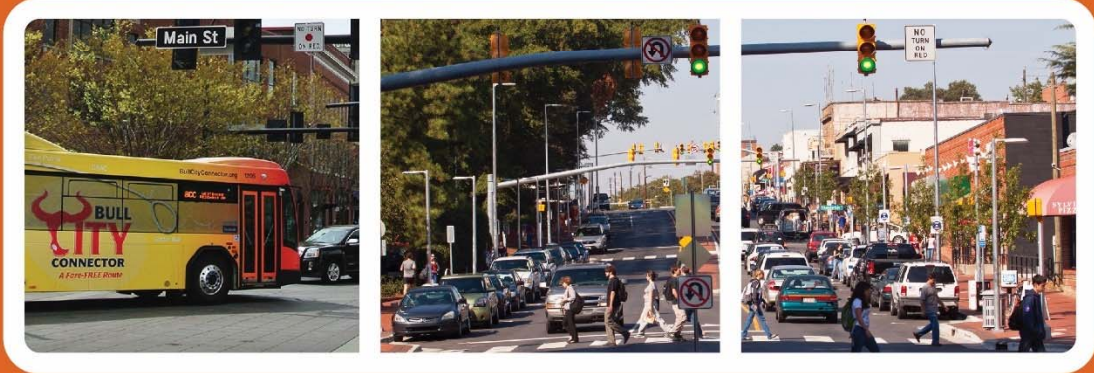


Mobility and Safety Transportation Systems Management and Operations Strategic Plan



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Introduction

Strategic planning is not always a focus for an agency, but is imperative in assessing the current direction of an organization and the trajectory of the overall mission and goals. This Strategic Plan is focused on merging previous efforts performed by individual units and the Department into a consolidated roadmap for the next 5–10 years. As part of that assessment, the plan builds upon the Mission Statement, Vision, and Values defined by the current executive leadership of the Department, shown in **Figure 1**.

The plan builds on previously completed efforts, which include the Capability Maturity Model (CMM) assessment completed in 2011 and the Traffic Systems Operations Unit (TSOU) Strategic Plan completed in 2012. In 2011, representatives from NCDOT and some partners participated in a CMM workshop sponsored and facilitated by the FHWA. In this workshop, NCDOT participants evaluated current levels of maturity regarding key processes, organization, staff, and collaboration. Results from that assessment are shown in **Figure 2**. The TSOU completed a strategic plan in 2012 that focused on moving toward a performance-based organization.

Both efforts seamlessly support the next iteration of the strategic plan to focus on Transportation Systems Management and Operations (TSMO). This plan development involved a larger group of stakeholders and allowed the core team to perform a new CMM assessment, develop a TSMO Mission Statement, and derive a consolidated list of activities that comprise the TSMO Strategic Plan.

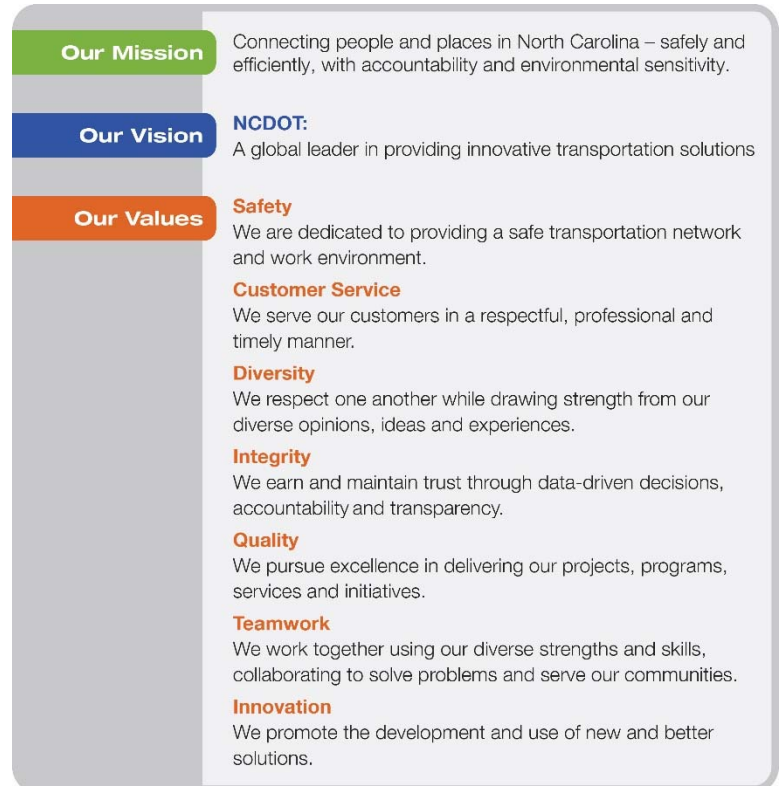


Figure 1. NCDOT Mission, Vision, and Values

Dimension	Level 1	Level 2	Level 3	Level 4
Business Processes <i>(Planning, programming, budgeting, implementation)</i>	✓ Processes related to SO&M activities ad hoc and un-integrated	Multiyear statewide SO&M plan and program exists with deficiencies, evaluation, and strategies	Programming, Budgeting, and project development processes for SO&M standardized and documented	Processes streamlined and subject to continuous improvement
Systems and Technology <i>(Systems engineering, standards, and technology interoperability)</i>	Ad hoc approaches outside systematic systems engineering	✓ Systems engineering employed and consistently used for ConOps, architecture and systems development	Systems and technology standardized, documented and trained statewide, and new technology incorporated	Systems and technology routinely upgraded and utilized to improve efficiency performance
Performance Measurement <i>(Measures, data & analytics, and utilization)</i>	No regular performance measurement related to SO&M	✓ SO&M strategies measurement largely via outputs, with limited after-action analyses	Outcome measures identified and consistently used for SO&M strategies improvement	Mission-related outputs/ outcomes data routinely utilized for management, reported internally and externally, and archived
Culture <i>(Technical understanding, leadership, outreach, and program authority)</i>	✓ Value of SO&M not widely understood beyond champions	Agency-wide appreciation of the value and role of SO&M	SO&M accepted as a formal core program	Explicit agency commitment to SO&M as key strategy to achieve full range of motility, safety and livability/ sustainability objectives

Figure 2. Snapshot of 2011 CMM Assessment

The document will focus on:

- A brief education on **Transportation Systems Management and Operations (TSMO)** terminology and links to additional resources.
- The process followed for the **Development of the TSMO Strategic Plan**.
- **CMM Assessment** including a summary of completed, planned, and future activities.
- A consolidated summary of **Smart Activities** including estimated impact and resource requirements.

Purpose of Document

Over the past decade, transportation agencies have increasingly integrated TSMO into practice at state and regional levels. Previous approaches to improve congestion and capacity on roadways were solely dedicated to high-cost infrastructure projects that may have offered only modest improvements to mobility and safety, while not entirely addressing the primary causes of congestion. As state DOTs increasingly focus on user and roadway performance, agencies must consider how best to approach operational and capacity expansion through a more cost-



effective and near-term approach. The purpose of this TSMO Strategic Plan is to provide the first step in guiding NCDOT on TSMO-focused strategies and activities that will expand or enhance programmatic and agency integrations.

TSMO Mission Statement

Building on the Department's Mission and Vision, the following TSMO-focused Mission Statement was developed.

Connecting people and places in North Carolina safely and efficiently, using Transportation System Management and Operations strategies (TSMO) to support NCDOT's overall mission through innovative processes and approaches, collaboration, and coordination among modes and systems on the transportation network.



What is Transportation Systems Management and Operations (TSMO)?

Traditional improvements to transportation infrastructure regarding mobility, reliability, safety, and accessibility are achieved through long-range planning and capital intensive investments. TSMO approaches these improvements with focused strategies that refocus large capital costs on investments that can optimize existing infrastructure through short-term multimodal solutions. These solutions allow the active management of transportation systems based on current operational and organizational conditions. These conditions include both real-time impacts on traffic behavior, such as crashes or severe weather, and existing physical conditions that may restrict the mobility or safety of the infrastructure. TSMO focuses on all aspects of agency and system operations and management, with an emphasis on agency collaboration, agency readiness, and a cultural shift away from some legacy approaches.

Additional information regarding TSMO can be found at the following links:

- **FHWA Planning for Operations**
https://ops.fhwa.dot.gov/plan4ops/focus_areas/integrating/transportation_sys.htm
- **Creating an Effective Program to Advance TSMO – Primer**
<https://ops.fhwa.dot.gov/publications/fhwahop12003/index.htm>
- **Business Process Frameworks for Transportation Operations**
<https://ops.fhwa.dot.gov/tsmoframeworktool/index.htm>

TSMO Deployments

TSMO deployments often focus on intelligent transportation systems (ITS), controlled communication, and other infrastructure applications that quickly and efficiently identify real-time roadway conditions. Monitoring transportation systems and integrating technology can help identify crashes, lane obstructions, congestion, and other scenarios that can impact traffic flow. Providing real-time traveler information to commuters and roadway users through dynamic message signs (DMS) may alert upstream drivers regarding an incident or redirect drivers to alternate routes. The integration of strategies typically is essential to addressing more complex causes of congestion and unreliability. For example, traffic incident management (TIM) programs help clear incidents more safely and efficiently, and the integration of traveler information with traffic management systems could improve fuel economy and reduce time lost.



Promoting Agency Collaboration

Promoting TSMO culture among partners, stakeholders, and agencies is critical to the program’s success. Embedding TSMO as a key priority within an agency typically requires the integration into other agency functions, plans, and programs to support optimized system performance. These functions may be investment and funding decisions, project designs and development, maintenance of infrastructure and assets, or long-range transportation documents. Regardless of whether a TSMO program is developed by a single agency, multiple agencies, or across a region, the TSMO program should be supported and communicated transparently to internal and external agencies so that the incorporation of TSMO activities is completed efficiently.

Comparing Legacy Outputs to TSMO Outcomes

Transportation agencies have an established practice, or legacy, of developing programs that are focused on the construction of high capacity roads and ongoing infrastructure maintenance. To support the adoption of TSMO within an organization, this legacy culture must be adjusted. provides comparisons between the capabilities of legacy-focused outputs and TSMO-focused outcomes. The primary difference between past or legacy agencies and a TSMO-focused organization is the shift to measuring outcomes as opposed to output. Outcomes allow an agency to assess if the predetermined needs were addressed through the applied solution.

Table 1. Comparing Legacy

FEATURE	LEGACY ORGANIZATION (output focused)	TSMO (outcome focused)
Mission Alignment	Conventional CE culture and missions	Nontraditional solutions
Performance	On time, under budget, meet standards	Customer service focus – reliability, delay
Focus	Project schedule in months, years	Real-time response (24 X 7)
Core Competencies	Defined via traditional, civil engineering training	New technology, data path analysis, process improvement
Unit Organization	By stages in project development	Nontraditional solutions (planning, design, construction)
Partnerships	Contracted, controlled by DOT	Collaboration, heavy dependence on internal and external partners



Assessing Agency TSMO Capabilities

The Capability Maturity Model (CMM) Assessment is designed for agencies to self-evaluate regarding key processes and capabilities related to their effectiveness. The six dimensions include:

- **Business Processes** including formal scoping, planning, programming, and budgeting
- **Systems and Technology** including use of systems, engineering of systems, and architecture standards
- **Performance Measurement** including measures definition, data acquisition, and utilization
- **Culture** including technical understanding, leadership, outreach, and legal authority
- **Organization and Staffing** including programmatic status, organizational structure, staff development, recruitment, and retention
- **Collaboration** including relationships with public safety agencies, local governments, MPOs, and the public sector

Each of the six dimensions include four distinct levels of capability that may reveal current strengths and weaknesses of an agency, and further provide a starting place for capability action. Each level emphasizes establishing a program with documented practices in each dimension. These levels range from performing ad hoc or fragmented activities (Level 1) to more optimized and institutionalized programs (Level 4). As an agency progresses through each level, its mission, process, management, and approaches become more efficient. In addition, each level of criteria must be achieved and is required for an agency to move up to the next levels of capability. **Table 2** presents the CMM framework that combines the six core dimensions and four capability levels into a single framework.

The levels are shown below:

- **Level 1** Performed – Activities and relationships largely ad hoc, fragmented, informal, and champion-driven
- **Level 2** Managed – Basic strategy applications in place with key technology and needed staff capacities under development—but limited accountability and lacking internal and external collaborative partners
- **Level 3** Integrated – Standardized strategy applications implemented in priority contexts and managed for performance; the TSMO technical and more diverse processes are developed, documented, and integrated into multiple agencies.
- **Level 4** Optimizing – TSMO is a full, sustainable, regionwide program, established based on continuous collaboration and improvement with all partnerships.

Table 2. Capability Maturity Model (CMM)

		CAPABILITY LEVEL CRITERIA			
DIMENSIONS	LEVEL 1 PERFORMED	LEVEL 2 MANAGED	LEVEL 3 INTEGRATED	LEVEL 4 OPTIMIZING	
Business Processes (Planning and Programming)	Each jurisdiction doing its own thing according to individual priorities and capabilities	Consensus regional approach developed regarding TSMO goals, deficiencies, B/C, networks, strategies and common priorities	Regional program integrated into jurisdictions' overall multimodal transportation plans with related staged program	TSMO integrated into jurisdictions' multi-sectoral plans and programs, based on formal continuing planning processes	
Systems and Technology	Ad hoc approaches to system implementation without consideration of systems engineering and appropriate procurement processes	Regional ConOps and architectures developed and documented with costs included; appropriate procurement process employed	Systems and technology standardized and integrated on a regional basis (including arterial focus) with other related processes and training as appropriate	Architectures and technology routinely upgraded to improve performance; systems integration interoperability maintained on continuing basis	
Performance Measurement	Some outputs measured and reported by some jurisdictions	Output data used directly for after-action debriefings and improvements; data easily available and dashboarded	Outcome measures identified (networks, modes, impacts) and routinely utilized for objective-based program improvements	Performance measures reported internally for utilization and externally for accountability and program justification	
Culture	Individual staff member champions promote TSMO, varying among jurisdictions	Jurisdictions' senior management understands TSMO business case and educates decision makers/public	Jurisdictions mission identifies TSMO and benefits with formal program and achieves wide public visibility/understanding	Customer mobility service commitment accountability accepted as formal, top level core program of all jurisdictions	
Organization / Staffing	TSMO added on to units within existing structure and staffing – dependent on technical champions	TSMO-specific organizational concept developed within among jurisdictions with core capacity needs identified, collaboration takes place	TSMO Managers have direct report to top management; Job specs, certification and training for core positions	TSMO senior managers at equivalent level with other jurisdiction services and staff professionalized	
Collaboration	Relationships as hoc and personal (public-public, public-private)	Objectives, strategies, and performance measures aligned among major players (transportation and public safety agencies (PSAs) with after-action debriefing	Rationalization/sharing/ formalization of responsibilities among key players through co-training, formal agreements, and incentives	High level of TSMO coordination among owners/operators (State, local, private)	



TSMO Strategic Plan Development Process

The Mobility and Safety Division took a consolidated workshop approach to information gathering for the TSMO Strategic Plan. Stakeholders were invited to specific breakout sessions over the course of the two-day workshop.

Subject matter experts (SMEs) were identified in each of the seven functional areas and educated on TSMO and CMM principles. This approach allowed the stakeholders to focus on their daily responsibilities and provide technical input and personal experiences related to the respective function. The information captured during the breakout sessions served as the first stage of information gathering that would feed the TSMO Strategic Plan. **Figure 3** highlights the initial workshop and the additional steps used to develop the plan.



Figure 3. TSMO Strategic Plan Development Process

The stakeholders represented various areas within NCDOT and partner agencies. They were invited to specific breakout sessions based on their collaboration within or with the Mobility and Safety Division. The breakout sessions focused on the following functional areas:

- Freeway Management (TIM/Tactical)
- Freeway Management (Operations/Strategic)
- Arterial Management
- Traveler Information
- Asset Management
- Data Performance
- Return on Investment

A complete list of the stakeholders who attended the workshop breakouts is provided in **Appendix A**. **Appendix B** includes the agenda from the workshop. Each breakout included a SME to actively engage in the sessions and to bridge the knowledge of other breakout sessions along with the CMM and TSMO framework. Since some stakeholders were unfamiliar with CMM and TSMO terminology, facilitation of the breakout focused on each stakeholder's responsibilities and was centered around four key categories:

- Successes,
- Challenges,
- Opportunities, and
- Risks.

Seven Functional Areas

Brief descriptions, or white papers (as shown in **Figure 4**), of each functional area were developed and provided to stakeholders in advance of the workshop. The white papers provided a framework of what the session would be discussing. Each white paper included initiatives currently occurring within NCDOT. Following the workshop, the white papers were revised to include additional feedback discussed during each of the breakout sessions. A brief description of each functional area is presented below, and the white papers can be found in **Appendix C**.

- **Freeway Management – TIM/Tactical** – *inter- and intraagency coordination for response and clearance of an incident. Aligns with the ‘boots-on-the-ground’ for incident management.*
- **Freeway Management – Ops/Strategic** – *strategies for improving freeway capacity during an event. Higher level concepts such as integrated corridor management (ICM) and active traffic management (ATM).*
- **Arterial Management** – *concentrated on operations along the arterial network. This includes real-time data collection on arterial performance, signal operations, and strategies for mobility and safety improvements.*
- **Traveler Info/Partner Agencies** – *a range of technology solutions for collecting, sharing, and disseminating information so travelers can make informed decisions.*
- **Asset Management** – *managing the infrastructure within the DOT network. This includes knowing what is installed, the condition of what is installed, the history or maintenance activities for each component, and the ability to forecast resources needs to maintain a set level or performance of the equipment installed.*

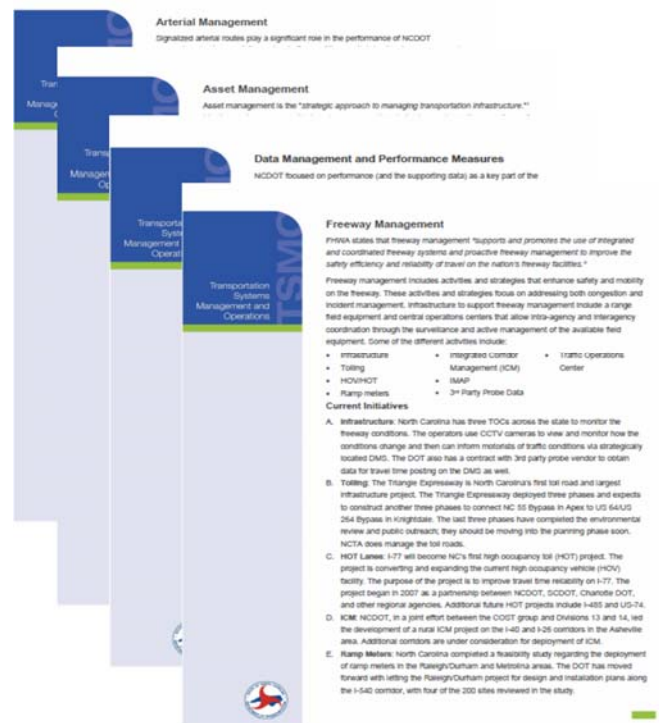


Figure 4. Snapshot of the White Papers

- **Data and Performance Measures** – knowing and understanding the types of available data and the ways to integrate the data into the decision-making process.
- **Return on Investment** – identifying and using data to calculate the benefit/cost of a potential project and the resulting built project. This calculation then can support the effective application of resources and funding.

Capability Maturity Assessment

The information gathered from the stakeholders was used to determine the current maturity levels within the seven breakout functional areas. **Figure 5** summarizes the scores for each functional area based on these stakeholder discussions. It is important to note that lower scores within the CMM should not be taken as a negative against the success of an agency. Instead, the assessment should be used to help identify where an agency should focus resources based on the current vision and goals.

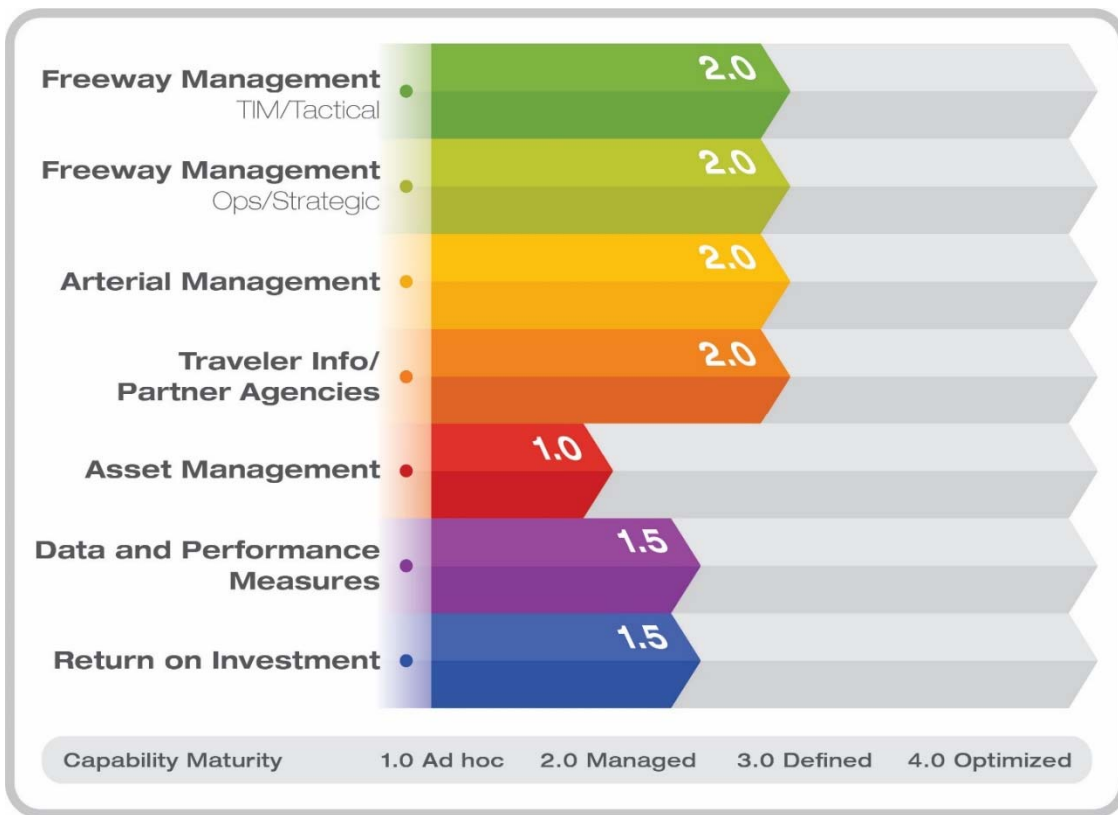


Figure 5. Capability Maturity by Functional Area

Similarly, the maturity level of the six CMM dimensions was assessed based on the feedback provided. presents the current maturity for each of the six dimensions.

CAPABILITY LEVEL CRITERIA				
DIMENSIONS	LEVEL 1 PERFORMED	LEVEL 2 MANAGED	LEVEL 3 INTEGRATED	LEVEL 4 OPTIMIZING
Business Processes (Planning and Programming)	Each jurisdiction doing its own thing according to individual priorities and capabilities	Consensus regional approach developed regarding TSMO goals, deficiencies, B/C, networks, strategies and common priorities	Regional program integrated into jurisdictions' overall multimodal transportation plans with related staged program	TSMO integrated into jurisdictions' multi-sectoral plans and programs, based on formal continuing planning processes
Systems and Technology	Ad hoc approaches to system implementation without consideration of systems engineering and appropriate procurement processes	Regional ConOps and architectures developed and documented with costs included; appropriate procurement process employed	Systems and technology standardized and integrated on a regional basis (including arterial focus) with other related processes and training as appropriate	Architectures and technology routinely upgraded to improve performance; systems integration interoperability maintained on continuing basis
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Collaboration	Relationships as hoc and personal (public-public, public-private)	Objectives, strategies, and performance measures aligned among major players (transportation and public safety agencies (PSAs) with after-action debriefing	Rationalization/sharing/ formalization of responsibilities among key players through co-training, formal agreements, and incentives	High level of TSMO coordination among owners/operators (State, local, private)

Figure 6. Capability Maturity by Dimension

Conversations revealed that the Department may not be accomplishing everything described within a higher maturity level; however, the SMEs agreed that certain dimensions should be recognized at that level. Some of those successes, either completed or in progress, are presented in **Table 3**. In addition, future activities also are shown relative to each dimension. Additionally, our activities are noted due to special funding provided by the *FHWA CMM Workshop Implementation Funding* based on the CMM Workshop results from 2013.



Notable successes highlighted within the table include the Spot Mobility Program, interest in establishing an ongoing TravInfo Forum, sharing how to access and apply iPEMS data, strong relationships developed through IMAP, and a support from SHP.

Table 3. Status Summary of TSMO Activities

CMM DIMENSIONS	COMPLETED	IN PROGRESS	FUTURE ACTIVITY
Business Processes	<ul style="list-style-type: none"> Signal System Timing Philosophy Manual* Spot Mobility Program Tracking recommendations from Signal System Timing Project analyses to support mobility projects I-40 Fortify 	<ul style="list-style-type: none"> Development of ROI summaries for Signal System Timing implementations 	<ul style="list-style-type: none"> Holistic assessment and programming of costs Formalizing corridor management strategies Integrate TSMO solutions and operational costs into typical project programming Phased project implementations that build on mobility solutions
Systems and Technology	<ul style="list-style-type: none"> Bluetooth Data Pilot Project* Freeway ATMS Software RFI Pilot ICM on I-40 ATMS RFI and Demonstrations Communications inventory in Triad Formal Initiation of I-85 ICM* Deployment of IMAP on I-95 Statewide signal system ATMS 	<ul style="list-style-type: none"> HRDC Pilot Corridors HOT lanes on I-77 ICM Corridor on I-85 ATMS Infrastructure Upgrade Ramp Meters in Triangle SPaT Challenge Adaptive Corridor Pilot Project Waze agreement 	<ul style="list-style-type: none"> Ramp Meters in Metrolina Department-wide Definition for Asset Management Freeway ATMS Software Upgrade
Performance Measurement	<ul style="list-style-type: none"> Statewide Performance Measures Workshop Incident data in TIMS IMAP Data 	<ul style="list-style-type: none"> iPEMS Data application (Safety, bottleneck reports) Development of online tool using probe data for prioritization of signal timing corridors Before and After analysis of ramp meter 	<ul style="list-style-type: none"> Use of performance data to make decisions Before and After analysis of ICM
Organization and Workforce	<ul style="list-style-type: none"> New Operations Staffing Contract – consolidated for TMC/NCTA staffing Statewide training and certification program for operations and IMAP 2016 Operations Academy Attendance* Office of Strategic Initiatives and Program Support 	<ul style="list-style-type: none"> ITS roles consolidated into single unit Integration and collaboration between NCTA and TSOU Statewide training and certification program for TIM SHRP2 Responder Training 	<ul style="list-style-type: none"> Continuous training and workforce development
Culture	<ul style="list-style-type: none"> ITS Carolinas Local Chapter 	<ul style="list-style-type: none"> 2017 TSMO / Strategic Plan TIM Strategic Plan 	<ul style="list-style-type: none"> Develop Statewide ICM Strategy Develop corridor system management strategy Develop alternate route strategic plan
Collaboration	<ul style="list-style-type: none"> ITS Forum Established 2017 Operations Academy – NCDOT and NCSHP attendance Retired SHP Major in place as Statewide TIM specialist Partnership with other state agencies for staffing 511 calls 	<ul style="list-style-type: none"> 2017 CMM / TSMO Workshop Application of drones for accident reconstruction Towing contract for I-40 Business 	<ul style="list-style-type: none"> Education on benefits of ROI for TSMO Strategies Multi-agency collaboration for TIM and TravInfo Education to project sponsors SHP driving course renovations for interagency training

*FHWA CMM Workshop Implementation Funding



Mobility and Safety Transportation Systems Management and Operations Smart Activities



SMART Activities

Based on input from the stakeholders and guidance from the SMEs, a draft listing of Smart Activities was derived. To help package and clarify these activities, three focus areas and a subset of strategies were identified. Those focus areas and strategies are listed below.

1. Culture

- Manage the whole transportation network
- Prioritization based on ROI
- Holistic assessment and programming of costs (include operational costs)
- Use of performance data to make decisions
- Establish asset management definition

2. Partnerships and Education










- Multi-agency collaboration for TIM and TravInfo
- Formalizing corridor management strategies
- Continuous training and workforce development

3. Balance with Delivery


- Integrate TSMO solutions and operational costs into typical project programming
- Phased project implementations that build on mobility solutions
- Educate project sponsors

The Smart Activities are presented on the following pages and are categorized by strategy. Along with each activity, an impact score and three resource requirements are provided. These high-level assessments are intended to help in effectively applying resources to the activities that are identified as having the largest impact. The resource requirements reflect staff, duration, and the cost of each activity—providing the agency with tangible requirements to achieve an intended outcome or impact.




Staff	Duration	Cost
 <i>not person intensive</i>	 <i>6 months – 1 year</i>	 <i>Low-Cost</i>
 <i>somewhat person intensive</i>	 <i>1 year – 3 years</i>	 <i>Medium-Cost</i>
 <i>person intensive</i>	 <i>3 years – 5 years</i>	 <i>High-Cost</i>

Impact




1.0 IMPACT 2.0

Small Impact



3.0 IMPACT 4.0

Medium Impact



5.0 IMPACT

Large Impact

1. Culture		Impact	Cost	Staff	Duration
1.1	Manage the whole transportation network				
1.1.1	Define statewide corridor management approach (reference 2.2.2)				
1.1.2	Define statewide alternate route approach				
1.1.3	Define statewide ICM approach (reference 2.2.1)				
1.2	Holistic assessment and programming of costs				
1.2.1	Develop strategy for calculating capital, operational, and lifecycle costs for TSMO strategies				
1.2.2	Prepare guidelines for applying holistic costs to TSMO strategies				
1.2.3	Integrate lifecycle costs into maintenance budgets (asset replacement planning)				
1.2.4	Develop integrated asset management program and tool (reference 1.5.1)				



1. Culture		Impact	Cost	Staff	Duration
1.3	Education on benefits of ROI for TSMO strategies				
1.3.1	Develop guidance tools for the analysis of benefit-cost for TSMO strategies				
1.3.2	Establish guidelines for applying a benefit-cost analysis (initial and after implementation analysis)				
1.4	Use of performance data to make decisions				
1.4.1	Define a TSMO performance management strategy that promotes data-driven decisions				
1.4.2	Identify current data and how it can be used to support decisions				
1.4.3	Determine sources to close data gaps in support of a TSMO performance management strategy				
1.5	Asset management definition				
1.5.1	Develop asset management philosophy (reference 1.2.4)				
1.5.2	Use asset management data to support costs data for TSMO projects				



2. Partnerships and Educations		Impact	Cost	Staff	Duration
2.1	Multi-agency collaboration for TIM and TravInfo				
2.1.1	Establish a joint operations policy statement with the state highway patrol (SHP)				
2.1.2	Establish statewide TIM objectives, performance goals (multi-agency joint reporting requirements)				
2.1.3	Formalize coalitions through TIM agreements at the regional level				
2.1.4	Establish a recommended format for multi-agency TIM coalition meetings				
2.1.5	Identify links between traveler information and TSMO strategies (statewide and corridor level)				
2.1.6	Establish a method to promote the awareness of TravInfo updates (new capabilities and functions)				
2.1.7	Develop a strategy to engage additional partners (media, local agencies)				



2. Partnerships and Educations		Impact	Cost	Staff	Duration
2.2	Formalizing corridor management strategies				
2.2.1	Educate TIM groups on ICM strategies (detour plans, notification processes, collaborative TIM)				
2.2.2	Establish focused TIM subgroups for specific corridor management strategies (WZ, events, incidents)				
2.2.3	Provide outreach and engagement to local agencies on TSMO strategies				
2.3	Continuous training and workforce development				
2.3.1	Analyze training and skill set needs to support TSMO strategies				
2.3.2	Identify key training needs and gaps (i.e., CV/AV, ICM, arterial operations, TIM)				
2.3.3	Integrate TSMO skill sets and expectations into specific position descriptions				
2.3.4	Provide training focused on interagency team development and support (reference 2.1.4)				



2. Partnerships and Educations		Impact	Cost	Staff	Duration
2.3.5	Provide training program for IM level engineer	4.0 IMPACT	\$\$		
2.3.6	Promote TIM as a conduit to establish more collaborative partnerships	3.0 IMPACT	\$		
2.3.7	Identify and promote training that can be delivered to multiple agencies and TIM partners	1.0 IMPACT	\$\$		
2.3.8	Work with FHWA to host a NC-specific regional operations forum (opportunity for federal funding/partial funding)	2.0 IMPACT	\$\$		

3. Balance with Delivery		Impact	Cost	Staff	Duration
3.1	Integrate TSMO solutions and operational costs into typical project programming				
3.1.1	Develop methodology for measuring benefits of TSMO strategies (reference 1.3.1)	5.0 IMPACT	\$\$		
3.1.2	Apply benefit-cost to TSMO strategies (reference 1.3.2)	4.0 IMPACT	\$\$		
3.1.3	Update project development and scoring process to account for anticipated benefits	5.0 IMPACT	\$\$		



3. Balance with Delivery		Impact	Cost	Staff	Duration
3.2	Phased project implementations that build on mobility solutions				
3.2.1	Establish TSMO strategies that can be implemented as stepping stones toward a final solution				
3.2.2	Identify large multi-year projects that can benefit from phased implementations				
3.3	Education to project sponsors				
3.3.1	Formalize partner roles to support data collection/analytics				
3.3.2	Develop tools to support the outreach and education of project sponsors				
3.3.3	Outreach and educate project sponsors (Divisions, RPOs, MPOs, local agencies) on project delivery options (phasing, TSMO strategies)				
3.3.4	Expand outreach and education to other funding mechanisms beyond STI process				



Appendix A: Stakeholders



Introduction Session

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Freeway Management – Tactical Focus / TIM

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Appendix B: Workshop Agenda



Agenda (Day 1) – NCDOT Greenfield Parkway

Wednesday, May 17th			
Time	Session	Lead	Objective
9:00-10:00			
9:00-9:15	Welcome and Charge for the Workshop	Lacy	Set the stage for the workshop. Provide the motivation for the TSMO Plan Development. Emphasize the NCDOT shift to place more emphasis on TSMO and how this aligns with the Secretary's Focus Areas for 2017. What are some important factors that will influence TSMO at NCDOT.
9:15-9:30	Other project champions or supporters	Trogdon / Holder	
9:30-10:00	What is TSMO?	McDiarmid / Burgess	Overview of some of NCDOT's current TSMO related initiatives and relating these to specific dimensions. (Prior CMM, performance measures, TIM, etc.) Overview of some of NCDOT's related initiatives – prior to CMM, Identify why this is a challenging shift for agencies to make. What we want the TSMO plan to do.
10:00-10:15	Break		
10:15-12:00			
10:15-11:30	SME Panel – Current TSMO Focus Areas for NCDOT	SMEs / Dale	Discuss current state of TSMO and key focus areas for NCDOT. Expect each SME to discuss their topic area for ~5 mins. Identify successes and challenges. Opportunity for Q&A for the panel. This session will give the group an update across the different focus areas, and set the stage for the breakout discussions.
11:30-12:00	Introduction to Breakouts	Good	Logistics for breakout sessions, general format and objectives for breakout sessions. Discuss specific items that need to come out of the break-out topics.
12:00-1:00	Lunch		
1:00-4:00	Wednesday PM Group Sessions		
	Freeway Management		
	Return on Investment (ROI)		

Agenda (Day 2) – NCDOT Greenfield Parkway

Thursday, May 18th			
Time	Session	Lead	Objective
9:00-12:00	Thursday AM Group Sessions		
	Arterial Management		
	Traveler Information and Partner Agencies		
12:00-1:00	Lunch		
1:00-4:00	Thursday PM Group Sessions		
	Data Management and Performance Measures		
	Asset Management		

Transportation
Systems
Management and
Operations

TSMC



Appendix C: White Papers



Freeway Management –TIM/Tactical

FHWA states that freeway management “*supports and promotes the use of integrated and coordinated freeway systems and proactive freeway management to improve the safety, efficiency, and reliability of travel on the nation’s freeway facilities.*”¹

Freeway management includes activities and strategies that enhance safety and mobility on the freeway. These activities and strategies focus on addressing both congestion and incident management. *Tactical* support for freeway management include intra-agency and interagency coordination for response and clearance of an incident safely, efficiently, and quickly to reduce congestion.

Current Initiatives

- A. **TIM:** NCDOT has a number of educational tools established for their DOT personnel in collaboration with state highway patrol (SHP), local law enforcement, and the Fire Department. NCDOT also has developed a video to educate new DOT employees about traffic incident management (TIM) and incident management assistance patrol (IMAP). NCDOT has a new TIM position strengthening relationships with partner agencies, including SHP. Also, this position is marketing for continued collaboration between first responders and DOT.
- B. **TOC:** The three transportation operation centers (TOCs) are located in the Greensboro, Charlotte, and Raleigh areas. The Raleigh or statewide TOC is the only 24-hour center in the state. The Greensboro (Triad) TOC only dispatches IMAP vehicles currently, while the Charlotte (Metrolina) covers the Charlotte and surrounding areas from AM to PM peak times and special events. The three TOCs help to provide better integration of responses in advance of weather, special, or incident events.
- C. **IMAP:** NCDOT has safety service patrols along portions of the freeways in Raleigh, Greensboro, Winston-Salem, Wilmington, Charlotte, Asheville, and Haywood County. The IMAP vehicles patrol the freeways, detect incidents, and respond to traffic-related events. IMAP 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.
- D. **Quick Clearance:** After a five-year study of abandoned vehicle crash involvement concluded in 2005, North Carolina passed a Quick Clearance law. The law provides DOT and law enforcements the right to move a vehicle “by any means necessary without facing any liability” if safety is of concern if the vehicle remains. The law typically is initiated during weather events, as the DOT needs to clear the roadway safely and efficiently for snow removal.



¹ <https://ops.fhwa.dot.gov/freewaygmt/index.htm>

Freeway Management – Ops/Strategic

FHWA states that freeway management “*supports and promotes the use of integrated and coordinated freeway systems and proactive freeway management to improve the safety, efficiency, and reliability of travel on the nation’s freeway facilities.*”¹

Freeway management includes activities and strategies that enhance safety and mobility on the freeway. These activities and strategies focus on addressing both congestion and incident management. *Operational* support for freeway management includes a range of strategies for improving freeway capacity during an event by providing alternative methods of moving people. Some of the potential strategies include Active Traffic Management (ATM), Integrated Corridor Management (ICM), Ramp Meters, and integration of Connect and Automated Vehicles.

Current Initiatives

- A. **Infrastructure:** North Carolina has three transportation management centers (TMCs) across the state to monitor freeway conditions. The operators use closed circuit television (CCTV) cameras to view and monitor how the conditions change and then can inform motorists of traffic conditions via strategically located dynamic message signs (DMS).
- B. **ICM:** NCDOT is implementing and evaluating the benefits of ICM strategies on a few corridors. As part of the implementation, NCDOT is establishing agreements with municipalities to control the partner agency’s signal systems and allow NCDOT to implement predetermined timing plans. NCDOT has developed a rural project on the I-40 and I-26 corridors in the Asheville area and a more urban corridor on I-85 near Gastonia.
- C. **ATM:** NCDOT recognizes the potential benefits of using 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 NC 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.
- D. **Ramp Meters:** North Carolina completed a feasibility study regarding the deployment of ramp meters in the Triangle and Metrolina areas. The Triangle’s ramp meter project involves completing installation of equipment on the I-540 corridor and will include four sites.
- E. **Connected and Automated Vehicles (CAV):** NCDOT completed a Roadmap for CAV and its potential impacts to North Carolina. The partnership was between DOT and DMV. Within the Roadmap, several activities were identified along with an executive committee and a program manager. At the end of June, the state legislation passed two bills, one defining in more detail the executive committee.

¹ <https://ops.fhwa.dot.gov/freewaygmt/index.htm>



Arterial Management

Signalized arterial routes play a significant role in the performance of NCDOT's comprehensive transportation network. Some of these arterial networks are managed through centralized signal systems that span signalized intersections on multiple corridors, but an even greater number are managed by interconnected coordinated signal systems located on a single corridor. Arterial management emphasizes:

- Signal operations
- Signal timing strategies
- Signal performance measures

DOTs across the country have been implementing different programs focusing on:

- Documenting their Traffic Signal Management Plan (TSMP) – outlining their strategy to plan, implement, operate, and maintain signal operations.
- Implementing Regional Traffic Signal Operations Programs (RTSOPs) – collaboration across multiple jurisdictions to have consistent management, operations, and maintenance of signal operations.
- Applying signal timing strategies – identifying the appropriate timing to incorporate at signalized intersections based on capacity and movement, thereby improving efficiency and meeting the needs of not only vehicles, but also pedestrians, freight, transit, and emergency vehicles.
- Identifying and fulfilling performance measures – distinguishing the relationship between an organization's objectives and their signal system's program level objectives to ensure they align and are supported by the strategies put in place.

Current Initiatives

North Carolina is actively pursuing numerous focus areas.

- Signal System Timing Philosophy Manual:** NCDOT developed a signal system timing philosophy manual that provides guidance and standard practices for how to implement signal timing in NC.
- Bluetooth Research Project:** NCDOT recently completed a project that deployed a pilot of Bluetooth technology and provides NCDOT with recommendations and next steps regarding the assessment and monitoring of arterial performance.
- SPaT Challenge:** NCDOT is participating in the AASHTO SPaT (Signal Phase and Timing) challenge. AASHTO is looking to have connected vehicle dedicated short-range communication (DSRC) deployed on at least one corridor in all 50 states by 2020. NCDOT will be partnering with the Town of Cary and providing a corridor for deployment of the equipment identified within the SPaT challenge.
- Continuous Data:** NCDOT is exploring the use of high resolution data collection (HRDC) for traffic management. NCDOT is exploring ways to incorporate third-party probe data collection into their projects. Improvements in the technology are providing the use of probe data as a more feasible alternative for evaluating arterial performance.



Traveler Information and Partner Agencies

NCDOT provides traveler information—including real-time notifications—to travelers using dynamic message signs (DMS), social media, and web sites. NCDOT disseminates traveler information through their multiple transportation management centers (TMCs), which represent the nerve center of state and local transportation agency system management and operations. NCDOT coordinates with multiple agencies regarding traveler information, either through the TMCs or via the Division offices to assemble and share data related to construction projects, signal timing operations, or providing public notifications about road hazards and travel concerns.

Current Initiatives

- A. **Phone and Web-based Traveler Information Systems:** NCDOT was an early adopter of 511 as an abbreviated dialing code for phone-based traveler information. 511 includes an Interactive Voice Response (IVR) system with links to the ATMS and TIMS incident databases. NCDOT also operates a web site (<https://tims.ncdot.gov/tims/>) whereby users can 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. A mobile application also is available (ReadyNC) that allows users to access real-time traffic conditions including alerts.
- B. **Technology Broadcast Systems:** DMS continue to be the most widely used method for providing information to travelers in North Carolina. Some of the information includes adverse weather notifications, detours, closures, and travel times. These systems enable drivers to make informed decisions.
- C. **Social Media:** NCDOT uses several social media tools, including Facebook, Instagram, Twitter, and YouTube. There are 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 DOT's social media feeds within the NCSHP's social tools.
- D. **Construction Information and Updates:** 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.
- E. **Partner Agencies:** NCDOT partners with NCSHP, who provides specific data from the computer-aided dispatch (CAD) feed. 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. Some of those municipalities include the Cities of Fayetteville, Raleigh, Winston-Salem, Greensboro, Charlotte, and Gastonia and the Town of Cary. NCDOT also coordinates with the media to share video for news broadcasts.



Asset Management

Asset management is the “*strategic approach to managing transportation infrastructure.*”¹ Ideally, asset management is knowing your assets (what, where, when), the operations of your assets, and the process for maintaining your assets (preventative maintenance). Effective asset management supports better program and project management through continuous knowledge of existing infrastructure health and better budget forecasting based on life cycle and maintenance costs for each device, system, and sub-system.

Current Initiatives

- A. **NC 811:** North Carolina has inventoried assets across the state to provide underground utility information to contractors, property owners, or anyone who plans to dig in an area. The idea is for anyone who will be digging in an area to call 811 and inquire about what assets are in the vicinity to avoid potentially damaging any existing utilities. In response to NC 811, the Triad region is completing a detailed communications inventory of its underground fiber. This includes GPS locating junction boxes and importing the information into GIS. The next phase of the initiative will be expanded to include more detailed information regarding field devices and equipment cabinets.
- B. **Statewide ITS Device Map:** NCDOT completed an estimated review of all ITS devices deployed across the state. They were placed on a Google map that can be shared with consultants and partner agencies as well as to support collaboration efforts.
- C. **Signal Database:** NCDOT maintains a mainframe database to capture the inventory of NCDOT’s more than 14,000 signals installed across the state.
- D. **Signal System Database:** The COST group maintains an inventory of the signal systems located across the state. The inventory includes physical characteristics of the system and historical information such as when the system was last retimed.
- E. **Fiber Management Tool:** NCDOT is currently investigating solutions to manage the inventory of the state’s fiber-optic communications infrastructure.

¹ <https://www.fhwa.dot.gov/infrastructure/asstmgmt/asstfact.cfm>



Data and Performance Measures

NCDOT focused on performance (and the supporting data) as a key part of the Department's Strategic Plan. Several goals and strategies point to the need for data-driven decision-making, improving quality and availability of data, and improving efficiency by using new types of data and establishing stronger data sharing partnerships. There is a need to be able to interpret and analyze the different sources of data NCDOT already generates or obtains to better inform day-to-day operations strategies. There is also an important need to share performance outcomes, in meaningful ways, with partner agencies and with the public.

MAP-21 outlines several key performance measures, and performance outcomes will be linked to federal aid highway program funding. System Performance and Highway Safety Improvement Program (HSIP)/Safety Performance Management are both MAP-21 performance focus areas that are applicable to NCDOT. MAP-21 performance requirements provide greater consistency in reporting system and safety performance, and the final rules state an expectation that performance data will be used to inform planning and programming decisions. For mobility, these metrics focus on interstate reliability and excessive delay. For safety, they focus on reducing fatalities and serious injuries.

Current Initiatives

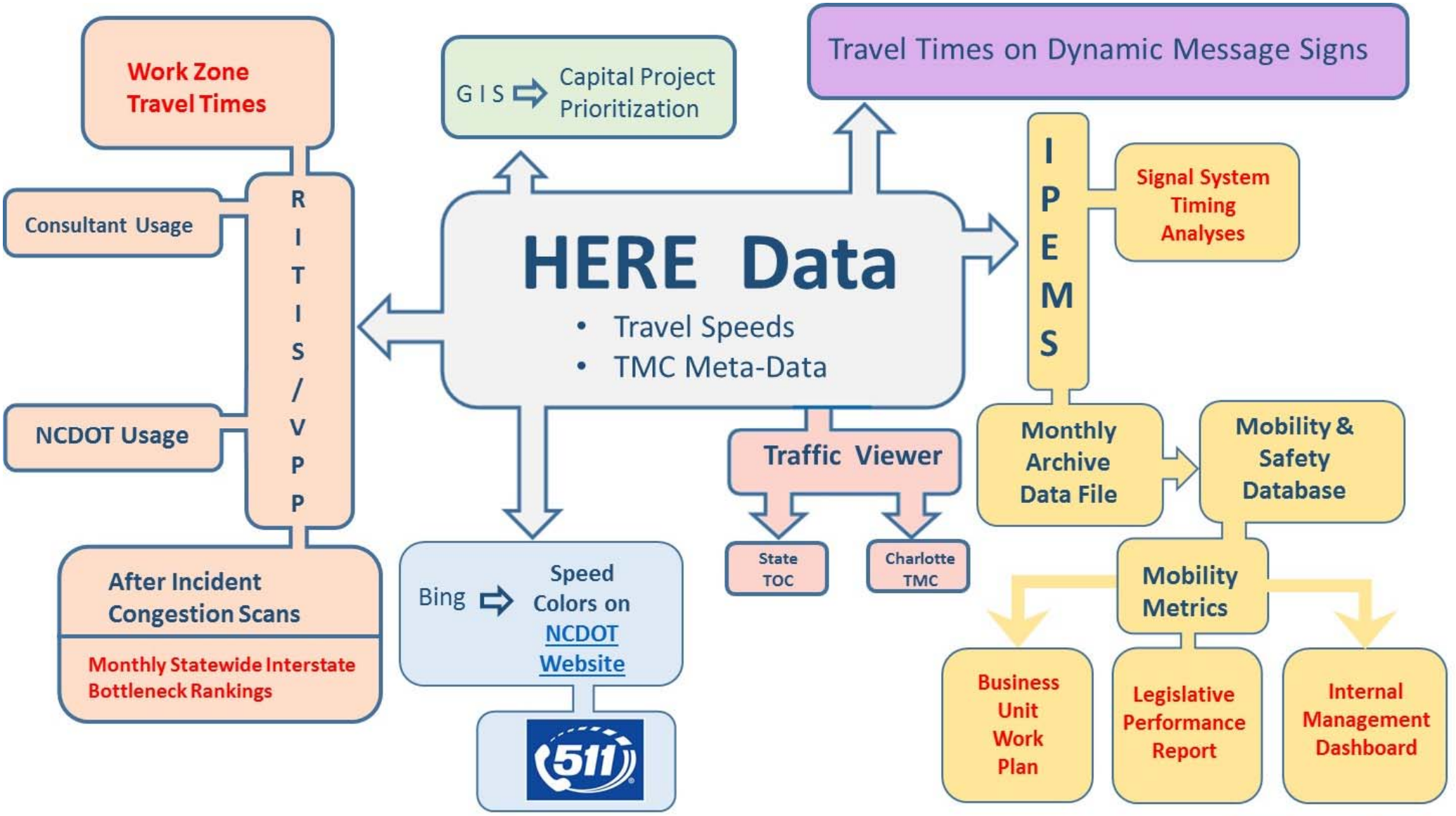
- A. **Speed Data:** NCDOT is a partner with the I-95 Corridor Coalition and participates in the traffic data mart that provides access to private-sector probe data for freeways and some arterials in North Carolina—over 16,000 miles of coverage. The data is used for work zone travel times, monthly statewide interstate bottleneck ratings, signal system timing analysis, and system performance reporting.
- B. **Safety Data:** NCDOT has a statewide traffic incident management (TIM) focus and tracks numerous metrics related to incident detection, verification, and response. There is a 90-minute target established to clear all incidents from NC highways, and this is reported on the dashboard. The TIM data is both real time and archived from the TIMS system. NCDOT is reviewing incident data from third parties to assist with the detection of incidents with the intent of identifying more incidents and further reducing clearance times.
- C. **IMAP Data:** NCDOT is collecting several elements per each incident management assistance patrol (IMAP) stop made. Each of the elements collected is used to produce various metrics used during decision-making meetings regarding IMAP and its benefit. The intent is to enhance this data to emphasize the benefits and impacts of IMAP by calculating a return on investment (ROI) for the program.
- D. **HERE Data:** NCDOT has a contract with HERE to provide travel times based on TMC meta-data. The data is analyzed and used to place travel times on the DMS.
- E. **High Resolution Data Collection (HRDC):** NCDOT is beginning to deploy infrastructure to collect high resolution data on specific arterials. The data collected



will be incorporated into performance measures and used to monitor arterial performance and assist in project prioritization.

- F. **Connected Vehicle Data:** NCDOT is initiating AASHTO's SPaT challenge on a corridor in Cary. Initially, the data will be one-way communication, where NCDOT will broadcast signal status.
- G. **Performance Goals:** Currently, NCDOT provides a dashboard and some of the performance metrics include 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 form of data collected above.
- H. **Project Selection Criteria:** Several data points are used to determine projects. These include volume, capacity, pavement condition, freight, and crash data. Benefit-to-cost ratios are used to help define the priorities.
- I. **Data Reliability and Cycle:** The performance measure data not only is collected by NCDOT, but also is provided by a third party. The classification of third party providers includes local municipalities, MPOs, other states or multi-state organizations, and private companies. NCDOT is assessing a process to manage the data life cycle.





Return on Investment (ROI)

Transportation Mobility and Safety is responsible for several key functions, including System Operations, Traffic Management, intelligent transportation systems (ITS) and Signals, Traffic Safety, Signing and Marking, and OS/OW Permitting. In recent years, the Division has made it a focus to heighten the available data and processes in place to demonstrate the most effective use of funds. To provide consistent metrics for all project types, the initiative is focusing on the return on investment (ROI).

North Carolina has a strong reputation within the safety program and the ability to provide a reliable, proven approach for the ROI of safety projects. The Division is implementing similar strategies on other projects. The Department has access to more reliable and accurate data through partnerships, advancements in data collection equipment, and third party hosted data sources—captured by tested and validated data collection methods. In addition, the Department can access a broader range of historical benefit and cost data to support the calculation of the ROI for technology or transportation system management and operations (TSMO) projects.

Current Initiatives

- A. **Spot Safety Funding:** Spot safety projects are intended to address near-term and potential safety hazards, and these projects can be developed throughout the year. There is funding set aside for these spot improvements (\$9M/year). Other funding adjustments can be made to capital improvement projects or maintenance activities to address specific countermeasures if detailed analyses indicate it is a high priority safety concern.
- B. **Research Efforts for Signal System Timing Prioritization:** The COST Group is partnering with other groups within the Department to assess the benefits of newer data sources, including High Resolution Data Collection (HRDC) and third-party probe data. It is expected that these data sources will be used to assess the anticipated and resulting ROI for updating signal system timing for a corridor.
- C. **Spot Mobility Funding:** Mobility and Safety has established a Spot Mobility Fund similar to the program that manages spot safety projects. Spot mobility projects are focused on mobility issues and mitigation strategies. Funding has been earmarked for these mobility improvements (\$10M/year). These projects will help to streamline processes for evaluating and capturing the ROI for mobility solutions.