-cycle costs was also reiterated. Concern for at-grade railroad crossings was identified; particularly in Fuquay-Varina. Parking availability and parking decks/lots are emerging interests across communities. Continued advancement in CV is important, but there is no interest in continuing Dynamic Message Sign (DMS) installations in this group.

Durham Group Interview Summary

The City of Durham does not currently manage traffic signals for any other jurisdictions. There are many different networks in use which presents difficulty in communicating across systems. There is sufficient infrastructure, but the connections are not standardized, meaning they are not interoperable. NCDOT owns more than 80% of the signals in Durham, but the City must get NCDOT permission to replace components that fail. Half of the signals have EVP: they are upgrading to a GPS system soon. The Durham perspective is that having the Regional and statewide signal systems and TMCs connected would be the best outcome. Durham is willing to begin with a new plan and process rather than continue to pursue its own agenda.

Data received from traffic signals is used for normal traffic operations with intersections counted every 2 years followed by corridor timings updated, as needed. From that corridor timings are updated as needed. There will be a new signal system beginning in 2019 and continuing over 3 years to implement. This system will have system loops and will provide opportunities to implement adaptive traffic signal coordination. Past implementations in the region were reportedly failures due to improper implementation and maintenance.

Durham issues are related to safety and emergency response rather than high-speed corridors with significant incidents. Flood-prone areas are mapped, and railroad corridors have preemption connected to the City signal system. Emergency plans for critical corridors are a priority.

Bicycle detection is available at signals, and regional ridesharing is under study. Many employees do not live in Durham so incentives to ride the bus, support for ridesharing, and others are attractive in Durham. A wayfinding program will be available soon, and DMS is used for special events, as needed.

Although Durham has an Innovation Center to integrate all departments into new technologies, ITS is not well understood at the decision maker level. The expectations of project outcomes may be too high based on this lack of understanding.

Chapel Hill and Carrboro Group Interview Summary

The UNC campus has a dominant influence on the needs of Chapel Hill and Carrboro. Transit is a major part of the transportation system, and parking is a premium. There are corridors with multiple traffic signals, some of which are owned by other jurisdictions, the City of Durham, NCDOT Division 7 and NCDOT Division 5. These signals are currently not interoperable with the Durham system; however, there are plans for interoperability in the

future. Municipal agreements for signal maintenance are in place between Chapel Hill and Carrboro; but currently not with Durham.

System loop detectors in Chapel Hill are used for collecting data, but not for system use since they are not programmed and maintained well. The traffic signal communications system uses a home-run serial connection without a self-healing ring configuration. Therefore, if one signal is not communicating, everything beyond it on that channel also will not communicate. On the NC 54 corridor, the municipalities would like adaptive signals to improve mobility and reduce delay during peak hours. They are installing video detection on that corridor to improve detection, especially for bikes.

Ten DMS signs are funded and planned for installation. Three of these are in the campus area and will be larger than temporary boards. The intent is to use these daily to promote bicycle/pedestrian safety; not only for special events. Town police have access to cameras and will be given access to DMS in the future.

There are 22 cameras and coordination plans between Chapel Hill and Carrboro as part of the Traffic Management Center (TMC). Some NCDOT cameras are also in the vicinity; however, currently Chapel Hill and Carrboro are unable to connect to them.

Chapel Hill is an AT&T spotlight city (https://www. prnewswire.com/news-releases/the-town-of-chapelhill-joins-att-smart-cities-initiative-300223709.html), providing access to cameras, sensors, and automatic flashers. Video feeds in the TMC are used for counting and traffic analytics. They are also working on parking, on-street and in decks. Plans are to have sensors added to detect utilization and used for directing traffic toward areas of downtown where more parking may be available.

Options for BRT are under development with plans to submit a design for Town Council approval soon. Signal priority for transit will be part of that design. There are some options for handling mid-block crosswalks including rectangular rapid flashing beacons (RRFBs), standard traffic signals and one implementation of a High-Intensity Activated crossWalK (HAWK) beacon. Before/after studies have indicated positive results using the RRFBs, but the town is still considering other options for improved pedestrian access.

The Chapel Hill Town Council is very supportive of technology and understands there is a need. Most council members are very interested in Smart Cities. Town Council instructed traffic engineering staff to use Transmodeler software in a town-wide model to analyze new impacts. This will eventually include the Carrboro area. Data collection and management is done by consultant contract and currently there is no central repository for this data.

Regional Perspective

Turnpike Authority Interview Summary

The first regional perspective interview was with the Turnpike Authority on November 2, 2018. Turnpike leads the Region in connected and automated vehicles (CAV) through coordination with NCDOT Operations for ordinance approval. They are also working with universities and participating in nationwide collaborative efforts. Data is essential for the toll system to monitor growth as well as identify issues and manage traffic.

Although there is currently no congestion on the Region's toll roads, this is expected to change in the next five years. The lack of coordination with signal systems that cross Turnpike corridors will become an issue over time. The Turnpike vision for the future includes dedicated short-range communications, technology refresh after 8 years, a centralized camera system, and statewide software for corridor management. They are currently evaluating various tools that can provide detection data as well as manage traffic.

The need for fiber across the region was reiterated in this interview along with well documented coverage. Increased collaboration across agencies and jurisdictions is desirable with signal system data fully available for both planning and assessment. NCDOT and the NC Legislative committees are interested in new products that can advance efficiency.

GoTriangle Interview Summary

Within the Triangle Region municipalities and regional partners are: GoTriangle, GoRaleigh, GoDurham, GoWake, GoCary, Chapel Hill, and transportation providers within those areas. Durham partners with Wolf line (NCSU), Duke Transit (not open to the public), and Orange public transportation. Durham also has some collaboration with the Piedmont Area Regional Transit (PART) in Greensboro.

Each transit provider has individual needs and integration is essential. There is a strong need for standard specifications to bid out for products. Differences between the providers sometimes result in the use of different platforms. For example, each municipality has a different idea for mobile ticketing. Raleigh is moving with smart cards on their fare boxes. Durham, due to budget issues, spend less on smart card and still collect cash with fare boxes. We need to make sure to integrate the platform Durham uses for mobile ticketing to accept the smart card from Raleigh. This will give people a regional pass to connect between systems. It is not necessary to be fully integrated at the operational level, but customers need an application to use regionally.

GoTriangle has initiated a Regional Technology Strategy study with an attempt to get agencies together and integrate different technologies into one. Active Stakeholders for this study are GoDurham, GoCary, GoRaleigh and GoWake. The current AVL technology is 8-10 years old with no back-up recovery plan. During a recent server crash, all three redundant systems failed. Fare boxes are breaking down.

Traffic signal priority is a common interest across the Region, but not currently in place. Raleigh has initiated a Transit Signal Priority project and looking in to what technology is best. Prioritizing rail at-grade crossings for preemption for emergency vehicles has been discussed in Durham.

It would be good to have radio communication to relay message to all agencies at one time. Gov.com channel is available statewide, and Durham Radio can use this channel to connect with all agencies. All Radios may not have that capability, but the architecture exists. The potential for having different technologies that talk to centralized clearing house was an interest in the ITS Plan. Alert notifications are issued by phone call or through email and may not be received when key personnel are unavailable.

There is no interest currently in connected or autonomous vehicles. The way in which GoTriangle is funded does not support being ahead in technology. The impact of Uber and Lyft usage has been noted, but not studied. GoDurham has submitted a grant application for Rides to Wellness to provide a cost effective solution for para-transit service. They are exploring heavily in Durham with Uber/Lyft contracts and looking at third party transportation providers.

Transportation staff at the management level are innovative and understand the justification of introducing these technologies. Although, the town and city councils are not always the most knowledgeable concerning the use of ITS, staff indicated that upper management is very supportive of their ITS initiatives to the elected officials..

NCDOT Perspective

Interviews with NCDOT for perspective on the Triangle Region were conducted in several groups. The first interview was with staff at the NCDOT Central Office which included statewide responsibilities as well as regional and Division-level. Subsequent interviews were held with individual NCDOT Division Office staff to understand the regional perspective from the NCDOT role.

Statewide Interview Summary

The NC 511 Information Line provides travelers information about crashes, weather-related closers and road construction. It also connects to 511 systems in neighboring states.

NCDOT responded to some information from the other interviews. The Schedule D funding reimbursement process will remain in effect, and NCDOT coordinates with communities on signal maintenance and support where local staff are not available. Although the communities were unclear about their connection to the NCDOT 511 call NCDOT stated that the TIMS (Traffic Incident Management System) connection was the required connection for 511. NCDOT pointed out that there is no disadvantage to strong connectivity across systems in the Region. All routes, even arterials, should be entered into the 511 system for strong coverage.

NCDOT shared experiences in developing two integrated corridor management (ICM) projects in the State which had been in development for more than two years and are now nearing implementation: one project in Gastonia and one on Business 40 in Winston Salem. These efforts have helped identify and address sometimes competing priorities between the State and the region. The Fortify project (I-40/I-440 Rebuild) is another example of lessons learned. This project was planned for several years prior to implementation. All incident management strategies were employed (IMAP, signal timing, towing, work zone safety) led by NCDOT Operations. Detours and signal timing involved the local municipalities. The outcome was coordinated traffic management with quick clearance rather than dumping traffic onto the arterial network.

Although interoperability is a common need in the Triangle, NCDOT expressed a concern about reliance on one vendor. A central software option with local controller integration and compatible protocols and standards is preferred. New NCDOT systems will incorporate CAV

communications technology. All new hardware will be CV ready. Dedicated short-range communications (DSRC) is preferred over cellular limited expectations of when 5G will be available.

Freeway fiber is not universally available, not fully connected to the TMC, and not mapped to identify gaps in a systematic way. Paper maps have been used, but this information has not been updated nor transferred to a digital file. The ITS system is part of asset management and should include both operations and maintenance. NCDOT agrees with the local perspective of standardizing the selection of fiber, software, signals, and controllers. Integrated corridor management is needed to provide a full system of operational strategies that become part of long-range planning as "planning for operations". Operational plans should be identified for each project as they are funded and move to implementation. Interface between planning and operations is required in an ongoing way to give NCDOT Operations sufficient time to develop plans. DMS is not expected to be supported by NCDOT as a continuing technology.

Division Office Interview Summary

Division 5 includes both Durham and Wake Counties and is therefore most knowledgeable about the Triangle Region. Division 4 contains Johnston County where the Town of Clayton is strongly influenced by transportation in the Triangle. Division 6 contains Harnett County which joins Wake County to the south. Division 7 contains Orange County to the west of Durham County. Chapel Hill and Carrboro are in Orange County.

All Divisions agreed the inventory of existing fiber is inadequate. It will be necessary to do some field work to address the location of gaps. In the future, smaller signal system projects can be used to map out sections with the entire Region mapped within this process. Divisions rely upon the NCDOT TIMS to broadcast all road/lane closures etc. The TIMS is to become integrated with Google and Waze in the future.

Division 5 identified the regulatory future of technology as a critical element of the ITS Plan. There is strong support for building a system that works across jurisdictions rather than issues addressed within individual municipalities. The Triangle could benefit from what other major metropolitan areas are doing. Arterial operations are more critical than ever.

Funding may not be as much of an issue as staffing and knowledge to operate and maintain the technology that is purchased. ITS can be easy to buy, but not necessarily easy to learn or use. Both Raleigh and Durham have experienced staff turnover. The area is also losing signal system timing expertise.

Input on strategies included the concern that DMS may soon be outdated. Ramp metering is proving to be a successful strategy with more coming in the future. Transit signal priority is a local issue, and NCDOT will only get involved at the end of discussions.

Division 4 is moving from cellular to fiber, and US-70 Business through Clayton could benefit from fiber connected to the larger Triangle Region. A signal system for Clayton is also upcoming. The Division would like a TMC within its boundaries to connect fiber on I-95, I-495, I-264, and US-70. Additional Division 4 interests include:

› Fiber network to replace modem and wireless radio communications

- Update/replace aging equipment
- Improved maintenance process

Direct access to DMS and CCTV cameras through the internal NCDOT network rather than relying on Division 5. The internal network is not accessible to the Division staff due to concerns about safety and equipment compatibility.

Division 6 interests in the Triangle Region are routes US 401 and NC 55. There are no message boards or cameras in the area. The Division does not maintain connected traffic signals in the Region. Growth in the Town of Angier in Harnett County may raise the need for ITS in the future; using cameras as the first step. There is no fiber nearby, so connection would require cell modems. The Division staff indicated that they have suggested to Angier to submit project requests to CAMPO. The Division is currently satisfied with the operation of their ITS and have started using smaller DMS in City of Fayetteville.

Appendix G: Stakeholder Workshop 2 Summary

Thursday, May 30, 2019: 1:00pm – 4:00pm, CAMPO Office

Cheryl Lowrance (VHB) gave welcoming remarks and provided a project background update. David Binkley (Iteris) reviewed the progress on the draft architecture and introduced draft webpages for group feedback. Following an introduction of the draft framing strategies and action items, the VHB team facilitated discussion in various break-out groups to gather input from the workshop attendees. The meeting summary is organized in the agenda topic headings. A full participant list follows the report.

Regional ITS Architecture Update

A full group session was used to reintroduce the components of ITS architecture and how they relate to the scope of this project, which focuses on the medium-term planning horizon (10 to 20 years with a focus on the first 10 years). Architecture components were discussed as follows. Updates to the current architecture are proposed based on inputs from the previous workshops.

- Architecture Scope
- Architecture Stakeholders
- Architecture Inventory
- Architecture Operations Concept
- Architecture Services
- Architecture Functions
- Architecture Interfaces

David provided an in-depth review of the draft architecture web pages and proceeded to discuss the next steps in developing the architecture. The draft web pages were provided to the group for further review and feedback.

Alex Rickard (CAMPO) stated that ideally, all entities desiring to share data or receive funding for ITS projects will be required to follow the same procedures and minimum requirements as set up in the ITS architecture. The VHB Team agreed, stating that this document will establish the requirements and provide the ability to accept or reject proposed projects in the future depending on how the proposed projects fit the identified needs and goals.

Mr. Rickard also asked why there is no specific software requirements included in this document. David Binkley (Iteris) replied that this architecture cannot make specific recommendations of software, but it will identify relationships and standards that must be met. Joe Geigle (FHWA) agreed that since this is a federal document, requirements of specific software cannot be specified.

Framing Strategies and Action Items

Continuing the full group session, Beverly Bowen (ICF) and Nadia Boller (VHB) reviewed the previous development of strategic plan goals, functional areas, and objectives, which were

discussed with the group in previous workshops. The following draft strategies were presented to align with the objectives. It was discussed how a strategy may align with multiple different objectives.

OBJECTIVE	STRATEGIES
Improve Multimodal Connectivity and Equitable Access	Establish and develop partnerships for operations, communication and information dissemination
Support Reliability Across an Integrated Transportation Network	Prioritize deployments to improve safety and provide accurate real time information Establish and develop partnerships for operations, communication and information dissemination Expand Integrated Corridor Management (ICM) Program
Enhance Network Mobility	Expand Integrated Corridor Management (ICM) Program Establish and develop partnerships for operations, communication and information dissemination Improve system communications for interconnectivity and data sharing Prioritize deployments to improve safety and provide accurate real time information
Support Vision Zero	Improve incident management and response Prioritize deployments to improve safety and provide accurate real time information Establish and develop partnerships for operations, communication and information dissemination Expand Integrated Corridor Management (ICM) Program
Improve, Monitor, and Manage Assets	Implement and asset management program
Support Economic Vitality	Evaluate and execute cost effective ITS solutions Allocate funding and effectively apply resources

Break

During the break, the list of objectives and draft strategies was provided to the group participants to consider. Slides are provided at the end of this document.

Strategy Plan – Walk-through Example

The VHB team presented Strategy 1, "establish and develop partnerships for operations, communication and information dissemination", as an example for the type of discussions each break-out group should consider. The team showed how a single strategy may support multiple objectives of the Strategic Plan, and presented the key points of the strategy, the benefits, and other considerations. Suggestions of action items were then presented to the group, including development of a network security plan, and establishment of an ITS

database. The VHB team requested that during break-out group sessions, each table will brainstorm action items for the strategies they consider most critical.

Jennifer Portanova (NCDOT) commented that this is the first time the group has seen draft strategies for the Strategic Plan Update. At the last workshop, the group was only developing objectives. If the intent is to assess each strategy and develop action items, the group should first consider the validity of each strategy as it relates to the objectives. The other participants had similar concerns, so the team offered continuing the breakouts using a different approach, allowing each group to develop a set of action items they would like to see deployed in the region. The VHB team would then map the action items back to the strategies previously developed and modify or add strategies if necessary.

Break-out Groups – Prioritize Strategies and Build Action Item List

The full group was divided into breakout groups to discuss and develop desired action items. The following information summarizes the major discussion items in each breakout group. Note that specific discussion topics were not assigned to each group. Each table held an open brainstorming session. Group assignments and an attendance summary are provided at the end of this document.

Group 1, Report Out by Matthew Frazier (GoTriangle)

Group 1 discussed the need to identify and map the existing network of fiber optic communications. The group acknowledged that much of the current infrastructure is not documented and only a few people know where it is. Similar acknowledgments were made from the other groups. It was suggested that an inventory initiative take place, but the data must be kept secure. If made publicly available, the communications network would be at risk. Jennifer Portanova (NCDOT) responded that each entity or municipality needs to understand where their own fiber network is located. Scott Clark (Town of Chapel Hill) agreed that no single individual needs an understanding of the entire network, but we need to understand who to contact for information on fiber location in a particular area. The group noted and others agreed that a communication network plan would support their needs and could be established under the objective to improve, monitor and manage assets.

Group 1 discussed the need to create a comprehensive information system designed to communicate roadway projects, construction activity and road closures. It was suggested that multiple agencies and construction authorities are given permission to update the system with the current status of construction and closures. The system would be beneficial not only to the general public, but also for all agencies in the Triangle area. Jennifer Portanova (NCDOT) commented that a similar but less comprehensive system was available previously as TIMS, which is now renamed DriveNC. gov. David Spencer (Town of Cary) commented that Cary currently attempts to input all significant road closures into Waze.

Group 1 recommended that strategies are developed for funding maintenance projects, which has been prioritized lower than new construction in the past. Maintenance of ITS systems will become increasingly important. Jennifer Portanova (NCDOT) agreed and also

pointed out that similar concerns should include some new construction projects. For example, projects such as the recently installed ramp meters on Interstate 540 are not included in the current funding mechanisms.

Group 1 concluded by stating that more detailed training for emergency responders should be developed. This need was encouraged by FHWA approximately 3 years ago. Jennifer Portanova (NCDOT) shares that the Department currently requires a minimum percentage of emergency responders receive this training. It is not required of all individuals but highly encouraged.

Group 2, Report Out by Jennifer Portanova (NCDOT)

Group 2 stated the need to prioritize education as the ITS systems grow in size and complexity. Education should be directed primarily toward elected officials, policy makers, management and other leaders. Doing so will assist in the development of funding and prioritization, and keeping uniformity and cohesiveness in the ITS systems. The general public should not be targeted for education.

Group 2 discussed how each agency and municipality have their own goals and needs in mind, which can make coordination across boundaries challenging. For example, the Town of Cary has different needs than Fuquay Varina. This plan should recommend strategic corridors that cross boundary lines.

Group 2 considered how help should be given to fund a new operations center. There are currently 3 major operations center in the area (NCDOT, Cary and Raleigh), but in the future another agency may request one. Careful consideration should be given to the value of a new operations center, as the needs may be able to be met by one of the existing centers.

Group 2 concluded by stating that emergency radio broadcasts may possibly be improved, especially with the goal of interoperability in mind. The current system relies heavily on 800 MHz radio systems, but there may be newer or more capable technology available or coming soon.

Group 3, Report Out by David Spencer (Town of Cary)

Group 3 discussed the need to establish performance objectives and monitoring. The full group noted how more detailed performance metrics would be beneficial for the education of management and officials, as recommended by Group 2.

Group 3 concurred with Group 1, reiterating the need to securely map the existing fiber optic cable networks.

Group 3 recommended that specific API protocols are developed. This can assist with data integration and infrastructure inventory, and Smart Cities are already required to develop API protocol. Patrick Stephens (GoTriangle) commented that although particular equipment cannot be mandated, we can carefully require minimum standards within the ITS architecture than ensure compatible and current equipment is being installed. Scott Clark (Town of Chapel Hill) suggested that this task should be undertaken while coordinating with each agency's IT department, once we have identified what data needs to be shared. The full group agreed that interoperability is a priority and while no single product or software can

meet all the needs of today's infrastructure, we need multiple products and software that must be compatible.

Group 3 concluded by noting that some considerations should be given to developing connected vehicle infrastructure and active traffic management systems, such as dynamic lane control.

Wrap Up and Next Steps

The VHB team thanked everyone for participating. The draft architecture web pages and other strategic plan materials will be made available to the group for comment. Meeting notes will be shared with the group.

Appendix H: Stakeholders Action Items Aligned with Strategies

1

How to close information gap?

- Develop a regional task force
- Fiber/Communications
- Action Plan
  - Non-Disclosure Agreements for municipal fiber
    - Who builds, who maintains, who has access
  - Infrastructure Communication
- Regional Fiber Mapping Plan

Establish and develop partnerships for operations, communication, and information dissemination

Expand Integrated Corridor Management (ICM) Program

Improve system communications for interconnectivity and data sharing

Implement an Asset Management Program

2

Distribution of information about roadwork, work zones, affecting transit lanes

- Central clearing house for road blocks
- DriveNC.gov
- Can DOT systems be set up for non-DOT roads?

Prioritize deployments to improve safety and provide accurate real time information

Improve system communications for interconnectivity and data sharing

3

Develop a Funding Plan

- Return on investment
- Benefit cost analysis
- Maintenance Plan
- Operations Plan
- Funding opportunities (i.e. STIP, HSIP, etc.)

Establish and develop partnerships for operations, communication, and information dissemination

Implement an Asset Management Program

Evaluate and execute cost effective solutions

4

Incident Management Response

- Develop a protocol for Emergency Response Training (NCDOT requires a certain percent, but it's not mandatory)

Improve incident management and response

5

Education to Political Leader and Senior Management and elected officials

- Eliminate Silos – encourage people talk to each other
- Create Buy-In
- Competing Agendas
- Identify Strategic Corridors prioritizing projects (states/cities, needs vary and agency's goals are different, challenging to make them all agree)
- Best cases (better management of Regional Mobility)
- Establish performance objectives and monitoring

Prioritize deployments to improve safety and provide accurate real time information

Establish and develop partnerships for operations, communication, and information dissemination

6

Data integration and inventory

- API protocols (Smarty City)
- Compliant with Architecture
- Set standards
- Work with IT groups
- Procurement:
  - Security
  - Interoperability
- Leveraging partners to acquire equipment
- Workgroup – priority systems

Establish and develop partnerships for operations, communication, and information dissemination

Expand Integrated Corridor Management (ICM) Program

Improve system communications for interconnectivity and data sharing

Appendix I: Sample Agreements

NORTH CAROLINA
DURHAM COUNTY

MUNICIPAL OPERATIONS – COMPUTER, COMMUNICATIONS, EQUIPMENT, AND SYSTEM OPERATIONS FOR COMPUTERIZED TRAFFIC SIGNAL SYSTEM AGREEMENT
SCHEDULE D

DATE: 02/04/2014

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

TIP #: R-4701E

AND

WBS Element: 36247.5.1

CITY OF DURHAM

THIS AGREEMENT is made and entered into on the last date executed below, by and between the North Carolina Department of Transportation, an agency of the State of North Carolina, hereinafter referred to as the "Department" and the City of Durham hereinafter referred to as the "Municipality."

W I T N E S S E T H:

WHEREAS, Section 1108 of the Moving Ahead for Progress in the 21st Century (MAP-21) allows Surface Transportation Program (STP) funds to be available for certain specified transportation activities; and,

WHEREAS, the provisions of the North Carolina General Statute (NCGS) §136-18 and §136-66.1 authorize the Municipality to contract with the Department for the installation, repair, operations and maintenance of highway signs and markings, electric traffic signals, and other traffic control devices on State Highway System streets within the Municipality; and,

WHEREAS, the Department and the Municipality have a mutual interest in the efficient and effective operation of traffic signals within the Municipality; and,

WHEREAS, the Department and the Municipality recognize that each party to this Agreement has an obligation and responsibility to provide for the safe, orderly, and efficient flow of traffic on their respective street systems; and,

WHEREAS, the Municipality finds that it is in the best public interest to enter into an Agreement with the Department to operate the computerized traffic signal system; and,

WHEREAS, the Department finds it desirable and advantageous to reimburse the Municipality for costs incurred, when the Municipality operates that portion of the computerized traffic signal system that is on the State Highway System within or near the Municipality;

NOW, THEREFORE, the Department and the Municipality do hereby agree as follows:

1. GENERAL PROVISIONS

FEDERAL FUNDING ACCOUNTABILITY AND TRANSPARENCY ACT

All parties to this Agreement, including contractors, subcontractors, and subsequent workforces associated with any work under the terms of this Agreement, shall provide reports as required by the Federal Funding Accountability and Transparency Act (FFATA) for this Project.

COMPLIANCE WITH STATE/FEDERAL POLICY

The Municipality and/or its agent, including all contractors, subcontractors, or sub-recipients shall comply with all applicable Federal and State policies and procedures, stated both in this Agreement and in the Department's guidelines and procedures.

FAILURE TO COMPLY - CONSEQUENCES

Failure on the part of the Municipality to comply with any of the provisions of this Agreement will be grounds for the Department to terminate participation in the costs of the Project and, if applicable, seek repayment of any reimbursed funds.

2. SCOPE OF THE PROJECT

The Municipality shall operate the computerized traffic signal system as defined in the Appendices and as indicated hereinafter.

TIMING PLANS

A. The Municipality shall be responsible for the evaluation and preparation of timing plans at all intersections in the traffic signal system. All traffic data needed for the evaluation and development of timing plans will be obtained by the Municipality whenever possible. The Municipality will notify the Department of any additional data that is required to evaluate and prepare the necessary timing plans. The Department shall, upon request, make available to the Municipality all current traffic count data for the existing signals.

B. The timing plans affecting intersections on the State Highway System, utilized in system operation, will be subject to the approval of the Department and will reflect the needs of traffic on both the State Highway System and the Municipality's System. In the event the Department and the Municipality cannot agree on the selection of a given timing plan, the decision of the Department will be final.

ONGOING OPERATION OF THE SIGNAL SYSTEM

C. The Municipality shall not install any traffic control devices, nor make any traffic signal phasing changes, on any State Highway System street without the prior approval of the Department, pursuant to NCGS §20-169.

D. The Municipality shall operate the signal system in accordance with North Carolina General Statutes, the Department's current policies and guidelines as included in the Appendices, and all local codes and ordinances. If, in the opinion of the Department, the Municipality does not operate the signal system in accordance with the specified criteria, the Department shall have the right to enter into a separate operational agreement with a private contractor and deduct these costs from the Municipality's funds allocated under NCGS §136-41.1 and this Agreement.

E. The Department shall review and concur with any contract entered into by the Municipality for the operation of any item(s).

- Any contract entered into with another party to perform work associated with the requirements of this Agreement shall contain appropriate provisions regarding the utilization of Disadvantaged Business Enterprises (DBEs), or as required and defined in Title 49 Part 26 of the Code of Federal Regulations and the North Carolina Administrative Code. These provisions are incorporated into this Agreement by reference https://connect.ncdot.gov/municipalities/Pages/Bid-Proposals-for-LGA.aspx.

- The Municipality shall not advertise nor enter into a contract for services performed as part of this Agreement, unless the Department provides written approval of the advertisement or the contents of the contract.

- If the Municipality fails to comply with these requirements, the Department will withhold funding until these requirements are met.

F. The Municipality agrees to an annual audit of the performance of intersection equipment and systems. The audit is to be performed by the Department and the Municipality.

3. TIME FRAME

This agreement shall be for the current state fiscal year, beginning July 1, 2013 and ending June 30, 2014. At the end of the state fiscal year, the provision of services and quality of results may be reviewed by the Department and Municipality. The Agreement may be extended for additional fiscal years, contingent upon the availability of NCDOT maintenance funds by the General Assembly. Extensions may be made in one (1)

year increments, incorporating any mutually agreed upon adjustments, up to a total of five (5) years with the end of the final fiscal year of service being June 30, 2018. On behalf of the Municipality, extensions may be authorized and executed by the Town/City Manager and/or Mayor without further resolution of the Town/City Council. The agreement may be terminated by either party upon a thirty (30) day written notice.

A. Upon termination of each year of service, and in connection with each extension of this Agreement, the Municipality may request an adjustment of the annual rates based on actual cost records for the prior years. This request must indicate the new rate for each Schedule D item. Each rate must be verifiable by time sheets, salary rates, materials, equipment, and other qualifying costs in conformance with the standards of allowable of costs set forth in the Office of Management and Budget (OMB) Circular A-87. This shall be actual cost incurred with the exception of equipment owned by the Municipality. Reimbursement for the rates of equipment owned by the Municipality cannot exceed the Department's rates in effect for the time period in which the work is performed.

B. The cost records may be audited by the Department to determine any adjustments or revisions in the new rates.

4. FUNDING

The funding for this Project includes Federal and State funds. For state fiscal year July 1, 2013, the funding is 77% Federal and 23% State.

5. REIMBURSEMENT

The Department shall reimburse the Municipality quarterly, based on an annual amount, for the operation of the computerized traffic signal system as included below:

ELIGIBLE COSTS

A. The reimbursement rates in this Agreement represent the Department's pro-rata share of the operational cost, which is based on the ratio of the number of State System intersections to the total number of intersections in the computerized traffic signal system. The Municipality shall maintain a current inventory list of all traffic signals within the system, and classify as

city- or state-owned. The current inventory list as included in the Appendices of this Agreement, will be used to determine the Department's pro-rata share.

B. The Department shall reimburse the Municipality based on the annual operational amount of the computerized traffic signal system as included in the Appendices of this Agreement. This total amount includes the Department's pro-rata share of cost, as included in Provision 5A, for the salary, payroll additives of a Systems Operations Engineer(s) and Traffic Signals System Specialist(s), (and others as determined by system). These positions, as a minimum, shall exhibit the qualifications and perform the duties as included in the Appendices. The Systems Operations Engineer(s) and Traffic Signals System Specialist(s), (and others as determined by system) costs shall be based on the pro-rata share of time dedicated to the operation of the system.

C. The Department shall reimburse the Municipality for operation of the Central Computer and Associated Hardware, CCTV Camera System, Communications Infrastructure, system detectors and other associated central and system field equipment. The Municipality shall be responsible for providing all needed replacement parts and equipment. Under this Agreement, the Department will reimburse the Municipality for its pro-rata share of the replacement or repair costs necessary for maintaining operability and any equipment included herein.

D. The Municipality will not receive an annual reimbursement for fiber optic communications cable and CCTV cameras. The Department will reimburse the Municipality its pro-rata share of the actual costs for the emergency restoration of fiber optic communications and CCTV cameras. This cost shall include: fiber optic cable, interconnect centers, splice trays, fusion splicing, transceivers, Ethernet switches, labor, etc.

E. Said reimbursement shall be limited to operational costs, which would include tasks associated with insuring the continuous, safe and efficient operation of traffic signals, traffic signal systems, and control facilities. Examples include, but are not limited to, emergency repairs to system components, periodic evaluation and adjustment to operational timing parameters, computer system and software upgrades, operational upgrades to maintain or improve safety or efficiency, etc.

F. The Department will not reimburse operational costs for activities that do not have a direct and immediate effect on the continuous, safe and efficient operation of traffic signals, traffic signal systems, and control facilities including, but not limited to, painting of poles and signal cabinets, vegetation control adjacent to facilities, interior and exterior care of traffic control centers and parking areas, furniture for traffic control centers, etc.

G. The Municipality agrees that it shall bear all costs for which it is unable to substantiate actual costs.

H. Any costs incurred by the Municipality prior to written notification by the Department to proceed with the work shall not be eligible for reimbursement.

I. The Department will reimburse the Municipality for its pro-rata share, as specified in the Appendices, for any Signal Systems operational contract in which it concurs. The Department shall have access to the contractor's records and documentation for audit, which pertains to any rates billed to the Municipality for the operation of those items for a period of five (5) years from the date of the final payment made under this agreement.

J. Equipment secured as a non-participating item by the Department (100% Municipality costs) will continue as non-participating items with respect to operations. The Division Engineer will provide the necessary documentation for non-participating items.

PROCESS

K. The Municipality shall submit a quarterly itemized invoice including the certified status report to the Department for said costs no later than three (3) months after the scheduled quarterly invoicing date. This invoice will reflect the balance between the quarterly payments issued by the Department and the total amount not to exceed $153,271.58, unless additional reimbursements are approved by the Department. All final invoices must be submitted within one (1) year after the work is performed or said work will be considered non-billable and will not be paid for by the Department. The Department, at its option, may elect to increase the reimbursement rates up to three percent (3%) each year in consideration of inflation rates and cost increases, subject to the availability of funds and the performance of the Municipality.

L. The Department shall reimburse the Municipality upon approval by the Department's Division Engineer and the Fiscal Management Section.

6. FORCE ACCOUNT

Work performed by the Municipality's own forces is considered force account work. Force account work that is not a part of the operational work included under this Agreement is only allowed when there is a finding of cost effectiveness for the work to be performed by some method other than contract awarded by competitive bidding process. Written approval from the FHWA Division Administrator is required **prior to the use of force account** by the Municipality.
Said invoices for force account work shall show a summary of labor, labor additives, equipment, materials and other qualifying costs in conformance with the standards for allowable costs set forth in Office of Management and Budget (OMB) Circular A-87

(www.whitehouse.gov/omb/circulars/index.html). Reimbursement shall be based on actual cost incurred with the exception of equipment owned by the Municipality or its Project partners. Reimbursement rates for equipment owned by the Municipality or its Project partners cannot exceed the Department's rates in effect for the time period in which the work is performed, nor the maximum amount included in Appendix VI.

EMERGENCY WORK

Under current Department policy, if force account work is necessary and performed by the Municipality during emergency occurrences or occurrences that endanger public safety, additional information shall be submitted to document the emergency situation, actions taken during the occurrence and the resolution with each quarterly invoice. Approval must be obtained from the Department and the FHWA-NC Division office, before reimbursement is made.

7. RECORDS AND REPORTS

A. The Municipality shall furnish the Department's Division Engineer a certified quarterly status report that details the operation of the signal system. The status report shall be certified in writing by the Systems Operations Engineer and shall indicate intersection failures, local and system detector failures, the percentage of time the computer system was off-line, the repairs that were made and the dates of said repairs/replacements. The quarterly report shall also identify any new/deleted intersections in the traffic signal system and all traffic signal timing optimization performed. The Division Engineer will provide detailed guidance and reporting forms for the Municipality.

B. In accordance with OMB Circular A-133, "Audits of States, Local Governments and NonProfit Organizations" (www.whitehouse.gov/omb/circulars/index.html), dated June 27, 2003, the Federal Single Audit Act Amendments of 1996, and NCGS §159-34, the Municipality shall arrange for an independent financial and compliance audit of its fiscal operations. The Municipality shall furnish the Department with a copy of the independent audit report within thirty (30) days of completion of the report, but not later than nine (9) months after the Municipality fiscal year ends.

C. The Municipality shall adhere to applicable administrative requirements of Title 49 Code of Federal Regulations, Part 18 (www.fhwa.dot.gov/legsregs/directives/fapgtoc.htm) and Office of Management and Budget (OMB) Circulars A-102 (www.whitehouse.gov/omb/circulars/index.html) "Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments." Reimbursement to the Municipality shall be subject to the policies and procedures contained in Title 23 Code of Federal Regulations, Part 140 and Part 172, which is being incorporated into this Agreement by reference at www.fhwa.dot.gov/legsregs/directives/fapgtoc.htm and by Office of

Management and Budget (OMB) Circular A-87 (www.whitehouse.gov/omb/circulars/index.html) "Cost Principles for State, Local, and Indian Tribal Governments." Reimbursement to the Municipality shall be subject to the guidance contained in Title 2 Code of Federal Regulations, Part 170 (http://edocket.access.gpo.gov/2010/pdf/2010-22705.pdf) and Office of Management and Budget (OMB) "Federal Funding Accountability and Transparency Act" (FFATA). Said reimbursement shall also be subject to the Department being reimbursed by the Federal Highway Administration and subject to compliance by the Municipality with all applicable federal policy and procedures.

D. The Municipality shall keep and maintain all books, documents, papers, accounting records, other such cost records and supporting documentation and evidence as may be appropriate to substantiate costs incurred under this Agreement. Further, the Municipality shall make such materials available at its office at all reasonable times during the Agreement period, and for five (5) years from the date of the final payment made under this agreement, for inspection and audit by the Department's Financial Management Division and FHWA.

8. ADDITIONAL PROVISIONS

A. This Agreement does not transfer legal control of, or responsibility, or legal liability for the State Highway System roads described herein to the Municipality, nor does it prohibit the Department from taking any action or undertaking any responsibilities with regard to such roads. This Agreement is solely for the benefit of the Municipality and the Department and not for the benefit of any other persons including, but not limited to, members of the public or users of the State Highway System roads, and no third party rights are created, or intended to be created, by this Agreement.

B. The Municipality shall comply with Title VI of the Civil Rights Act of 1964, (Title 49 CFR, Subtitle A, Part 21). Title VI prohibits discrimination on the basis of race, color, national origin, disability, gender, and age in all programs or activities of any recipient of Federal assistance.

C. It is the policy of the Department not to enter into any agreement with another party that has been debarred by any government agency (Federal or State). The Municipality certifies, by signature of this agreement, that neither it nor its agents or contractors are presently

debarred, suspended, proposed for debarment, declared ineligible or voluntarily excluded from participation in this transaction by any Federal or State Department or Agency.

D. Each of the parties covenants that if it enters into any subcontracts in order to perform any of its obligations under this contract, it shall require that the contractors and their subcontractors comply with the requirements

of NC Gen. Stat. Article 2 of Chapter 64. In this E-Verify Compliance section, the words contractors, subcontractors, and comply shall have the meanings intended by N.C. Gen. Stat. § 160A-20.1.

E. The Municipality shall certify to the Department compliance with all applicable Federal and State laws and regulations and ordinances and shall indemnify the Department against any fines, assessments or other penalties resulting from noncompliance by any entity performing work under contract with the Municipality.

F. The Municipality is solely responsible for all agreements, contracts, and work orders entered into or issued by the Municipality for this Project. The Department shall not be held liable by the Municipality for any expenses or obligations incurred for the Project except those specifically eligible for the federal funds and obligations as approved by the Department under the terms of this Agreement. The Department shall not reimburse the Municipality any costs that exceed the total funding at any time.

G. The Municipality will indemnify and hold harmless the Department, FHWA, and the State of North Carolina, their respective officers, directors, principals, employees, agents, successors, and assigns from and against any and all claims for damage and/or liability in connection with the project activities performed pursuant to this Agreement including construction of the Project. The Department shall not be responsible for any damages or claims for damages, which may be initiated by third parties.

H. The Department must approve any assignment or transfer of the responsibilities of the Municipality set forth in this Agreement to other parties or entities.

I. By Executive Order 24, issued by Governor Perdue, and N.C. G.S.§133-32, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, landlord, offeror, seller, subcontractor, supplier, or vendor), to make gifts or to give favors to any State employee of the Governor's Cabinet Agencies (i.e.,

Administration, Commerce, Correction, Crime Control and Public Safety, Cultural Resources, Environment and Natural Resources, Health and Human Services, Juvenile Justice and Delinquency Prevention, Revenue, Transportation, and the Office of the Governor).

J. This Agreement contains the entire agreement between the parties and there are no understandings or agreements, verbal or otherwise, regarding this Agreement except as expressly set forth herein.

K. The parties hereby acknowledge that the individual executing the Agreement on their behalf is authorized to execute this Agreement on their behalf and to bind the respective entities to the terms contained herein and that he has read this Agreement, conferred with his attorney, and fully understands its contents.

L. A copy or facsimile copy of the signature of any party shall be deemed an original with each fully executed copy of this Agreement as binding as an original, and the parties agree that this Agreement can be executed

in counterparts, as duplicate originals, with facsimile signatures sufficient to evidence an agreement to be bound by the terms of the Agreement.

CONTRACT CONTROL FORM
TOWN OF CARY

CCN: PW 16-186-00

D E P A R T M E N T .....: PW
CONTRACT ADMINISTRATOR .: SCOTT HECHT
ADMINISTRATOR'S PHONE ..: 4093
CONTRACT NAME .....: ILA- ATM EXTENSION & SIGNAL SERVICE
CONTRACTOR'S NAME .....: TOWN OF MORRISVILLE
CONTRACT EXPIRATION DATE: JUNE 30, 2021 6/30/2021

TYPE: 4
1=SERVICE
2=EQUIPMENT
3=CONSTRUCTION
4=AGREEMENT
5=REIMBURSEMENT

STATUS: 1
1=NEW
2=RENEWAL
3=REVISION
4=CHANGE ORDER

TRANSMITAL INFORMATION: ACTION DATES
NOTICE OF AWARD SENT ....:
BONDS RECEIVED .....:
* NOTICE TO PROCEED SENT ..:
* INSURANCE CERTIF.RECEIVED:
* OCCURS AFTER CONTRACT EXECUTION

" " ATTORNEY'S REVIEW NOT REQUIRED.

Level 4
One time S/W upgrade +25,600.00
Annual fee of 15,960.00 x 5 years = +79,800.00
105,400.00

FINANCE INFORMATION
CARY BUSINESS LICENSE VERIFIED:
ENCUMBRANCE/PO NUMBER:
ACCOUNT NUMBER:
PROJECT NAME .:
PROJECT NUMBER:
OBLIGATES REVENUE TO THE TOWN: $105,400.00
OBLIGATES TOWN EXPENDITURE ..:
" " NO CHANGE IN PRESENT ENCUMBRANCE/PO

COMMITTEE APPROVALS: ACTION DATES
SAFETY/PUBLIC WORKS ..:
PLANNING & DEVELOPMENT:
FINANCE/PERSONNEL ....:

OTHER APPROVALS: ACTION DATES
COUNCIL .....:
BUDGET ADJUSTMENT:
OTHER:

DEPARTMENT DIR APPROVAL DATE: 6-1-16

F I N A N C E
INITIALS: MBlack DATE IN: 6/1/16 ACTION DATE: 6/1/16
COMMENTS:

T O W N M A N A G E R
INITIALS: DATE IN: 6/2/16 ACTION DATE: 6/2/16
COMMENTS:

"

T O W N C L E R K
INITIALS: ACTION DATE: 6/8/2016
COMMENTS:
" TO MAYOR FOR SIGNATURE

CONTRACT ADMIN. EXECUTED DATE: 7/6/16

T O W N A T T O R N E Y (Approved as to form only)
INITIALS: DATE IN: ACTION DATE:
COMMENTS:

RESOLUTION OF THE TOWN COUNCIL AUTHORIZING INTERLOCAL AGREEMENT

WHEREAS the Town of Morrisville and the Town of Cary have general authority and control over their respective street systems; and

WHEREAS, the Town of Cary has an Advanced Traffic Management System ('ATMS') that includes fiber optic cable and traffic signal controller devices, and traffic signal timing plans that assist motorists in realizing shorter travel times; and

WHEREAS, the Towns abut at several intersections that are not state roads; and

WHEREAS, the Towns have, since 2009, cooperated in the extension of Cary's ATMS to include certain Morrisville traffic signals and Cary's operation and maintenance of such signals; and

WHEREAS, the Towns desire to continue such cooperation; and

WHEREAS, the Towns are authorized to enter into an agreement such as this pursuant to Chapter 160A, Articles 15 and 20.

NOW THEREFORE, THE TOWN COUNCIL OF CARY RESOLVES THAT:

The Interlocal Agreement for ATMS Extension and Signal Service attached hereto is hereby approved and ratified and the Town manager or assistant manager is authorized to make minor modifications to the Agreement and to execute said Agreement and provide such notice and take such action as Agreement contemplates.

This Resolution shall be effective upon adoption.

Adopted: May 26, 2016

Harold Weinbrecht, Jr., Mayor

Virginia H. Johnson, Town Clerk

Attachment: Interlocal Agreement for ATMS Extension and Signal Service

NORTH CAROLINA

COUNTY OF WAKE

INTERLOCAL AGREEMENT
FOR
ATMS EXTENSION AND SIGNAL SERVICE

This Interlocal Agreement for ATMS Extension and Signal Service ('Agreement') made and entered into this the 28th day of JUNE, 2016 by and between the Town of Cary whose address is 316 N. Academy Street, PO Box 8005, Cary N.C. 27512-8005 ('Cary') and the Town of Morrisville, whose address is 100 Town Hall Drive, Morrisville, N.C. 27560, ('Morrisville') both N.C. municipal corporations.

WITNESSETH

WHEREAS, each party to this Agreement has an obligation to provide for the safe, orderly, and efficient flow of traffic on their respective street systems; and

WHEREAS, Cary has an Advanced Traffic Management System (ATMS) that includes fiber optic cable and traffic signal controller devices. The ATMS also includes traffic signal timing plans along Cary's main corridors that assist motorists in realizing shorter travel times; and

WHEREAS, Morrisville and Cary abut at certain intersections that are not state roads; and

WHEREAS, Morrisville and Cary in May 2009 entered into Interlocal for ATMS Extension and Signal Service ('First Interlocal') and under the First Interlocal, Cary extended the ATMS to certain MORRISVILLE electric traffic signals on non-State system streets that abut Cary and operated, repaired and maintained those signals; and

WHEREAS, pursuant to First Interlocal, Cary has accepted the signals listed in Attachment 1 ('Covered Signal(s)') such that it owns and maintains the fiber to the connection with each Covered Signal and maintains and operates the Covered Signals and ATMS connections hereto;

WHEREAS, Morrisville and Cary desire to continue such cooperation recognizing it will continue to be more efficient and effective and will benefit both parties and the citizens of each if Cary's ATMS were extended to include certain Morrisville traffic signals that are on roads that are not state roads and if Cary were to operate and maintain said existing Covered Signals and new signals and own and maintain the fiber connections thereto.

NOW, THEREFORE, Cary and Morrisville do hereby agree as follows:

1. Purpose. This Agreement sets forth the terms and conditions pursuant to which (i) Morrisville will lay fiber to, and install traffic signals and related traffic control devices such as associated control cabinets, signs and markings, at certain intersections on non-DOT streets in Morrisville and (ii) Cary will own and maintain such fiber and operate and maintain such traffic signals and Covered Signals.

2. Identified Signals and Changes to Signal Plans for Covered Signals. To make any additional traffic signal not listed on Attachment 1 subject to this Agreement, Morrisville may, from time to time, provide a written request to Cary when it identifies an intersection with a traffic signal it desires for Cary to operate and maintain. Such request shall be made on the form attached as Attachment 2. Cary shall review such requests and notify Morrisville in writing if it appears that such request is consistent with the Agreement. Morrisville shall then develop a signal plan for the traffic signal ('Signal Plan') in accordance with all NCDOT requirements and generally accepted engineering principles, which Signal Plan must be accepted by Cary. Modifications to a signal plan for a Covered Signal shall follow the same process as outlined above for the addition of new traffic signals.

   The Town Manager for each party is authorized to provide written requests and to approve and accept requests. Additionally, by 'Letter of Agreement' the parties' Town Managers are authorized to enter into agreements where the parties agree to technical adjustments to this Agreement.

3. Installation. Upon acceptance of Signal Plan by Cary, Morrisville shall install fiber to the traffic signal for which it provided the Signal Plan ('Identified Signal') and shall install the Identified Signal (and all associated traffic control devices) and connect Identified Signal to the Cary ATMS. All such installations shall be in accord with this Agreement, the Signal Plan and Cary, policies, procedures, standards and specifications. Morrisville shall be responsible for providing, and shall own, the Identified Signal. Morrisville shall notify Cary prior to the start of installation of any Identified Signal and in advance of commencing operation of Identified Signals. Morrisville shall coordinate the installation and inspection of the fiber connection and Identified Signals with Cary. Cary shall inspect the installation and upon written acceptance by Cary, Cary shall own and maintain the fiber to its connection with Identified Signal and shall maintain and operate the Identified Signals and ATMS connections thereto as described herein, at which point Identified Signals become Covered Signals under this Agreement. Morrisville shall not install any traffic control signal or device at an intersection covered by this Agreement, nor shall Morrisville connect any traffic control signal or device to Cary ATMS without the written consent of Cary.

4. Responsibilities. The parties shall have the following responsibilities;

   A. Morrisville responsibilities:

a. Morrisville shall: (i) identify intersections at which it desires Cary to operate the traffic signal; (ii) provide written request to Cary on the form attached (attachment 2); (iii) develop a Signal Plan for Cary's review and approval; (iv) upon Cary acceptance, install fiber, Identified Signal and related traffic control devices; (v) permit Cary inspection of Identified Signal; (vi) by this Agreement, agree that upon Cary acceptance, the fiber becomes the property of Cary; (vii) upon Cary acceptance of Identified Signals, permit Cary to operate such signals as Covered Signals in accord with this Agreement; (viii) in the event of any change to the Covered Signal or related traffic control devices, notify Cary and provide a revised Signal Plan for acceptance by Cary and permit Cary inspection of any changes. Morrisville understands and agrees that Cary has the right to approve all Identified and Covered Signals as to hardware and software to assure that traffic needs are met;(ix) Morrisville shall provide all necessary public easements or right-of-way, in which the traffic signal equipment or fiber will be located prior to Cary allowing the signal to be placed in operation.
b. Morrisville shall own Covered Signals and other traffic control devices.
c. Morrisville shall immediately notify Cary by telephone and in writing of any problems with Covered Signals or related traffic control devices. Morrisville shall own and be responsible for operating and maintaining all traffic control devices related to the Covered Signal (associated signage and markings) consistent with the approved Signal Plan.
d. Upon Cary acceptance of Covered or Identified Signals for operation and maintenance, Morrisville shall not: (i) interfere with, or change Covered Signals or installed fiber cable except in accord with an approved revised Signal Plan; (ii) change the traffic signal timing or phasing or in any way interfere with Covered Signal without the prior written approval of Cary.
e. After installation of Identified Signals, Morrisville shall be responsible for all costs of fiber relocation work regardless of the reason for the fiber relocation. Cary shall be responsible for fiber replacement due to fiber failure or damage.

B. Cary responsibilities:
a. Upon acceptance, CARY shall own and maintain the fiber optic cable and associated hardware to its connection with Covered Signals, and shall be responsible for performing utility locates of the fiber.
b. Upon acceptance, CARY shall operate and maintain Covered Signals in accordance with Cary ATMS standards and specifications, the Signal Plan and this Agreement. MORRISVILLE shall neither make any change to the Covered Signals nor make any traffic signal phasing change without the prior approval of CARY.

c. Approvals and acceptances by Cary under this agreement are for Cary's purposes only and shall not be construed or deemed to be approvals as a regulatory or other authority.

5. Fees for Service. Morrisville shall pay Cary for Cary services as follows:

A. For new installation, Morrisville shall pay Cary per intersection as Identified Signals are installed to account for design and implementation of the signal timing plans and Signal Plan review. The fees for signal plan review will be the direct hourly rate basis for Cary employees reviewing the plan. Such amount shall be billed by Cary and shall be due and payable thirty days after billing.

B. For emergency maintenance and repairs, Morrisville shall pay Cary an amount equal to the direct documented costs to Cary of emergency maintenance work and repairs done by CARY staff as documented on Cary's maintenance management software;

C. For operation and maintenance of Covered and Identified Signals, Morrisville shall pay Cary a fee detailed in the below chart at the commencement of this Agreement, as follows:

Perimeter Park Dr. / Paramount Pkwy and Paramount Pkwy/Carrington Mill Blvd.
As shown in Attachment I

Description	**Cost/Intersection**	**Annual Cost**	**Comments**
Traffic Signal System Software Upgrade	$12,800	$25,600	
Total		**$25,600**	**One time charge**
Hardware/software maintenance agreement	$430	$860	For traffic signal system software upgrade referenced above
Annual maintenance	$6,800	$13,600	Preventative and routine
Administrative fee	$750	$1,500	Analysis and timing refinements
Total		**$15,960**	**Annual charge**

i. Such amounts shall be billed by CARY and shall be due and payable thirty days after billing. All equipment, labor and administrative fees are based on actual costs and may be adjusted annually through the Cary annual budget process.
ii. Cary shall bill Morrisville for fiber relocation work following such work.
iii. The parties agree that, in addition to routine and scheduled inspection and maintenance, Cary will respond to complaints and notice of citizens and others as to Covered and Identified Signal maintenance.

6. Maintenance Level. CARY shall maintain and operate the Covered Signals in accordance with NCDOT Schedule C & D agreements.

Appendix J: Projects with Implementation Notations

Transit Signal Priority/Bus Rapid Transit (TSP/BRT)

TSP and BRT have been under study in the region recently and projects in the City of Raleigh (New Bern BRT and Western Boulevard BRT) and the Town of Chapel Hill (North-South BRT) are moving forward to design and implementation. These projects will be useful cases for learning lessons to apply to future projects in the region. In total, the city of Raleigh has studied two additional corridors for implementation of BRT.

Transit agencies and municipalities in the region should continue to assess the surface transportation network to identify key corridors that could benefit from the implementation of TSP/BRT. The transit agencies and municipalities should consider partnering arrangements that would support the multiple agencies and municipalities seeking funding together. All municipalities should coordinate with the transit agencies to ensure that implementation of traffic signal improvements will support future implementation of TSP and BRT.

Unified Transit Farebox System

Farebox technology is quickly advancing and is enabling easier, customized trip payment. This type of technology enables the use of smart phones or prepaid cards to quickly "tap and go" for quicker boarding, improved connectivity among multiple systems/modes for a seamless trip, and the ability to use multiple payment options. In some systems, the option for off-board collections requires riders to pre-pay before boarding, eliminating payment delays. With this type of technology, all doors can be used for access rather than just the driver door, allowing for quicker boarding.

Transit agencies in the Triangle region should coordinate through the regional task force/working group to develop equipment specifications to ensure interoperability of the farebox technologies across all agencies. The following agencies are included in the 2020-2029 NCDOT STIP to receive funds for improvements including fareboxes:

- Triangle Transit Authority (TG-4821B)
- Chapel Hill Transit (TG-4327A)

The transit agencies in the Triangle should seek ways to combine funding to implement a unified farebox system regionally.

Implement AVL Technology for Transit

During stakeholder interviews and workshops, transit agency staff indicated that the existing AVL systems are dated and in need of replacement. Transit agencies in the region should seek funding to replace or upgrade aging AVL systems.

New Municipal Traffic Signal System – Fuquay-Varina (U-6022)

Funding for U-6023 is included in the 2020-2029 STIP with funding indicated in 2022 and in future years beyond 2023. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained.

New Municipal Traffic Signal System – Knightdale (U-6026)

Funding for U-6026 is included in the 2020-2029 STIP with funding indicated in 2022 and in future years beyond 2023. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained.

New Municipal Traffic Signal System – Morrisville (U-5967)

Funding for U-5967 is included in the 2020-2029 STIP with funding indicated in 2022 and in future years beyond 2023. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained. The Town should coordinate with the Town of Cary to define specifications for the traffic signal system to ensure interoperability after the signal systems for the towns are consolidated.

New Municipal Traffic Signal System – Wake Forest (U-6023)

Funding for U-6023 is included in the 2020-2029 STIP with funding indicated in 2022 and in future years beyond 2023. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained. The Town should coordinate with the City of Raleigh to define specifications for the traffic signal system to ensure interoperability after the signal systems are consolidated.

New Municipal Traffic Signal System – Clayton (U-5943)

Funding for U-5943 is included in the 2020-2029 STIP with funding indicated in 2023 and in 2025. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained. The Town should coordinate with the City of Raleigh to define specifications for the traffic signal system to ensure interoperability after the signal systems are consolidated.

Upgrade Municipal Traffic Signal System – Apex (U-6117)

Funding for U-6117 is included in the 2020-2029 STIP with funding indicated in 2028 and in future years beyond 2029. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained. The Town should coordinate with the Town of Cary to define specifications for the traffic signal system to ensure interoperability after the signal systems for the towns are consolidated.

New Municipal Traffic Signal System – Garner (U-6194)

Funding for U-6194 is included in the 2020-2029 STIP with funding indicated in 2025 and in future years beyond 2029. The Town should continue to monitor the NCDOT budget status to ensure funding for the project is maintained. The Town should coordinate with the City of Raleigh to define specifications for the traffic signal system to ensure interoperability after the signal systems are consolidated.

Upgrade Municipal Traffic Signal System – Raleigh (U-6119)

Funding for U-6119 is included in the 2020-2029 STIP with funding indicated in 2025 and in future years beyond 2029. The City of Raleigh should continue to monitor the NCDOT budget status to ensure funding for the project is maintained. This is an important project to provide the City with traffic signal components that are more compatible then their existing system with those of their neighboring municipalities.

New Municipal Traffic Signal System – Holly Springs

The Town of Holly Springs is a growing community in the Triangle region and as a result traffic volumes are increasing on roadways in the town. While there are closed loop signal systems on some key corridors within the Town limits (NC 55 Bypass and Holly Springs Road), the implementation of a traffic signal system with fiber connectivity to all traffic signals will provide great benefit to the community – reduced congestion, improved safety, and improved system reliability. The NCDOT 2020-2029 STIP does not include funding for a new traffic signal system in Holly Springs, however, the Town should seek funding to design and construct a traffic signal system. The Town of Holly Springs should coordinate through the regional task force/working group to determine standards and specifications for software and hardware platforms in order to ensure interoperability should the signal system be consolidated with that of the Town of Cary.

Upgrade Municipal Traffic Signal System – City of Durham (U-5969)

Funding for U-5969 is included in the 2020-2029 STIP with funding indicated in 2020 and in 2021. Construction is underway, but the City of Durham should continue to monitor the NCDOT budget to ensure that funding for the project is maintained through completed construction.

Complete Regional Fiber Network

NCDOT and the municipalities in the Triangle region should work together to identify gaps in the fiber network and develop approaches and projects to fill the gaps. This effort will require participating agencies and municipalities to gather all plans and digital files for the existing fiber networks, establish a software platform that can be used by all participating agencies and municipalities in the region to share the data (ArcGIS and AutoCAD are common platforms and could be a useful and powerful tool for mapping existing fiber and associated data), and develop projects to provide new fiber to fill gaps in the existing network. The participating agencies and municipalities could consider teaming together to obtain funding for this type of project given the intent of completing the fiber networks to enable more seamless data exchange and operations of the transportation system across jurisdictional boundaries.

Nine municipalities in the region are included in the NCDOT 2020-2029 STIP to receive funds for either upgrading existing traffic signal systems or constructing new traffic signal systems.

These projects should include the addition of new or replacement of existing traffic signal fiber to close gaps in the existing regional fiber network.

After consideration of the new and upgraded signal systems in the region, if gaps in the fiber network are still evident at jurisdictional borders, municipalities should team together to develop projects to provide new fiber across the jurisdictional boundaries if their signal systems are to be consolidated.

Other funding options include leveraging maintenance and operational funds to pay for improvements to the existing fiber network. As new developments are proposed for construction in the Triangle, the host municipalities can consider requiring the installation of new fiber in concert with requirements for new traffic signals that result in location of traffic signals that would be advantageous to form closed loop signal systems or to extend the existing traffic signal fiber network.

Consolidate Municipal Signal Systems Management

Discussions during workshops and stakeholder interviews indicated that discussions are already underway to propose consolidation of some traffic signal systems. While some traffic signal systems are already consolidated (Chapel Hill with Carrboro and Cary with Morrisville), the following municipalities could move forward with consolidating traffic signal systems for the purpose of operating, monitoring, and maintaining the systems:

- City of Raleigh signal system with signal systems in Garner, Clayton, Knightdale, and Wake Forest
- Town of Cary signal system with signal systems in Apex, Fuquay-Varina, and Holly Springs

Some of the municipalities included do not currently have traffic signal systems, so efforts should be made during the design phase of the new traffic signal systems to ensure that the proposed traffic signal systems will be interoperable with those of the municipality that is proposed to operate, monitor, and maintain the new traffic signal systems.

Establish Agreements for System Consolidation and Management

Partnerships between municipalities for operation, monitoring, and maintenance of traffic signal systems must be formalized through written agreements. Where possible, municipalities should start the process of writing and executing agreements as soon as possible. Important considerations for the agreements include:

- The level and type of service to be provided such as installation, operation, and maintenance typically in accordance with NCDOT Schedule C and D agreements.
- Insurance requirements
- Reporting requirements (typically telephone and writing)
- Description of all costs to be incurred by the service provided, with a consideration for unanticipated incidents and expenses and annual increases in costs.

- Processes for expanding the scope of services and geographic area as systems grow.
- Details on operation of system components during events that disrupt normal operations – special planned events, weather events, etc.
- Identification of equipment storage in locations in proximity to where services are to be provided.
- Term of the agreement.
- Agreement termination requirements.

Examples of existing agreements in the region are included in Appendix I.

Assess New Sub-Region Transportation Management Center

Some discussions during workshops and stakeholder interviews focused on proposals for a new sub-region transportation management center (TMC) in the southeast area of the region. The regional task force/working group could either perform the necessary tasks in-house or outsource for services from a consultant. The following should be considered when assessing the need for a new sub-region TMC:

- How much additional workload can the existing TMCs take on?
- What is the added workload demand of the currently proposed system consolidations?
- Do the TMCs have available capacity to accommodate the proposed workload with existing staff and resources and provide the required level of service across the expanded areas of responsibility?
    - If so, then TMC workloads should be monitored to ensure that the required level of service is provided following system consolidation.
    - If not, then options to meet the new demands include expanding the staff and resources of the existing TMCs or building a new TMC in a location that will provide additional capacity for systems management and enable the existing TMCs and the new TMC to provide services at the required levels.

The next step in assessing the feasibility of constructing a new TMC includes performing benefit/costs analyses of the two options: expansion of an existing TMC and construction of a new TMC.

Centralize Data Warehousing and Distribution

Centralizing data warehousing and distribution offers the following benefits over siloed data warehousing and distribution:

- Less bad data
- Improves data security
- Time and money saving
- Improves physical security
- Enables cross-silo tracking and messaging

- More accurate analytics
- Improved reliability and update speeds

The regional task force/working group should assess current data sharing and distribution capabilities for all agencies and municipalities in the region in order to identify the data that should be in a central data warehouse, the preferred format for the data, the platforms for managing the data warehouse, how the data should be distributed, and how the data should be updated.

Coordinated Corridor Traffic Signal Timing

Coordinated corridor traffic signal timing is vital to improving traffic flow along corridors. Municipalities with TMCs can leverage the data gather through the system to assess corridor signal timings and implement adjustments to improve operations. As part of the implementation of the signal system upgrades and new systems, coordinated corridor signal timing should be one of the key requirements for the system implementation. Municipalities may also take advantage of opportunities to fund individual projects for optimizing corridor traffic signal timing. Maintaining efficient corridor traffic signal timing will help to sustain investments in the implementation of the traffic signal system.

Establish software and hardware platforms to serve connected and automated vehicles (CAVs)

With the anticipated increased presence of vehicles equipped to be connected, the agencies and municipalities in the region should proactively establish requirements for software and hardware platforms to provide service to those vehicles. It is anticipated that as more CAVs appear on the roadways and more corridors are equipped for CAV technologies, the more efficient the transportation systems will become, as mobility increases, travel times improve, and number of crashes is reduced.

The Town of Cary has been performing Signal Phasing and Timing (SPaT) test case. The lessons learned from the SPaT test case will help direct discussions of the recommended software and hardware platforms.

Another important consideration is the type of communication system that will be required. Two options are currently being considered – dedicated short-range communications (DSRC) and 5G LTE communications. DSRC systems are ready for deployment now, but 5G LTE communications are not currently widespread enough to be a viable solution. The regional task force/working group should continue to monitor the development of 5G LTE communications to ascertain which should be implemented in the region.

Regional standards for software, hardware, and communication platforms

Interoperability of systems between agencies and municipalities in the region is a major goal for the region. Setting standards for software, hardware, and communication platforms is

vital to ensure interoperability of systems. The regional task force should lead an effort to establish standards for software, hardware, and communication platforms. Considerations for this task include the current state of systems in each agency and municipality, existing obstacles to interoperability of systems across the region, and anticipated needs for software, hardware, and communication upgrades for each agency. Standards should be set in the near-term to guide future plans, designs, and purchases.

Inventory of Current Deployments

The regional task force/working group should lead efforts to establish an asset management system that can be used universally across the region by all agencies and municipalities that operate and maintain ITS components. The database/inventory should include data on all ITS hardware including date of installation, condition, remaining capacities, location, etc. The regional task force/working group should develop the asset management plan and parameters and coordinate with all agencies to determine the preferred platforms for the inventories of system components. The resulting asset management system should be available to all participating agencies and municipalities to support maintenance, replacements and upgrade schedules for system components.

This effort should be a regional effort involving all agencies and municipalities that own, operate, or maintain ITS systems in the Triangle region. This should be an opportunity for all participating agencies and municipalities to work cohesively. The initial efforts may require specific funding, but it is recommended that maintenance of the asset management system becomes a standard practice.

Integrated Corridor Management

Integrated corridor management has already been successfully implemented by NCDOT for a major construction project in the region and the state. The lessons learned from those projects can be applied to all major corridors in the region that experience significant recurring congestion and where future construction projects on critical corridors in the region are proposed. Implementing integrated corridor management strategies will help maintain system reliability by improving timeliness of traveler information, reducing vehicle delays, reducing crashes, and improving incident response time and incident clearance times.

Managed Motorways

The 2020-2029 STIP includes two projects for conversion of existing roadways to managed motorway in the Triangle region.

- U-6101 is planned for right-of-way acquisition beginning FY 2026 with construction planned for FY 2029. This project will covert sections of I-40, I-87, I-440, and US 1/US 64 in Wake County and Johnston County to managed motorways.
- U-6006 is planned for right-of-way acquisition in FY 2025 and planned for construction in FY 2025, FY 2026, and FY 2027. This project will convert a section of I-40 in Wake County and Durham County to a managed motorway.

The roadways included in the managed motorways projects carry significant volumes of traffic on a daily basis and continuing to build new lanes on these roadways is not desirable. Implementing managed motorways strategies will maximize efficient of the roadways to reduce travel delays, reduce crashes, and improve system reliability. Regional leadership should continue to monitor the NCDOT budget to ensure that funding for these critical projects remain intact.

Training for Incident Response

All agencies involved with incident response in the region should continuously train staff, so they are equipped with the skills to respond in a coordinated fashion and clear incidents safely and as quickly as possible. Training resources are available through FHWA's website. Here are some useful resources:

- National Traffic Incident Management Responder Training Program (https://www.fhwa.dot.gov/goshrp2/Solutions/Reliability/L12_L32A_L32B/National_Traffic_Incident_Management_Responder_Training_Program)
- Maintenance Training Series: Weather-related Operations (https://www.nhi.fhwa.dot.gov/course-search?sf=0&course_no=134109H)
- RESPONDERSAFETY.com Learning Network, "National Unified Goal for Traffic Incident Management" (https://learning.respondersafety.com/Training_Programs/National_Unified_Goal_for_Traffic_Incident_Management.aspx)
- RESPONDERSAFETY.com Learning Network, "Traffic Incident Management Requirements in NFPA 1500" (https://learning.respondersafety.com/Training_Programs/Traffic_Incident_Management_Requirements_in_NFPA_1500.aspx)
- CATT Lab, "Virtual Incident Management Training" (http://www.cattlab.umd.edu/?portfolio=virtual-incident-management-training-2)
- US Federal Emergency Management Agency, "Traffic Incident Management Systems, FA-330" (https://www.usfa.fema.gov/downloads/pdf/publications/fa_330.pdf)
- US Federal Emergency Management Agency, "National Incident Management System Training Program" (https://www.fema.gov/pdf/emergency/nims/nims_training_program.pdf)

Emergency Pre-emption

Emergency pre-emption is already in use in the region. The regional task force/working group should work jointly with the emergency services providers in the region to continue to expand the implementation of emergency pre-emption along key corridors and to identify the preferred pre-emption systems to implement in order to interoperable across jurisdictional boundaries. GPS-based systems are being considered by some municipalities in the region, but radar-based systems are still in use. Determining the preferred emergency pre-emption system will require all emergency services providers and municipalities in the

region to identify the preferred system, develop projects for implementation, and to seek funding for the implementation.

Adaptive Traffic Signal Systems

The NCDOT 2020-2029 STIP includes funding for implementation of an adaptive traffic signal system on US 74 (Wilkinson Boulevard) in Gaston County (U-6038). The system will adjust traffic signal timing in response to traffic demand. The project includes replacing 14 traffic signal cabinets, installing six miles of fiber optic communications cable, and six CCTV cameras. The Triangle region ITS task force/working group should move forward with the following tasks:

- Coordinate with NCDOT to assess the impacts of the U-6038 project in Gaston County to identify lessons learned to help assess the feasibility of implementing a similar system in the Triangle.
- Identify corridors in the region that might benefit from implementation of an adaptive traffic signal system. Candidate roadways include those that experience significant fluctuations in traffic volume and those that might be impacted due to diversion of traffic from a parallel roadway during emergencies or major incidents.

Once candidate corridors are identified, the host municipality should seek funding for design and construction.

Occupancy Detection in Parking Decks

Automated parking guidance systems (APGS) featuring detection systems to indicate parking deck occupancy are evolving. Systems are capable of tracking occupancy/availability for entire deck, on a level by level basis, on a row by row basis, and even individual spaces. The types of detection systems in common use include inductive loops, systems based on sensors in individual spaces, and systems based on cameras. Each system type has its own advantages and disadvantages and considerations for implementation. As the level of detail in the occupancy detection goes up so do costs for implementation. Costs include a server with the appropriate software, detection devices (loops, ultrasonic sensors, cameras, etc.), signs, and overhead costs.

APGS benefits include:

- Simpler access to available parking spaces reducing time drivers will spend looking for available spaces.
- If a license plate recognition system (LPRS) is utilized, drivers can find their vehicle in the system by searching for their license plate number.
- Security personnel have quicker access to locate vehicles based on license plate numbers when LRPS is used.

Duke University has implemented a camera-based system in Parking Garage 1. The garage houses 1,750 spaces and has an average of approximately 3,400 guests entering the patient and visitor level daily. As motorist enter the garage, the number of available spaces for each

level of the deck is displayed on a screen in the garage. Each floor of the deck is equipped with sensors that emits a green LED light over the available spaces. The University implemented the system in April 2019 and will assess the technology before installing in other parking garages on campus.

The regional task force/working group should consult with the Duke University parking staff to hear lessons learned on the camera-based system to assist in determining the preferred technology for the region to consider.

Staff Training for Operation and Maintenance of ITS Equipment

Availability of skilled staff to operate and maintain ITS equipment is vital to maintaining efficient operation of ITS systems and obtaining the highest return on investment. Staff attrition and everchanging technologies are challenges to keeping pace with operation and maintenance needs. Agencies and municipalities in the region that are responsible for operating and maintaining ITS equipment must take steps to improve availability of skilled staff. Costs for retaining skilled staff would likely be less than the cost of replacing skilled staff with new staff that then need to be trained. Along with taking steps to retain staff, the agencies and municipalities must take steps to provide or obtain training for staff members, so they are current with the latest technologies and methods for operating and maintaining the deployed ITS equipment.

Options for training staff include:

- Utilize the services of the vendors and manufacturers of the ITS equipment they deploy to train staff on the proper maintenance techniques.
- Reference training materials available from the US Department of Transportation and FHWA to develop maintenance programs
- The regional task force/working group can lead efforts to establish training recommendations that could be implemented across the region.

Expand Travel Information Coverage

NCDOT and some municipalities in the region already gather and distribute travel information to the public. Even with that expanse of geographic coverage in the region, there are opportunities to further expand coverage into areas that currently are not included in the footprint of existing coverage. As more signal systems with CCTV camera technologies are constructed and as traffic signal systems are consolidated, those are areas the coverage for travel information will be expanded. The regional task force/working group should assess the current coverages and the potential coverages of the new and consolidated traffic signal systems to identify any remaining gaps in coverage and develop projects to expand the fiber network and implement new monitoring devices, likely CCTV cameras, to fill the gaps in coverage.

Appendix K: Action Items with Implementation Notations

Develop Policy and Procedures To Share Data with Public and Third Parties

This action items supports the following Objectives:

- Support Vision Zero
- Improve Multimodal Connectivity And Equitable Access

These are key considerations for developing policies and procedures for sharing data with the public and third parties:

- Define the contents of data files. Specify units of measurement, definitions of codes or acronyms, and other descriptors.
- Use consistent data organization. Decide on the appropriate format for each dataset and use the format consistently.
- Use consistent file structure and stable file formats for data and images. Choose data formats that can be read in the future, regardless of any change of data usage or application.
- Include descriptive file names. Include unique file names that reflect the file contents.
- Perform quality assurance: Conduct quality assurance of the data before sharing.
- Assign descriptive dataset titles. Use dataset titles that reflect the contents of the dataset.
- Provide documentation. Provide easily-understood documentation to ensure understanding by users.
- Data security. Implement security measures that ensure security of datasets, data environments, and hardware and software.
- Data privacy. Use guidance of the Fair Information Practice Principles and implement technologies to anonymize the identity of individuals protect those individuals from exposure of sensitive and private information.
- Intellectual property. Do not include any software developed by others without obtaining rights to do so from the developer.
- Liability. Clearly state limits to liability for use of datasets that are shared.

The following are useful resources:

- Open Government Data Act of 2019 (https://www.data.gov/meta/data-gov-at-ten-and-the-open-government-data-act/)
- FHWA "State of the Practice on Data Access, Sharing, and Integration" (https://www.fhwa.dot.gov/publications/research/operations/15072/index.cfm)

Establish Performance Objectives (Metrics) and Monitoring

This action items supports the following Objectives:

- Support Vision Zero
- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility
- Support Economic Vitality

The regional task force/working group should lead agencies and municipalities in the region to establish performance objectives and measurable performance measures to assess the impact of ITS deployment on achieving stated goals. Objectives and measures should include:

- Mobility – Use travel time, delay, and throughput to measure mobility
- Emissions and Fuel Consumption – Estimate based on facility type, vehicle mix, and travel speed
- System Reliability – NCDOT's objective (which is the same as the national goal) is to clear crashes from roadways within 90 minutes. The current performance is 70 minutes. System reliability and crash clearance times on surface streets in local municipalities should targeted to meet or exceed those established by NCDOT and national goals. Crash clearance times should be gathered for all incidents.
- System Safety – The regional task force/working group must identify a goal for reducing crashes for the entire system, but can also set goals for key corridors where ITS deployments are intended to reduce crashes. The NCDOT Traffic Engineering Accident Analysis System (TEAAS) should be to summarize data regionally and on key corridors to annually assess crash totals.
- Transit On-Time Performance – On-time performance for transit vehicles is an important measure to assess impacts of corridor improvements as well the implementation of ITS technologies such as TSP and BRT. Transit agencies should continuously track the on-time performance of transit vehicles and coordinate with local municipal and/or NCDOT staff concerning improvements along key corridors.
- Traffic Congestion – FHWA measures congestion using the following measures:
  - Congested Hours – The average number of hours between 6:00am and 10:00pm that road sections are congested (i.e. travel speeds less than 90% of free flow speed).
  - Travel Time Index – The ratio of the peak-period travel time to the free-flow travel time during the hours of 6:00am to 9:00am and 4:00pm to 7:00pm.
  - Planning Time Index – The ratio of the 95th percentile travel time to the free-flow travel time

The latest measures by FHWA indicated the following measures for the Raleigh area in 2019:

- Congested Hours – 2:05
- Travel Time Index – 1.16
- Planning Time Index – 1.71

The data used by FHWA is acquired from the National Performance Management Research Data Set (NPMRDS). The regional task force/working group should review the data used by

FHWA and supplement with local data to the fullest extent possible and monitor these measures on an annual basis to assess system performance.

The following are useful resources:

› FHWA, "Operations Performance Measurement" (https://ops.fhwa.dot.gov/perf_measurement/)
› FHWA, "Urban Congestion Reports" (https://ops.fhwa.dot.gov/perf_measurement/ucr/)
› FHWA, "Scoping and Conducting Data-Driven 21st Century Transportation System Analyses" (https://ops.fhwa.dot.gov/publications/fhwahop16072/)

Establish a Regional Task Force/Working Group

This action item supports the following Objectives:

› Support Vision Zero
› Enhance Network Mobility
› Improve Multimodal Connectivity And Equitable Access

The DCHCMPO and CAMPO should establish a task force/working group with the following recommended membership:

› One staff member from each MPO
› One transit agency staff member to represent all transit interests and agencies in the region
› One NCDOT staff member from each of the following: Division 5 office, Division 7 office, Central Region office, and Eastern & OBX Region office.
› One staff member from each municipality in the combined MPO boundary
› One emergency services staff member from each MPO

One of the benefits of a regional task force/working group is to develop a partnership culture to eliminate silo mentalities that might exist.

Responsibilities of the regional task force/working group include:

› Continuously monitor the introduction of new technologies and applications for consideration in the Triangle region
› Establish guidelines for the following items to ensure uniform standards and system interoperability
  - Establishing performance objectives (metrics) and monitoring
  - Developing partnerships between agencies and municipalities in the region for the purposes of integrating and sharing data, sharing resources, and pursuing funding
  - Establishing uniform asset management across the region
  - Develop a toolbox of analysis tools to assess impacts of proposed ITS strategies
  - Identification of strategic/critical corridors in the region
  - Development of a regional architecture conformance form

- Planning to upgrade traffic signal systems across the region
- Planning for transit signal priority
- Development a network security plan
- Development of base materials to educate elected officials and decision-makers

The task force/working group will identify other existing user groups in the region that could support or be supported by the efforts of the task force/working group.

Establish Partnership Agreements Between Stakeholders in the Region

This action item supports the following Objectives:

› Support Vision Zero
› Support Reliability Across An Integrated Transportation Network
› Enhance Network Mobility

Develop partnership agreements between regional agencies and local municipalities to achieve the following benefits:

› Sharing of resources and costs
› Improved system reliability by improving system operations across agency and municipal boundaries
› Improved coordination during crisis conditions such as significant emergencies requiring large-scale detours and evacuations.

Consider the following principles when developing agreements for collaboration:

› Identify opportunities. Performing needs assessments to identify service areas that could benefit form from agreements with regional and local partners.
› Conduct a feasibility analysis. Perform a quick assessment with identified partners to determine that the proposed service agreement is beneficial to all partners. The feasibility analysis should clearly describe how the services are currently being provided, the level of service currently being provided by each partner, total costs (current and proposed) for each partner, and assess if the proposed agreement provides services at level to satisfy goals of each partner.
› Negotiate the agreement. Consider the following issues during negotiation of the agreement: revenue and cost allocation; staffing and compensation; ownership, maintenance, and operation of equipment and facilities; liabilities: and frequency and method of financial reporting.

Developing operational agreements between agencies and municipalities, particularly for control and maintenance of traffic signal systems, benefits the region by providing opportunities to share resources and reduces overall costs and to provide network wide coordination, speed management, and emergency vehicle response preemption and transit priority across jurisdictional boundaries.

Important considerations for this type of agreement include:

- The level and type of service to be provided such as installation, operation, and maintenance typically in accordance with NCDOT Schedule C and D agreements.
- Insurance requirements
- Reporting requirements (typically telephone and writing)
- Description of all costs to be incurred by the service provided, with a consideration for unanticipated incidents and expenses and annual increases in costs.
- Processes for expanding the scope of services and geographic area as systems grow.
- Details on operation of system components during events that disrupt normal operations – special planned events, weather events, etc.
- Identification of equipment storage in locations in proximity to where services are to be provided.
- Term of the agreement.
- Agreement termination requirements.

The following are useful resources:

- New York State Comptroller, "Intermunicipal Cooperation and Consolidation" (https://www.osc.state.ny.us/localgov/pubs/research/cooperation1.pdf)
- IBM Center for The Business of Government, "A County Manager's Guide to Shared Services in Local Government" (https://www.naco.org/sites/default/files/event_attachments/Additional%20Service%20Sharing%20Resources.pdf)

Create and Encourage Regional Partnership Culture to Eliminate Silo Mentality

This action item supports the following Objectives:

- Support Vision Zero
- Enhance Network Mobility
- Improve Multimodal Connectivity And Equitable Access

Establishing a regional task force/working group will provide opportunity to further foster partnerships between agencies and municipalities in the region. The regional task force/working group will bring together staff from municipalities and agencies across the region with the following intents: provide open communication on individual needs and fulfilling those needs with a regional perspective; encourage collaboration to eliminate any silo mentalities; create buy-in on approaches to solving regional and in-common local issues; eliminate competing agendas that may exist; create global guidelines for use across the region for developing projects and funding priorities; and provide opportunities for developing partnership agreements between agencies and municipalities in the region.

Develop a Plan for Emergency Vehicle Preemption (EVP)

This action item supports the following Objectives:

- Support Vision Zero
- Support Reliability Across An Integrated Transportation Network

Develop a plan for emergency vehicle preemption with the following objectives:

- Reduce response times for emergency vehicles to incidents
- Improve health and safety of emergency personnel.
- Reduce conflicts between emergency vehicles and non-emergency vehicles to reduce likelihood of crashes during emergency responses.

Important considerations during planning for EVP include:

- Establish equipment specifications that apply regionally to ensure EVP systems are operable across jurisdictional boundaries.
- Identify critical emergency response routes and ensure clear sight lines between emergency vehicles and detection devices for radar-based EVP systems.
- Assessment of impacts on the corridors where EVP may be implemented
- Process to record individuals and vehicles that trigger a EVP device
- Establish specific emergency service providers that are allowed to use the system ensuring inclusion of use by emergency personnel and vehicles from adjacent municipalities.
- When upgrading traffic signal and control systems, ensure that the proposed equipment and technologies support implementation of EVP.

Some municipalities in the region are considering GPS based EVP systems while other are operating radar-based systems. The regional working group/task force should work to establish technology standards and specifications that will ensure compatibility across the region.

The following are useful resources:

- for the Planning and Deployment of Emergency Vehicle Preemption and Transit Signal Priority Strategies"
- FHWA, "NCHRP Report 500 / Volume 12: A Guide for Reducing Collisions at Signalized Intersections" (https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/sa5.cfm)

Develop and Implement a TIM Plan Integrating Freeways and Arterials

This action item supports the following Objective:

› Support Vision Zero

NCDOT operates Traffic Incident Management (TIM) on state-owned interstates and freeways. When significant incidents occur on these high-volume roadways in the Triangle region, motorists divert onto local arterial roadways which often results in congested conditions both on the interstate and the local arterial. NCDOT and the statewide traffic operations center (STOC) and local TMCs already coordinate when significant incitements occur, but the agencies should formally adopt a traffic incident management plan that provides the decision support system to accelerate decision times, identify roles of the involved agencies, and mobilizes resources quickly. The goals of the TIM plan should be to improve system reliability by reducing crash clearance times; secure the safety of the traveling public, responders, and the incident site; and provide timely information to the public.

Increase and Improve Roadway Surveillance Coverage

This action item supports the following Objective:

› Support Vision Zero

Expand fiber and wireless networks to provide connectivity to new CCTV cameras and system detectors in areas where coverage is not already provided. The implementation of the improvements can be standalone projects or become part of concurrent construction projects. The new equipment should comply with current requirements but be expandable to comply with future technologies.

Integrate TMCs and Computer Aided Dispatch

This action item supports the following Objective:

› Support Vision Zero

Integrating traffic management centers and local computer aided dispatch (CAD) systems would TMC operators to be alerted more quickly of incidents on the roadways that are being monitored which would provide opportunities to take action more quickly to deploy resources to respond to the incident. This could potentially result in reduced incident response times and clearance response times which could reduce traffic congestion and secondary incidents.

The NCDOT Statewide Traffic Operations Center (STOC) already has already integrated CAD. The operations of the STOC operations can be a model for how other TMCs in the region can integrate CAD.

Specific benefits that could be realized include the following:

Benefits to transportation system operators

- More timely alerts of incidents
- Improved incident information allowing system operators to more intelligently deploy resources
- Provides opportunity to more accurately track incident data which could build support for safety improvements

Benefits to Law Enforcement and Emergency Services

- Transportation resources can be engaged more quickly to provide traffic management
- Reduced call volume as a result of quicker response and clearing incidents
- Enables transportation system resources to address incidents that do not require law enforcement
- Removes some responsibility of traffic management during incidents

Other joint benefits

- Improved safety for all parties due to potential for reduced secondary crashes, shorter incident durations, and improved traffic management
- Improved traveler information
- Opportunity to gather data to show benefits of services

These are useful resources:

- I-95 Corridor Coalition, "CAD and TMS Integration Workshop Summary" (https://i95coalition.org/wp-content/uploads/2018/06/I95CC_CAD_Workshop_Summary_Report-Final-04_23-24_2018.pdf?x70560)

Develop ITS Resource Toolbox

This action item supports the following Objectives:

- Support Vision Zero
- Improve, Monitor And Manage Assets

The regional task force/working group should develop a toolbox of analysis tools to assess impacts of proposed ITS strategies. Many tools are readily available. The tools listed below should be considered for the toolbox. Some of these applications are already in use in the region.

- Triangle Regional Travel Demand Model
- Highway Capacity Manual
- FHWA Tool for Operations Benefit Cost Analysis (https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm)

- Florida ITS Evaluation Tool (http://www.fsutmsonline.net/index.php?/model_pages/comments/fitseval/)
- California Life-Cycle Benefit/Cost Analysis Model (http://bca.transportationeconomics.org/models/cal-b-c)
- FHWA Benefits-Costs Database (https://www.benefitcost.its.dot.gov/its/itsbcllwebpage.nsf/KRHomePage)
- FHWA QuickZone (https://ops.fhwa.dot.gov/wz/traffic_analysis/quickzone/index.htm)
- FHWA "Work Zone Intelligent Transportation Systems Implementation Guide" (https://ops.fhwa.dot.gov/publications/fhwahop14008/index.htm)
- TransModeler Traffic Simulation Software (https://www.caliper.com/transmodeler/trafficcontrol.htm)
- Synchro Signal Timing and Analysis Software (https://www.trafficware.com/synchro.html)

Identify Strategic/Critical Corridors Prioritizing Projects

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility

The regional task force/working group should define guidelines for designating strategic/critical corridors. The guidelines established by the task force/working group should be uniformly applied across the Triangle region. Key factors in the guidelines should include current designation in the NCDOT Statewide Strategic Corridor Plan (https://connect.ncdot.gov/projects/planning/STC%20Documents/NCTN_STC_StratTransCorridors_DurOrChatWake.pdf), inclusion in the triangle regional travel demand model, access to major activity centers in the region, congested corridors, and corridors with high-crash history.

Develop Guidelines to Evaluate Projects for Compliance With Regional Architecture

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility

To document the conformity of an ITS project with the regional architecture, the regional task force/working group should oversee the development of a regional architecture conformance form to guide project managers through the process. The steps of the process should be as follows:

6. Identify the ITS components in the project;
7. Identify the corresponding market packages from the regional ITS Architecture;
8. Locate the component within the market package;

9. Compare the connections to other agencies or elements documented in the ITS Architecture as well as the information flows between them to the connections that will be part of the project;
10. Assess the use of relevant standards; and
11. Document any changes necessary to the ITS Architecture or the project to ensure there is conformance.

The guidance developed by the regional task force/working group should be used uniformly by all agencies and municipalities in the region.

Develop Project Prioritization Methodology

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Support Economic Vitality

The VHB Team developed a spreadsheet-based project prioritization tool that is intended to assist with comparing proposed projects that are competing for funding based on how well each project meets the needs and goals of the Triangle Region ITS Strategic Deployment Plan Update. The Prioritization tool includes scoring criteria that consider geographic and strategic benefits, estimated construction and maintenance costs, and rewards projects that align with the strategies of this update to the regional ITS deployment plan.

These are useful resources:

- FHWA, Organizing and Planning for Operations, Tool for Operations Benefit Cost Analysis (TOPS-BC) (https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm)
- USDOT Intelligent Transportation Systems Joint Program Office (https://www.itskrs.its.dot.gov/its/itsbcllwebpage.nsf/KRHomePage)
- FHWA "Operations Benefit/Cost Analysis Desk Reference" (https://ops.fhwa.dot.gov/publications/fhwahop12028/fhwahop12028.pdf)

Involve All Agencies in the Region in Planning Development Process

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network

The DCHC MPO and CAMPO already provide opportunities for all agencies and municipalities to participate in the regional planning process for transportation. Participation in the regional ITS task force/working group will provide opportunities for agencies and municipalities in the region to actively participate in the regional planning process specifically for ITS deployment.

Develop a Plan for Traffic Signal System Upgrade

This action item supports the following Objective:

› Support Reliability Across An Integrated Transportation Network

All agencies that own, maintain, and operate traffic signal systems in the Triangle region should develop plans and priorities for replacing their existing traffic signal components. Historically, the jurisdictions in the Triangle have used traffic signal equipment from a variety of manufactures. Some are on the same platforms as NCDOT, while other jurisdictions are still operating on a different platform or are in the process of upgrading to a platform that is compatible with NCDOT. Given the intent to have interoperable systems across jurisdictional boundaries, it is imperative that upgrades are aimed at installing interoperable technologies. The regional task force/working group should develop guidelines for planning to upgrade traffic signal systems across the region. Some key factors to consider in the plan development include:

› Current deployments in the region
› Interoperability of existing deployments
› Identify desired operations for new or upgraded systems including TSP/BRT, EVP, and CAV operations.
› Identify upcoming software and hardware platform developments and how they would operate in conjunction with existing deployments.
› Identify plans for NCDOT upgrades to their systems and technologies to ensure compatibility between local municipal deployments and those on the state system.

The plan developed by the regional task force/working group should be used by all municipalities in the region that are planning upgrade existing systems or install new systems.

The current NCDOT STIP includes funding for upgrades to three existing signal systems in the region (Raleigh, Durham, and Apex) and construction of six new traffic signal systems in the region (Wake Forest, Garner, Fuquay-Varina, Clayton, Knightdale, and Morrisville).

Develop Plan for Transit Signal Priority (TSP)

This action item supports the following Objectives:

› Support Reliability Across An Integrated Transportation Network
› Enhance Network Mobility

Transit signal priority (TSP) is a key component of successful operation of bus rapid transit (BRT) systems. The benefits of TSP improvements include reduced transit travel times, improved schedule adherence (reliability), and improved transit and road network efficiency especially on corridor streets with long signal cycles and distances between signals, allowing traffic signals to change in response to bus movement. As development and implementation of BRT continues to expand in the Triangle region, NCDOT, transit agencies, and municipalities must start laying the groundwork to provide infrastructure to support TSP. The regional working group/task force can

lead discussions on TSP such as: guidelines for choosing passive transit signal priority versus active traffic signal priority: identifying the preferences for hardware and software platforms; and transit vehicle detection technology for active traffic signal priority systems (on-board automatic vehicle location (AVL), GPS, optical or laser communication, or other methods to link transit vehicles to the corridor traffic signal system.

The following are key recommendations when planning for TSP

› Utilize traffic simulation models for comparing TSP strategies
› Prepare analyses to assess local impacts of a TSP deployment
› Compare transit priority strategies during planning
› Conduct site surveys to ensure that designs accommodate local characteristics

The following are useful resources:

› NACTO's "Transit Street Design Guide"
› USDOT Lessons Learned Summary, https://www.itslessons.its.dot.gov/its/benecost.nsf/LessonHome

Establish ITS Database/Inventory

This action item supports the following Objectives:

› Support Reliability Across An Integrated Transportation Network
› Improve, Monitor And Manage Assets

The regional task force/working group should lead efforts to establish an asset management system that can be used universally across the region by all agencies and municipalities that operate and maintain ITS components. The database/inventory should include data on all ITS hardware including date of installation, condition, remaining capacities, location.

Developing a regional ITS database will include the following:

› Gather data of existing ITS elements from NCDOT and local municipalities in a digital format, preferably a CADD file or GIS file
› Establish a software platform that can be used by all participating agencies and municipalities in the region to share the data. ArcGIS is a common platform and could be a useful and powerful tool for mapping existing fiber and associated data.
› Compile available mapping data into the preferred software platform.

The following are useful resources:

› NCDOT "Transportation Asset Management Plan 2019 Final Report" (https://connect.ncdot.gov/resources/Asset-Management/TAMP/Final%20TAMP%20-%20June%202019.pdf)
› FHWA "Transportation Asset Management Plans" (https://www.fhwa.dot.gov/asset/plans.cfm)
› FHWA "Asset Management Guidance" (https://www.fhwa.dot.gov/asset/guidance.cfm)

Develop Network Security Plan

This action item supports the following Objective:

› Support Reliability Across An Integrated Transportation Network

The regional task force/working group should lead development a network security plan that can be implemented by all agencies and municipalities in the region. Key areas of focus for the plan includes protection against penetration of the following system components:

› ITS Field Components
› Embedded Hardware and Firmware
› Wireless Communication
› Fiber Network
› Application and Management Software
› Social Engineering

The following are useful sources:

› SANS Institute "SEC440: Critical Security Controls: Planning, Implementing, and Auditing" (https://www.sans.org/course/critical-security-controls-planning-implementing-auditing?msc=cishp)
› Protection of Transportation Infrastructure from Cyber Attacks: A Primer (http://www.trb.org/Main/Blurbs/174382.aspx)
› FHWA "Cybersecurity and Intelligent Transportation Systems – A Best Practice Guide" (https://www.hsdl.org/?abstract&did=830513)
› Roads & Bridges "Vulnerability analysis and defense framework for the cybersecurity of a traffic control system" (https://www.roadsbridges.com/vulnerability-analysis-and-defense-framework-cybersecurity-traffic-control-system)
› Springer "Understanding the Security of Traffic Signal Infrastructure" (https://link.springer.com/chapter/10.1007%2F978-3-030-22038-9_8)
› Trend Micro "Securing the Transportation Network of Tomorrow" (https://www.trendmicro.com/vinfo/us/security/news/internet-of-things/securing-the-transportation-network-of-tomorrow)
› US Department of Transportation, "NHTSA Cyber Security Best Practices Study" (https://www.pcb.its.dot.gov/t3/s111207/s111207_weisenberger_presentation.pdf)

Identify Potential Deployments on High Crash Corridors

This action item supports the following Objective:

› Support Reliability Across An Integrated Transportation Network

Deployments in high crash corridors can be implemented to make improvements in the following program areas: Traveler Information, Traffic Management and Operation, and Incident Management. The following deployments should be considered to support these improvements:

- Install DMS at key locations
- Utilize freight traveler information systems
- Install queue warning systems
- Improve traffic signal timing and coordination
- Install surveillance cameras and detector
- Provide enhanced bicycle and pedestrian crossings
- Establish TIM teams for key locations
- Consider TDM measures to reduce vehicular demand

Create Regional Central Clearing House Database for Lane Closures (i.e., DriveNC.gov extended to local agencies)

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility

Agencies and municipalities in the region should develop agreements to share data concerning road closures and lane closure information and establish a consolidated online portal for sharing the information with all agencies and municipalities and with the public. NCDOT operates the DriveNC.gov website illustrating active and upcoming lane and road closures due to construction and maintenance activities, but only includes those activities on state-maintained roadways. The regional task force/working group should work with NCDOT to establish agreements with all agencies and municipalities in the region to share lane and road closure information so the data can be included on the DriveNC.gov website.

The websites listed below is a sampling of the websites currently operated by NCDOT and municipalities in the region to share data concerning lane and road closures, traffic alerts, and traffic conditions.

- NCDOT DriveNC.gov (https://www.drivenc.gov/)
- NCDOT Traveler Information Management System (https://tims.ncdot.gov/tims/)
- City of Raleigh Road Closures and Events Map (https://raleighnc.gov/services/apps-maps-and-open-data/road-closures-and-special-events-map)
- Town of Cary Alerts and Closures Live Traffic Map (https://www.townofcary.org/projects-initiatives/alerts-closures)
- Town of Cary Traffic Camera Live Feed (https://www.townofcary.org/services-publications/traffic)
- Town of Apex Street Maintenance Map (https://www.apexnc.org/1206/Street-Maintenance-Map)
- NCDOT Current DriveNC/TIMS Incidents Dashboard (https://www.arcgis.com/apps/opsdashboard/index.html#/4b2caeae4ae745eda31dadde3f995cdd)
- ShareTheRideNC (https://www.sharetheridenc.org/Public/Home.aspx)

Develop Decision Support Systems for Transportation Systems Management

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility

A decision support system (DSS) is an automated system that supports decision making for management of multimodal transportation systems. The primary functions of a DSS include:

- Analyzing stored event data to determine appropriate strategies and responses
- Analyzing and detecting anomalies in road conditions
- Analyzing and detecting return to normal conditions
- Analyzing stored ITS device status data to determine the availability of devices
- Analyzing events, network conditions, and status of devices to select appropriate responses
- Providing users with appropriate response plans (changes to messages, signal timing, etc.)
- Predicting the potential benefit of implementing a response
- Evaluating the impact of enacted response plans on the transportation network

A DSS can accelerate objective decision-making resulting in the accurate information being provided to the appropriate user/stakeholder in a timely manner which can reduce response times and improve system reliability.

An effective DSS requires cooperation between multiple agencies so that resulting decisions are aligned with the policies and protocols agreed up by the participating agencies. Operational agreements between the cooperating agencies will define the policies and protocols for the DSS. Cooperating agencies should include NCDOT operations staff, NC State Highway Patrol, local municipal traffic operations staff, local municipal emergency services, local municipal police, local and regional transit agencies, and private partners such as tow truck service companies.

The following are useful sources:

- FHWA's Elements of Business Rules and Decision Support Systems within Integrated Corridor Management: Understanding the Intersection of These Three Components (https://ops.fhwa.dot.gov/publications/fhwahop17027/ch1.htm)
- FHWA's Presentation on "Decision Support Systems for Integrated Corridor Management", April 2015 (https://www.its.dot.gov/meetings/pdf/DSS_ICM.pdf)

Develop Operational Scenarios

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility

Operational scenarios are key to demonstrating the capabilities of transportation management systems under a wide range of conditions – typical daily conditions to extreme conditions that might push the system to near failure. The following elements should be considered during development of the operational scenarios:

- User perspective – Scenarios should be developed to include the perspective of individual key users of the system.
- Variety of user classes – All system users should be included in the development of the scenarios to maximize stakeholder buy-in and system effectiveness.
- Stress/Failure scenarios – Scenarios should be developed to model events that could be considered extreme events which could push the system to near failure. Examples of extreme events might include evacuations, significant special events, and wide area emergencies.
- Multiple circumstances – Multiple scenarios should be developed in order to accurately portray system and user performance during a range of conditions. Each key user/stakeholder should identify a scenario to demonstrate how they will use the system during events specific to their agency.

The following is a useful sources:

- FHWA's "Developing and Using a Concept of Operations in Transportation Management Systems".

Improve Fiber/Communications Network

This action item supports the following Objectives:

- Support Reliability Across An Integrated Transportation Network
- Enhance Network Mobility
- Improve, Monitor And Manage Assets

Leverage the regional fiber mapping plan to identify gaps in the existing network and physical obstacles that may be contributing to the gaps in the existing network, then develop plans for additional deployment of fiber and wireless networks to fill the gaps. Development of the plans can be prepared as stand-alone projects or as part of concurrent construction projects.

Establish Partnerships for Data Integration and Inventory Compliance with Architecture

Per the FHWA Asset Management Primer, "A comprehensive, fully integrated Transportation Asset Management System weaves together information on all asset inventories, condition and performance databases, and alternative investment options". Options for data integration include maintaining current datasets in their legacy platform and transferring the legacy datasets into a platform that will be common to all agencies and municipalities in the region. Other factors in data integration include options for either warehousing all data in a single dataset or distributing datasets across multiple servers and utilizing a compatible referencing system to retrieve data.

The regional task force/working group should lead the effort to establish the guidelines for data integration for the region. Roles for the task force/working group on this topic include providing guidance to municipalities and agencies to assess current datasets and platforms, gather preferences from the individual agencies and municipalities on whether or not to warehouse data in a single location, and to identify compatible data platforms that all agencies and municipalities in the region should implement to establish regional data integration.

The regional task force/working group will also develop a checklist for users to ensure that individual projects are in compliance with the regional architecture. The compliance checklist can be used as guidance for establishing the format of datasets pulled from a variety of sources to ensure ITS assets comply with the architecture.

The following are useful resources for developing regional data integration and architecture compliance:

- FHWA "Data Integration Documents" (https://www.fhwa.dot.gov/infrastructure/asstmgmt/difact.cfm)
- FHWA "Data Integration: Key to Practice of Asset Management" (https://www.fhwa.dot.gov/publications/focus/01sep/dataintegration.cfm)

Develop Best Practices Guidance Document to Manage Regional Mobility

This action item supports the following Objective:

- Enhance Network Mobility

The regional ITS working task force/working group should coordinate with staff of the DCHCMPO and CAMPO to develop a best practices guide for managing mobility across the Triangle region. The focus of the best practices will be inclusive of all modes of transportation and system elements, not just ITS elements.

Best practices for managing regional mobility will include the following components:

- Establish cooperation and common goals among the agencies and municipalities in the region including those that are involved with funding decisions, transportation planning, land use, public safety, and law enforcement
- Emphasis on accessibility and mobility of people and goods rather than just vehicles
- Consideration of people that are disadvantaged physically, economically, and socially
- Consideration of long-term funding sources
- Education of decision-makers and staff about mobility objectives, techniques, and resources
- Give equal consideration to both management strategies and capacity expansion project when making funding decisions
- Revise polices and planning practices, including land use, that do not support transit use
- Consider policies to fund operations and maintenance programs before committing funds to capacity building projects
- Track progress toward goals and objectives
- Some strategies to be considered include:
- Smart Growth-Land Use Management Strategies
- Non-Motorized Transportation Planning
- Transportation Market And Pricing Reforms
- Investments In Transit
- Transportation Demand Management Programs (TDM)
- Freight Transportation Management
- Parking Management

The following are useful resources:

- Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, "A Sourcebook for Policy-makers in Developing Cities, Module 2b: Mobility Management" (https://www.vtpi.org/gtz_module.pdf)
- Greater Portland Council of Government. "Building a Regional Mobility Management Network: Lessons from a Regional Planning Organization" (https://nationalcenterformobilitymanagement.org/wp-content/uploads/2018/12/NCMM_Brief_Regional_Network_FINAL.pdf)
- National Cooperative Highway Research Program, "Successful Mobility Management Practices for Improving Transportation Services in Small Urban and Rural Areas" (https://www.michigan.gov/documents/mdot/NCHRP20-6568FinalReportMobilityManagement_621561_7.pdf)
- US Department of Transportation, "Mobility Management Brochure" (https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/resources/171/mobility-management-brochure.pdf)
- ShareTheRideNC (https://www.sharetheridenc.org/Public/Home.aspx)

Educate Political Leaders, Senior Management, and Elected Officials

This action item supports the following Objective:

› Enhance Network Mobility

› Improve Multimodal Connectivity And Equitable Access

Continued support of ITS by elected officials and senior management is important to advancing deployment, management, and maintenance of ITS infrastructure. While many elected officials and senior management staff may be aware of the benefits of ITS, it would be beneficial to continuously update the decision-makers on the benefits of current and proposed deployments as well as new emerging technologies that could be considered for deployment. The regional task force/working group should lead the development of approach and development of materials which could then be tailored by each agency and municipality. The timing and frequency of presentations to individual agencies and municipal decision makers will vary, but the task force/working group should present information to the DCHC MPO and CAMPO at least once a year or more frequently should a new technology be introduced that would be suitable for consideration in the region.

Improve Information Dissemination at Operations Level

This action item supports the following Objective:

› Enhance Network Mobility

Action items included in this report will support efforts of agencies and municipalities to improve dissemination of information at the operations level. Some of those action items include developing agreements to integrate and share data and utilizing a consistent decision support system.

Provide Quality ITS Data to the Public

This action item supports the following Objective:

› Enhance Network Mobility

› Regional and municipal transportation agencies should continue to take steps to provide high-quality travel data to the public to improve mobility and safety. The following activities can support this action item:

› Continue expanding deployment of ITS devices to gather accurate data quickly and efficiently.

› Maintain ITS infrastructure to mitigate outages and to ensure collection of high-quality data.

› Continue to partner with broadcast and online media partners to distribute the data on a timely basis.

› Maintain and expand on-line portals for sharing travel data.

› Adhere to the policies and procedures for sharing data with the public as established by the regional ITS task force/working group.

Develop Regional Fiber Mapping Plan

This action item supports the following Objective:

› Enhance Network Mobility

› Improve, Monitor And Manage Assets

Developing a regional fiber map plan will include the following:

› Gather plans for existing fiber locations from NCDOT and local municipalities in a digital format, preferably a CADD file or GIS file

› Establish a software platform that can be used by all participating agencies and municipalities in the region to share the data. ArcGIS and AutoCAD are common platforms and could be a useful and powerful tool for mapping existing fiber and associated data.

› Compile available mapping data into the preferred software platform.

› Identify gaps in the inventory of existing fiber infrastructure and supplement the data with new field data collection if necessary.

The following data should be included with the mapping plan: sizes of cables and conduits, remaining capacity of cables and conduits, installation type (overhead or underground), owner agency, and maintenance agency.

The fiber map should become part of the regional ITS asset management system and should be continuously updated as new fiber installations are completed.

Establish Procurement Process for Security and Interoperability

This action item supports the following Objective:

› Enhance Network Mobility

› Improve Multimodal Connectivity And Equitable Access

The regional task force/working group should lead development of procurement process for ITS system components to maximize security potential and interoperability. Important considerations when developing procurement processes and requests for proposals (RFP) for ITS projects include:

› Test vendor equipment with existing equipment to assess compatibility prior to releasing the RFP

› Vet project requirements with agencies and municipalities in the region to help to ensure interoperability

› Budget additional time for software development and equipment testing in the RFP

› Involve procurement personnel from the beginning of a project

› Ensure the procurement documentation if forward-focused and provides opportunity to support future technologies and standards

› Consider contracting techniques that minimizes the deployment schedule

› Choose a contracting technique that is appropriate for the project scope: Design-Bid-Build, Design-Build, and Systems Manager

› Utilize prequalification of bidders

› Include warranty provisions

› Incorporate requirements of the regional ITS network security plan as established by the regional task force/working group

› The following are useful resources:

› FHWA "Connected Vehicle Procurement State of the Practice Assessment" (https://rosap.ntl.bts.gov/view/dot/37173)

› FHWA "Federal-Aid ITS Procurement Regulations and Contracting Options" (https://rosap.ntl.bts.gov/view/dot/35881)

› IJIS Institute "Interoperability Standards and the Procurement Process" (https://www.ijis.org/blogpost/1268934/218612/Interoperability-Standards-and-the-Procurement-Process)

Allocate Funding for Maintenance and Operations

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

During workshops and stakeholder interviews, some discussions focused on insufficient funding for maintenance and operation of transportation systems and components, both for traditional systems and for ITS systems and components. NCDOT along with agencies and municipalities in the region, should proactively seek and allocate funding to properly maintain the earlier investments in the transportation system. Doing so can extend the useful life of the existing systems, and can also ensure that the systems are operating as efficiently as possible providing the most benefit to operators and the public.

Allocate Appropriate Resources and Funds for Asset Replacements or System Expansions

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

Agencies and municipalities in the region should utilize an asset management system to track the condition of ITS system components in order to plan for replacements. Each agency should also include requests for funding to replace and upgrade components that are failing or are near the end of the expected life cycle.

Continue to Assess Stakeholders Needs and Resource Availability

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

Assessing stakeholder needs and availability of resources should be one of the functions of the regional ITS task force/working group. This will provide an opportunities for all agencies and municipalities in the region to proactively discuss needs and new project opportunities to fill those needs.

Develop Program Management Process for System Utilization After Maintenance and Replacement

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

Each agency and municipality in the region should utilize the asset management process to continuously track the condition and remaining useful life of all system components. The monitoring process will enable agencies and municipalities to make more informed decisions on how to allocate funding for maintenance and replacement and support sustainability of the overall system.

Identify and Maximize Potential of Key ITS Assets

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

Important considerations for identifying and maximizing potential of ITS assets include the following:

› Asset Management. An important practice in maximizing potential of key ITS assets is the effective use of asset management. Every transportation agency and local municipality in the Triangle region that owns, operates, and maintains ITS components of the transportation system should develop an asset management plan. An asset management plan should include all information relevant to the state of the assets including location, condition, and remaining useful life of assets.

› Maintenance. Regular maintenance of an ITS asset is important to ensure efficient performance and extended service life of the assets. All agencies and local municipalities in the Triangle region that own, operate, and maintain ITS components of the transportation system should proactively include funding for maintenance in annual budgets.

› Educate and Retain Staff. The lack of staff experienced in operating and maintaining ITS technologies can negatively impact the ability to achieve the full benefit of ITS assets. It is important that agencies and municipalities operating ITS assets continuously educate

staff and take steps to retain the key experienced staff that operate and maintain the ITS assets.

› Outsourcing. Agencies and municipalities can consider outsourcing to fill staffing needs. Some of the benefits to outsourcing include:
  - The contracted private company would bear the responsibility to hire and train staff to meet qualifications specified by the agency or municipality.
  - Potential for easier funding requests for contracted staff instead of in-house staff.
  - Reduced need for full-time in-house staff.
  - Continued support during agency and municipality hiring freezes.

The following are useful resources:

› FHWA Handbook for Developing a TMC Operations Manual (https://tmcpfs.ops.fhwa.dot.gov/cfprojects/uploaded_files/Handbook_TMC_Ops_Manual1.pdf)

› FHWA Assessment of Insourcing/Outsourcing Practices for Traffic Monitoring Data Collection (https://www.fhwa.dot.gov/policyinformation/travel_monitoring/pubs/pl16024/pl16024_report.pdf)

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

Asset management will provide the information critical to agencies and municipalities to proactively replace ITS infrastructure. Every transportation agency and local municipality in the Triangle region that owns, operates, and maintains ITS components of the transportation system should develop an asset management plan. An asset management plan should include all information relevant to the state of the assets including location, condition, and remaining useful life of assets. The asset management system will provide the necessary information on the status of the infrastructure to operators and decision-makers to enable them to request funding for replacing deficient equipment.

Partner Up to Pursue Funding Opportunities

This action item supports the following Objective:

› Improve, Monitor And Manage Assets

› Support Economic Vitality

Agencies and municipalities should assess opportunities to form partnerships to obtain funding for projects that impact multiple agencies and municipalities. Examples of projects that might benefit from this type of partnership include installation of compatible equipment across the region for EVP and TSP/BRT operations, projects that enhance system continuity across jurisdictional boundaries, and projects to enhance seamless communications between transit agencies, emergency services, and local and regional transportation management centers.

The scope of the project will dictate the appropriate project development approach and the necessity to include state agencies (i.e. NCDOT) or federal agencies (i.e. FHWA). If the project is to be a locally administered project, then the partnering agencies should identify a lead agency for the purposes of requesting funding and then administering the project.

Perform Benefit Cost Analysis

This action item supports the following Objectives:

› Support Economic Vitality

Many tools are available that could be implemented by the agencies and municipalities in the region to perform benefit cost analysis for proposed ITS projects. Two examples are described below.

› FHWA prepared the "Tool for Operations Benefit Cost Analysis" as a sketch-planning level decision support tool as guidance for benefit cost analysis (BCA) for a wide range of TSMO strategies. The tool and accompanying manual are available on the FHWA website for Organizing and Planning for Operations (https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm). The tool is a Microsoft Excel-based tool that contains default parameters but local data can be used where available so supplement the analyses.

› The Florida Department of Transportation (FDOT) developed the "Florida Intelligent Transportation Systems Analysis Tool (FITSEVAL)" to allow evaluation of ITS deployments. The tool produces various performance measures including mobility, safety, energy, and emissions. The outputs include the benefits, costs, and benefit/cost ratio. The tool can be downloaded from the FDOT website (http://www.fsutmsonline.net/index.php?/model_pages/comments/fitseval/).

Both tools should be considered for performing benefit cost analyses in the Triangle Region. The regional task force/working group can review the default parameters in the tools and identify local data to supplement the tool.

These are useful resources:

› FHWA, Organizing and Planning for Operations, Tool for Operations Benefit Cost Analysis (TOPS-BC) (https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm)

› USDOT Intelligent Transportation Systems Joint Program Office (https://www.itskrs.its.dot.gov/its/itsbcllwebpage.nsf/KRHomePage)

› FHWA "Operations Benefit/Cost Analysis Desk Reference" (https://ops.fhwa.dot.gov/publications/fhwahop12028/fhwahop12028.pdf)

Evaluate Best Practices and Lessons Learned

This action item supports the following Objectives:

› Support Economic Vitality

The regional task force/working group should work with agencies and municipalities in the region to develop best practices for strategies that have been implemented and document lessons learned. The exercise will be useful for all agencies and municipalities to learn what is or is not achieving the desired outcome. The focus should be across all system objectives.

These are useful sources as example best practices documents:

› FHWA, "Work Zone Best Practices Guidebook" (https://ops.fhwa.dot.gov/wz/practices/best/bestpractices.htm)
› FHWA, "Best Practices in Traffic Incident Management", (https://ops.fhwa.dot.gov/publications/fhwahop10050/index.htm)
› US Department of Transportation, "NHTSA Cyber Security Best Practices Study" (https://www.pcb.its.dot.gov/t3/s111207/s111207_weisenberger_presentation.pdf)

Identify Alternative Funding Sources and Project Criteria

This action item supports the following Objectives:

› Support Economic Vitality

Available funding sources include:

› Advanced Transportation And Congestion Management Technologies Deployment (https://www.fhwa.dot.gov/fastact/factsheets/advtranscongmgmtfs.cfm)
    - Eligible project types include:
        - advanced traveler information systems;
        - advanced transportation management technologies;
        - infrastructure maintenance, monitoring, and condition assessment;
        - advanced public transportation systems;
        - transportation system performance data collection, analysis, and dissemination systems;
        - advanced safety systems, including vehicle-to-vehicle and vehicle-to-infrastructure communications;
        - technologies associated with autonomous vehicles, and other collision avoidance technologies, including systems using cellular technology;
        - integration of intelligent transportation systems with the Smart Grid and other energy distribution and charging systems;
        - electronic pricing and payment systems; or

    - advanced mobility and access technologies, such as dynamic ridesharing and information systems to support human services for elderly and disabled individuals
- Eligible Applicants include:
    - State or local government or political subdivision thereof,
    - Transit agency,
    - Metropolitan planning organization (MPO) representing a population of more than 200,000,
    - Multijurisdictional group made up of the above eligible applicants, with a signed agreement to implement the initiative across jurisdictional boundaries, and
    - Consortium of research or academic institutions.

The following are useful resources:

› Better Utilizing Investments to Leverage Development (BUILD) Grants (https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/391/fy-2019-build-nofo-fr.pdf)

› Federal Transit Administration offers a variety of grant programs. Some are competitive and others are formula-based (https://www.transit.dot.gov/grants)

Quantify ITS Benefits

This action item supports the following Objectives:

› Support Economic Vitality

The following are key considerations to enable quantifying benefits of deployed ITS systems.

› During planning phases, utilize available tools to determine benefit/cost ratios for ITS strategies and systems.

› Prior to implementation of an ITS strategy or system, gather data for those performance measures intended to be affected by the ITS strategy or system. Data to be gathered include the number of crashes by type, severity, and mode; time to detect, respond to, and clear incidents; transit schedule adherence, and travel time. Gather data after implementation of the ITS strategy or system in order to quantify the impact of the implementation.

The following are useful resources:

› FHWA Tool for Operations Benefit Cost Analysis (https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm)

› Florida ITS Evaluation Tool (http://www.fsutmsonline.net/index.php?/model_pages/comments/fitseval/)

› California Life-Cycle Benefit/Cost Analysis Model (http://bca.transportationeconomics.org/models/cal-b-c)

› FHWA Benefits-Costs Database (https://www.benefitcost.its.dot.gov/its/itsbcllwebpage.nsf/KRHomePage)

Achieve the Highest Return on Investment

This action item supports the following Objectives:

› Support Economic Vitality

› Some recommended actions to achieve the highest on investment (ROI) include:

› Utilize available planning tools to determine benefit/cost ratio for ITS strategies under consideration

› After construction of the ITS system, perform regular maintenance of the system components to extend the useful life of the system.

› Ensure that qualified staff are operating and maintaining the system either through internal staff development or through outsourcing some services.

› Maintain asset management practices to continuously track the age and condition of the system components.

The following are useful resources:

› FHWA Tool for Operations Benefit Cost Analysis (https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm)

› Florida ITS Evaluation Tool (http://www.fsutmsonline.net/index.php?/model_pages/comments/fitseval/)

› California Life-Cycle Benefit/Cost Analysis Model (http://bca.transportationeconomics.org/models/cal-b-c)

› FHWA Benefits-Costs Database (https://www.benefitcost.its.dot.gov/its/itsbcllwebpage.nsf/KRHomePage)