NOCoE
National Operations Center of Excellence

2019 TSMO Summit

FUNDING AND CAPITAL IMPROVEMENT PROCESS INTEGRATION

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EXECUTIVE SUMMARY

On August 7-8, the National Operations Center of Excellence convened a group of transportation systems management and operations (TSMO) practitioners from state, regional and local transportation agencies to discuss major practices around funding and planning for TSMO within their transportation departments.

The two goals of the 2019 NOCoE TSMO Summit on Funding and Capital Improvement Process Integration[1] were to:

1. Identify the current practices for funding of TSMO.
2. Identify current practices, along with research and resource needs, for integrating TSMO into the capital improvement process.

This report not only encapsulates the findings of the summit, discovered thanks to the contributions of specific agencies that prepared materials and participated, but also provides details on how TSMO is currently deployed in a variety of transportation agencies. The in-depth discussion that captured specific best practices also identified gaps in how TSMO is deployed and funded inside transportation agency processes. Practitioners also identified a number of research and resource needs to efficiently advance the adoption of TSMO.

TSMO Funds – Where Do They Come From? Where Do They Go?

When we talk about best practices around funding for TSMO, **it is necessary to understand the variety of funding models by which agencies fund a majority or significant portion of their TSMO activities**. TSMO, as an integrative and programmatic concept, allows variable funding sources to be used to achieve the goals of the department of transportation (DOT). From responses from the participants, we could identify specific funding sources for various TSMO activities, ranging from federal grants and congestion programs to regional programs and fuel taxes. In collecting and discussing the general operations budget and process within each agency, the summit identified three groupings of funding models: Federal Focused Funds, State/Local Focused Funds and Regional Organizations. Note that most agencies use a combination of the identified funding sources and the following structure is meant to associate funding models of TSMO activities and agency structures for similarity recognition. In doing so, we hope other practitioners will correlate the funding models of participating agencies with best practices identified in this report.

A variety of approaches for budget management and funds is provided around each of the three funding models. For **agencies focused on federal funds**, their success in funding TSMO was due to these factors: 1) dedicated/protected or long-standing funds for TSMO set aside within capital budget, 2) TSMO champions established at every phase of capital projects and 3) good relationships with a variety of DOT divisions to ensure TSMO is adopted and maintained through the budget approval process.

For **agencies reliant on state and local funds**, TSMO funding is based on the priorities of the governing body and the DOT. In evaluating these agencies, the summit identified a spectrum of flexibility around TSMO funding that creates another layer of variation. While states like Delaware, where TSMO is funded directly out of the capital budget, maintain flexibility in how they integrate TSMO into their

[1] The original title of the summit was "2019 NOCoE TSMO Summit on Funding, Planning and Capital Projects" and changed as planning is recognized to be a part of the capital improvement process.

transportation systems, other states are more reliant on the priorities of a governing body in how funds are allocated to TSMO projects.

Regional organizations that are granted authority to distribute funds are key partners in the transportation industry for the adoption of TSMO. Though just as varied as states in how funding is allotted, regional organizations hold the responsibility of implementing concepts inherently linked to TSMO, such as congestion management, congestion mitigations and air quality programs. These programs inherently prioritize funding TSMO or specific aspects of TSMO before expansion and can provide crucial funding for improving how the transportation system is operated. Some funding sources are generated from regional transportation taxes that allocate money for specific capital and system improvements, providing little flexibility for how the funds are spent.

TSMO in Capital Infrastructure Projects

It is possible to correlate the efficacy and sustainability of the adoption of TSMO as a mainstream practice within the transportation system community with integrating TSMO into the capital improvement process. **This report looks at each step of the capital improvement process to extract lessons learned and positive and encouraging policies and procedures. It also identifies areas the TSMO industry can focus on.**

In the area of **planning**, a major discussion item was data governance. Not only is data governance an issue in how projects are planned for years out, but best practices, especially from regional organizations, might help ensure multi-agency acceptance. For example, the Atlanta Regional Commission wrote data governance directly into its long-term action plans to ensure strong data collection systems were in place to communicate the effectiveness of TSMO deployments and system-wide benefits to the community. Additional leading practices around planning include:

- Unified Planning Work Programs contribute to the inclusion of TSMO at multiple DOTs and help to break down silos.
- Planning for TSMO benefits greatly from strong relationships that can be institutionalized in processes.
- TSMO workgroups within committee and organizational structures can be faced with difficulties integrating their work flows and objectives as the original committee and organizational structures were not created with a TSMO mindset. Therefore, thinking ahead for how TSMO strategies and committees will fit within an organization is as important as the contents of the TSMO plan.
- Focus on communicating the principles of TSMO, which is often better received as opposed to having others appreciate and remember the acronym or the spelled-out words.
- TSMO operational planning and integrating TSMO planning with other disciplines within the agency need to be included. These should be at the forefront of resource needs and resource identification activities.

Programming is an area of the capital improvement process in which TSMO positively helps deliver the organization's planning goals. Participants offered the following approaches: programming separate funding for TSMO, reorganizing the DOT to align TSMO, project evaluation frameworks, stewardship and cultural change, and unique initiatives. Lessons learned by the participants include:

- Early engagement in capital projects is a necessity.

- Formal processes help ensure engagement/consideration occurs.
- Non-infrastructure needs are challenging, including funding for operating systems and labor to effectively operate new or expanded systems.
- DOTs need to transition from relationship-based programming to data-driven programming.

The **design** stage of the capital improvement process is an opportune area for additional resources and knowledge sharing to integrate TSMO concepts positively across all capital projects. As a key step, the priority for designers is to make the planning concepts and goals a reality. The assumption for designers is that most of the needs of the system and goals of the project have been identified. While this assumption is generally true, unique aspects for TSMO, including both technology and non-technology considerations, need to be communicated to designers. Participants shared the following lessons learned:

- The concept is important – get everyone on the right page with the concept and you have something powerful. If you have the concept and the funding, you can do anything.
- Including operations and maintenance teams in the design process, especially during design reviews, is beneficial. However, it adds additional staffing responsibilities and personnel across the agency that may be difficult to sustain.
- Specific disciplines (for example TSMO) need to have ownership of associated content regardless of where associated manuals and documents reside.
- Sustaining expertise is challenging, particularly in smaller regions for a state DOT, when funding constraints exist across all programs.
- Updating state DOT design manuals with operations and maintenance needs for protecting roadway workers is an important step for DOTs to undertake.
- Coordination with the state DOT's Traffic Operations Division on administration of congestion mitigation air quality (CMAQ) grant projects leads to better designs.

Construction occurs frequently, simultaneously and across the entire transportation system within a DOT's jurisdiction. Circumstances to consider for one construction project as they relate to system performance include other construction, maintenance, and reoccurring and non-reoccurring congestion. As conflicting priorities emerge, operations and TSMO strategies are considered a viable path for resolving conflicting priorities of the multitude of activity within the transportation system. Lessons learned around incorporating TSMO into construction include:

- North Central Texas Council of Governments (NCTCOG) recognized that every DOT doesn't enter construction the same way. Some DOTs provide advanced notification; other DOTs provide notification as closures occur. NCTCOG is working to hire a construction coordination contractor to help agencies within the region better coordinate construction activity. This position will coordinate road closures to reduce the number of parallel facilities under construction at the same time.
- Proactive work zone impact analysis utilizes data from traffic management centers (TMCs) and intelligent transportation system (ITS) devices and concurrently provides robust analyses that can be used by multiple groups within a DOT.
- Development of work zone strategies needs to occur early in the project's development and involve multiple disciplines.

- Innovative work zone strategies take dedicated staff to develop and effectively implement, often starting as pilot projects before being integrated into the Transportation Improvement Program (TIP).

Operations and Maintenance

The symbiotic relationship between operations and maintenance provides an opportunity for DOTs to achieve the next level of organizational capability for the near future. TSMO strategies are reliant on existing non-technology maintenance procedures that are enhanced through the implementation of best practices in DOTs. Most operations departments typically manage the ITS devices and systems that are used within TSMO. The ability of a DOT to operate and maintain any new technology or innovative method and to meet or exceed public expectations relies heavily on the DOT's ability to maintain its respective roadway infrastructure holistically. Lessons learned around incorporating TSMO into operations include:

- Growth of TSMO within a DOT is dependent on many factors but can also be limited by statewide or DOT policies.
- New or revamped templates for capital projects funding and programming provide opportunities to ensure funds for operations are also included from the beginning. These include funds for capital, operations and maintenance.
- Procurement for capital projects within DOTs does not typically usually include expenses for operations activities. Ensuring proper funding for those expenses is important for the implementation of TSMO strategies and tactics.

One of the first steps a TSMO-oriented DOT can take to improve its organizational capability is ITS maintenance. ITS devices and software systems are the enabling technologies that significantly improve organizational capability. Developing or updating a robust asset management plan that includes ITS devices, TMC software and equipment, and field equipment used for TSMO strategies is considered a leading practice. TSMO strategies provide the context for which ITS assets will be needed and is inclusive of non-ITS assets that are also needed. This provides a holistic approach to managing the system based on the operational needs of the DOT. Leading DOTs have indicated the need to consider life-cycle replacement timeframes, full system replacements instead of partial upgrades and developing a workforce plan for ITS maintenance needs. Lessons learned around incorporating TSMO into maintenance include:

- Know the restrictions that come with using federal funds for maintenance. Be able to differentiate between preventative maintenance vs. recurring maintenance.
- TSMO programs are utilizing pavement resurfacing projects for maintenance needs along the resurfacing roadways.
- Operations and maintenance funding needs are identified and allocated at the same time a project is funded.

TSMO Knowledge, Research Need and NOCoE Action Items

Through the process of exploring and synthesizing current leading practices, summit attendees were also able to discuss major challenges and identify research and resource needs for future funding of TSMO. Many of these challenges can be addressed by the knowledge needs, research ideas and NOCoE action items identified below.

TSMO Knowledge Needs:

1. Examples of agency manuals that have been updated and include TSMO
    a. **NOCoE Action Item: As DOTs share their updated manuals and materials, NOCoE can provide a compiled landing page to share with the TSMO industry.**
2. Data governance best practices among regional partners to show multi-agency acceptance
3. Examples of the TSMO practice being emphasized and prioritized in design and construction phases
4. Funding and normalizing digital projects, equipment and software in a DOT's budget and day-to-day operations
5. Understanding how agencies are budgeting operations and maintenance costs for new projects at the time of project identification and funding

TSMO Research Needs:

1. How to handle funding TSMO projects that have a short implementation and construction time frame
2. Synthesizing TSMO best practices in construction inspection on roadway projects
3. Synthesizing the leading and best practices for asset management for TSMO
    a. **NOCoE Action Item: 2020 peer exchange on asset management for TSMO scheduled.**

NOCoE recognizes the countless number of champions, stakeholders and partners involved in advancing the TSMO practice to achieve the vision of institutionalizing TSMO within all of our DOTs. NOCoE extends its thanks and appreciation to all those who took part and helped make the 2019 TSMO summit on Funding and Capital Improvement Process Integration a success.

OVERVIEW

On August 7-8, the National Operations Center of Excellence convened a group of transportation management and operations (TSMO) practitioners from state, regional and local transportation agencies to discuss the major practices around funding and planning for transportation systems management and operations (TSMO) within their transportation departments.

The two overarching goals for the summit were to:

1. Identify the current practices for funding of TSMO.
2. Identify current practices, along with research and resource needs, for integrating TSMO into the capital improvement process.

To plan for the summit, the NOCoE Technical Advisory Committee (TAC) assembled a planning committee representing state and local agencies. This committee developed the summit goals, approach and agenda and identified attendees representing state, regional and local agencies. Read-ahead materials included specific questions around funding within their agency and participants were asked to come ready to speak to funding around various processes in their agency. It should be noted that the intent of the summit was to find best practices, which materialized into a synthesis of current practices.

A full list of attendees and the day and half agenda can be found in the appendices of this document.

The first day, attendees shared their practices around TSMO funding, planning and capital projects in the following manner:

1. Best practices for funding of TSMO

    a. Approving authorities
    b. Funding sources
2. Best practices for TSMO in capital infrastructure projects
    a. Programming
    b. Planning
    c. Design
    d. Construction
    e. Operations and maintenance

In the process, attendees shared major challenges funding and planning for TSMO and potential research or resource needs that can address the challenge.

The second day, attendees were asked to put their knowledge to practice by splitting into four groups to evaluate four potential projects and funding challenges that the projects might present. Ranging from maintenance costs to procurement of digital infrastructure, this exercise identified a number of challenges the TSMO industry faces.

How to Read This Report

This report is structured around the two summit goals:

1. To identify the leading practices for each of the discussion topics outlined above. We then present a synthesis of these practices to assist other agencies. As outlined in the following section, the summit revealed that any discussion of best practices on this topic must consider how a DOT (state, regional or local) is structured in relation to federal and state funding levels and the various practices that result from that structure. Appendices profiling each state further clarify these practices in relation to funding models and aim to be resources unto themselves.

2. To identify research needs and industry action items for TSMO practitioners. The report concludes by presenting research and resource needs developed from both gaps identified during the day one discussion, as well as during day two, through the exercise around putting specific projects into practice.

TSMO FUNDS – WHERE DO THEY COME FROM? WHERE DO THEY GO?

The summit opened with agencies sharing their practices around funding. The discussion illuminated a wide variation among the agencies in how they funded and planned for TSMO, based on organizational set-up, approving authorities and general approach to how funding sources are acquired and disbursed. For example, the practices in a state like Maryland, which relies more heavily on federal funding for operations and initiatives, were widely different than a state like Delaware that relies on a state highway fund for most of its operations. So while best practices are certainly valuable for how they might work around specific agencies, adoption is dependent on the agency's specific funding model, organizational set-up and internal policy.

Common Funding Sources for TSMO

TSMO, as an integrative and programmatic concept, allows variable funding sources to be used to achieve the goals of the DOT. From responses from the participants, we could identify specific funding sources for various TSMO activities:

- Federal grants
- CMAQ – congestion mitigation and air quality
- HSIP – Highway Safety Improvement Program
- Metropolitan Planning Funds
- General Fund
- Agency Indirect Funds
- Highway User Revenue Fund
- Surface Transportation Block Grant Program
- Sponsorships (safety service patrol)
- State Planning and Research Funds
- Safety Funds
- Regional taxes
- Fuel Tax

An exercise was attempted with the participants to try and map out the particular TSMO or operations activity with each unique funding source. But difficulties arose in trying to understand how programs or TSMO activity in one DOT may be funded compared to another due to these significant variations found in agency structure, policies and rules. Another factor is the variation in approving authorities and budget controls that exist between governing bodies compared to a DOT executive's authority. Additionally, TSMO activities may have a combination of funding sources depending on the phases of the program and the needs of the system. This combination of funding sources, while more evident at local agencies, is also a testament to the complexity of understanding funding sources for TSMO, since TSMO's solution implementation timelines vary from very short (1-2 months) to typical capital improvement spans (3-5+ years).

So while multiple funding sources are used for different programs and projects, how an agency determines funding and distribution is directly dependent on the structure (further defined below) of that agency.

Identify Your DOT Structure

Understanding what funding may be available for various TSMO programs is essential to the success of TSMO departments and initiatives throughout the country. To help understand which funding sources may be beneficial, Table 1 describes three structural groupings for DOTs to compare and contrast their organizational structure with other leading TSMO agencies. Before inquiring further from other leading peers, practitioners should understand the structure of another DOT to quickly ascertain how similar the policies, procedures and structure are and how they could be applicable within one's organization.

The goal of Table 1 is to initiate the conversation (and further research) on possible quick ways to understand similarities in another organization to determine the challenges or similarities of implementing a TSMO solution in one's organization.

Table 1: Initial Structure for TSMO Activities Related to Funding Within Organizations*		
Federal Funds	**State/Local Focused Funds**	**Regional Funding**
Maryland Tennessee Michigan Pennsylvania	Delaware Iowa Washington State Maricopa County	North Central Texas COG Mid-America Regional Council Atlanta Regional Commission

*The categorization in the table above is intended to help practitioners bridge organizational structure discussions and quickly identify similarities and differences. It is understood that many agencies use multiple types of funding sources for various aspects of their TSMO programs.

Federal Focused Funds – Common Structural Elements

The *Federal Focused Funds* organizations are managing and operating their TSMO functions with a large portion of funding coming from federally sourced funds. These organizations share similarities in the types of programs they typically will create and sustain through the use of targeted yet flexible rules and regulations of the various federal programs. This yields similarities in the targets, goals and approaches to capital improvements, asset management, implementation, proactive maintenance, etc. It allows similarly structured DOTs to apply for the same funding sources if their goal is to create TSMO programs and initiatives that are similar. These DOTs benefit from many collaborative approaches with other DOTs and can take advantage of early adopters to minimize duplicate activities.

State/Local Focused Funds – Common Structural Elements

The *State and Local Funds* organizations share the common trait that their chief executives, in conjunction with their respective governing bodies, have a more direct impact on the use of funds and implementation of programs. These organizations rely less on federal funds (and in some ways provide flexibility in using various federal funds), allowing the executives to work with their governing bodies to determine fund allocations and to make day-to-day decisions within specific guidelines. DOTs that share this characteristic benefit from having executives who are also TSMO champions, who can allocate funds at their discretion (with some limits) and also share the accountability within their state or agency to their respective governing bodies. Common limits for these DOTs are related to amounts bonded, yearly spending caps and proportioned spending limits. TSMO funding is usually coming out of the department's overall or capital budget.

Regional Organizations – Common Programmatic Elements

The *Regional Funds* organizations are primarily Metropolitan Planning Organizations (MPOs) and Councils of Governments who share the common characteristic of having the authority to distribute funds (some MPOs do not have the function or authority to distribute funds). Organizations within this category have the ability to institute policies and procedures based on TSMO principles and can help move the state, regional and local agencies towards a TSMO-first mentality. The ability of these organizations to work within the rules and regulations, but set policies and goals that are in line with TSMO, is a unique characteristic. These organizations are able to adapt funding to regional needs quicker than state or federal funding sources as they typically have a governing body that can vote to make changes within a given year.

Identifying DOTs by how their funding is utilized allows this proceedings report to efficiently share best practices, insights and lessons learned from summit participants. A secondary benefit of this structure is it allows for TSMO funding conversation to be discussed concisely, allowing the reader to easily understand the top-level differences of the best practices and lessons learned shared in this report. We do encourage learning about differently structured organizations because innovation and creativity come from unique and diverse elements more so than similarities.

Approaches for Budget Management and Funds

The following section will highlight similar features of the approach for managing DOT budgets and funds using the previously mentioned structure in Table 1. The synthesis of participants' comments and insights is described briefly as additional information on each state can be found in the state profiles provided in Appendix A and Appendix B.

Federally Focused

The DOTs that share the approach of applying for and receiving a sizeable portion of their budget from federal funds work within a structure that is optimal for developing trust and relationships among other divisions within the DOT. The success of these DOTs in obtaining TSMO funding within their DOT budgets have resulted in the common elements below:

- Dedicated/protected or long-standing funds for TSMO are set aside within the capital budget.
- DOTs are heavy in capital projects so TSMO needs to be championed at every phase of the project.
- Budget approval requires good relations with other divisions within the DOT in order to get TSMO adopted.

Of the four DOTs within this federally focused category, Maryland, Pennsylvania and Tennessee all have a dedicated and separate fund for TSMO expenditures, allowing for the flexibility to plan, construct and implement initial or separate TSMO projects needed for their systems. Michigan DOT's line item is not protected, but there is long-standing acceptance among the other divisions for TSMO. In each of these DOTs, the approach is best described as using all of the dedicated TSMO funds before the use of additional funding sources.

When the DOTs do need to find additional funding for TSMO projects and initiatives, the focus turns more toward incorporation of TSMO into other projects and programs through an integrative process compared to a standalone process. The integrative process is due to the multi-step procedure of working with the other division to get TSMO included at every level of the capital improvement process, having the relations and buy-in to incorporate TSMO elements and ultimately getting the budget approved with TSMO components.

Integrating TSMO components into other projects is a key milestone in this process, which takes a lot of time, energy and relationship building among the different division and project leads. The other key milestone is when decisions need to be made around reduced project budgets. The relationships and value of TSMO become front and center, especially in data-driven organizations, to not cut TSMO aspects of the project. Both Maryland and Michigan DOT commented on how a data-driven process will almost always favor TSMO initiatives and allow for a meaningful and objective discussion on what elements to reduce. The objectiveness of a data-driven approach helps maintain the relationship by allowing others to see that the decision is not subjectively biased on an individual's personal preference.

A common starting point for all of the DOTs in the summit, but particularly the DOTs that are federally focused, is the need to have clear long-term plans understood by key individuals within the departments. Without a long-term plan with goals, initiatives, phases and other key elements, TSMO conversations have a shorter shelf life and gains are independent of a systematic approach. The advantage of long-term planning to these DOTs is the ability to consider systematic improvements ahead of time, which can be incorporated easily when funding becomes available. We will look at the differences of how these long-term plans benefit DOTs with a structure more focused on state/local funds in the following section.

Lesson Learned: A common starting point for all DOTs is to have clear, long-term plans understood by key individuals within the DOTs that enables the ability to consider systematic improvements ahead of time as funding becomes available.

State/Local Funds Focused

DOTs that have a state/local funds focused structure are typically governed by the Legislature, a commission or similarly structured governing body that allows for the direct oversight of the DOT's budget and expenditures. The budget for TSMO is dependent on how the priorities of the governing body and the DOT and how the expectations of their constituents align in any given budget period.

The key difference in understanding the approaches of each of these DOTs depends on how much authority the governing bodies exercise over the DOT budget and at how granular a level. Even within our small sample of DOTs listed in this category (Delaware, Iowa, Maricopa County and Washington state) the contrast in governance granularity is evident in how the DOT approaches TSMO.

DOT executives in this category have a range of flexibility over their budgets. At one of the spectrum is a governing body that allocates an allotment for the DOT within the state's overall budget and allows DOT executives to manage and budget accordingly. This is the most flexible scenario. The other end of the spectrum occurs when the governing body discusses and reviews every line item within the DOT budget and each line item is subject to various level of scrutiny and variability based upon the governing body. This is the least flexible arrangement. The following DOTs are described from most flexible to least flexible[2].

(Most Flexible) Delaware DOT

- Governing body - Delaware DOT reports to a Council of Transportation , which determines the amount of funds available.
- Distribution and allocation of TSMO funds is mostly up to Delaware DOT executives. Typically the finance director and Secretary of Transportation's Office make decisions.
- In Delaware, TSMO comes directly out of the capital budget, in the same annual capital planning document for the DOT and the Council doesn't have purview over most TSMO aspects.
- The operations budget covers personnel salaries and maintenance activities.

(Somewhat Flexible) Iowa DOT

[2] Level of flexibility is subjective to the author and compares the executive's ability to manage and modify the DOT's budget at will.

- Governing body – Iowa DOT reports to a seven-member commission that has authority over capital and operations budgets with a dedicated road use trust fund that is protected.
- Operations is programmed in as a high priority whenever the budget allows.
- Iowa DOT is working to integrate TSMO into the entire process to build a culture and governance around TSMO.

(Somewhat Flexible) Maricopa County DOT

- Governing body – Maricopa County DOT reports to a board of supervisors at the county level. In addition, a Transportation Advisory Board gives input and helps sell TSMO and other initiatives to the board of supervisors.
- The DOT is fortunate to have a board of supervisors that's open to new technology and process improvement, which helps with coming up with TSMO ideas and trying to sell it.
- Maricopa County DOT maintains what practitioners consider a reasonable five-year program.
- The region and other neighboring agencies have established strong relationships and are typically supportive of TSMO.

(Least Flexible) Washington State Department of Transportation

- Governing body – Washington State DOT reports directly to the state Legislature as the approving authority on a biannual basis. The funding and budget is controlled by account and line item with some capital projects receiving an individual line item for the legislature to track. TSMO does have dedicated funding but to increase funding requires legislative buy-in. The state Legislature also is able to appropriate MPO funding (60 percent of the funds stay with the state) which is not always aligned with the MPO's interest.
- Any increases in TSMO (operations and maintenance) through any gas tax increase is difficult because gas tax increases are focused primarily on individual projects.
- The capital program is funded through the use of federal funds but TSMO and maintenance is funded exclusively with state funds.

Understanding the level of flexibility DOT executives have provides common structural elements to relate an individual practitioner's understanding of why certain DOTs are able to accomplish program objectives at a seemingly quicker pace. One measure of success for TSMO adoption is, therefore, the ability to navigate one's own DOT structure and funding model. One source to obtain funds for TSMO is partnering with regional organizations that have a different kind of flexibility and beneficial when aligned with TSMO as discussed in the following section.

Lesson Learned: Understanding common structural elements can help practitioners relate to why certain DOTs are able to accomplish certain program objectives at a seemingly quicker pace.

Regional Funding

A regional organization functions either as a purely planning organization with no or minimal authority over the distribution of funds or as a planning organization with authority over the distribution of funds. Limitations and advantages are typically dependent on regional and local funding measure restrictions, the governing policies and rules that were developed in establishing the organization and the ability to maintain a consensus on how the region's funds should be spent.

A key difference in the responsibilities of the overall transportation system between DOTs and regional planning organizations are the concepts born from programs like the Congestion Management Process (CMP) and Congestion Mitigation and Air Quality programs, as well as other funding programs that inherently prioritize funding TSMO before expansion. The three regional organizations attending the summit, Atlanta Regional Commission, Mid-America Regional Council and the North Central Texas Council of Governments, are able to adopt and adapt policies that prioritize the principles and strategies of TSMO tied to the funding that they distribute. This allows for the adoption of TSMO within the local cities and counties that receive funding.

Examples of how this is accomplished are listed below.

- **Atlanta Regional Commission** – Following the Congestion Management Process guidelines, all of its projects fund TSMO before expansion drawing from their comprehensive transportation funds to include multi-modal funding.
- **Mid-America Regional Council** – "Manage existing systems to achieve reliable and efficient performance and maximize the value of existing investments" is one of 10 goals in the council's Metropolitan Transportation Plan. Its CMP includes a toolbox that identifies alternatives strategies, including specific TSMO strategies for addressing congestion issues.
- **North Central Texas Council of Government** – It has access to local funds called Regional Transportation Council and a local initiatives program that allows for projects that are not federally funded. Transportation planning funds are used for TSMO, allowing for the adoption of TSMO practices early in the planning process.

Key highlight: Regional Organizations that are granted authority to distribute funds are key partners in the transportation industry for the adoption of TSMO.

The ability of regional organizations to effectively influence the capital improvement process, specifically in planning and sometimes other stages, is discussed in the Best Practices for Planning section below. The advantage of the regional organizations is also evident in the system-wide approach through the inclusion and focus on multi-modal and systematic approaches, which are a positive stimulus to bring together multiple stakeholders around regional and local initiatives.

Lesson Learned: A common thread among all of the participants was the importance of the TIP, and for TSMO to be well-represented in all TIP projects.

Addressing Budget Issues and Project Delays

Budget issues occur when a TSMO strategy or activity is included but then a project's funding is encouraged to be reduced. Project delays can increase the potential overall cost of the project. The ability to address these budget issues and project delays while also managing budget expectations from initial planning estimates, is a constant in DOTs throughout the country.

One of the pitfalls of any agency is to approach a project with a one-and-done mentality, especially as it relates to the planning-level budget and estimates of how much the project will cost. Assumptions vs. on-the-ground differences change frequently on our roadways, and accounting for inevitable changes to assumptions should be a given. Two DOTs that have addressed this in their systematic approaches are Tennessee and Delaware.

In going through scoping, planning, budgeting and processes, TSMO is often easily removed from a project. What organizational actions can ensure operations remains in projects?

- Tennessee DOT: Initial planning level budgets are allowed to be adjusted in the design phase, ensuring no operations components are removed due to budget constraints.
- Delaware DOT: The project is viewed for the entirety of its components and if budget increases due to systems and operations needs, the project is pushed to the next year or accomplished in stages rather than reducing intended improvements.

Understanding the value of TSMO within a project among all of the other priorities for that project benefits from an additive approach as opposed to a reductive approach. Delaware DOT has a policy that builds off of the concept of "Dig Once[3]" and institutes a 5-year period following construction during which no additional construction projects can in the same location, minimizing disruption from construction.

Lessons Learned for Funding and TSMO

The following list compiles lessons learned shared by the participants during this discussion session

- A common starting point for all DOTs is to have clear, long-term plans understood by key individuals within the DOTs that enable the ability to consider systematic improvements ahead of time as funding becomes available.
- Understanding common structural elements can help practitioners relate to why certain DOTs are able to accomplish certain program objectives at a seemingly quicker pace.
- A common thread among all participants was the importance of the TIP and for TSMO to be well-represented in all TIP projects

TSMO IN CAPITAL INFRASTRUCTURE PROJECTS

The efficacy and sustainability of the adoption of TSMO as a mainstream practice within the transportation system community can be correlated with the full integration of TSMO into the capital improvement process. This effort looked at each step of the capital infrastructure process to extract lessons learned and positive and encouraging policies and procedures. It also identified areas that the TSMO industry can focus on. The synthesis and summaries provided below are only of the summit participants and not a comprehensive industry analysis. However, as previously stated, given the leading nature of these DOTs, they are representative of the DOTs implementing TSMO around the country.

Planning for TSMO – Develop Plans With a TSMO Focus

The first part of the process to consider is planning. All long-term, strategic, program and regional plans should be developed with a TSMO focus or, at the least, TSMO elements. The ability of a DOT to be proactive in TSMO efforts comes from its ability to plan ahead and align efforts across divisions. Efforts to integrate TSMO into planning are progressing within the industry and consequently the actions shed light into areas that will require additional resources.

The approaches by regional planning organizations demonstrate a multi-faceted ability for TSMO to be integrated into the region based on the needs of all of the agencies. The Atlanta Regional Commission decided to create a Regional TSMO Plan, The Mid-America Regional Council incorporated TSMO into its Unified Work Plan and the North Central Texas Council of Governments created goals and policies that

[3] FHWA, Dig Once Policy Brief - https://www.fhwa.dot.gov/policy/otps/policy_brief_dig_once.pdf

drive the region towards prioritizing and implementing TSMO in all of its projects. The lessons learned and best practices for each summit participating organization is described in further detail below.

Atlanta Regional Commission – Recent TSMO Planning Best Practices

The Atlanta Regional Commission came together to develop and create a Regional TSMO Plan. The focus for the Atlanta Regional Commission centers on leveraging technology and piloting ideas to gauge the interest of transportation technologies and improve upon their Project Evaluation Framework. One key aspect in consideration of technology is the data governance focus and the Regional Technology Assessment and Strategic Plan. The emphasis on bringing all stakeholders together to share in the vision and integration that is needed for future applications is key for any TSMO plan.

Another key aspect of integration that the Atlanta Regional Commission actively works on is to make TSMO recommendations into its many modal and subject area plans such as *Walk Bike Thrive, Bike/Ped Safety Action Plan, Freight Parking Study, etc.*

Action Item: Compile and share data governance best practices being led by regional organizations that show multi-agency acceptance.

Some highlights from their TSMO planning and examples of best practices for objectives within a strategic TSMO plan are:

- **Data governance** is included to recognize the reality that TSMO applications are becoming more connected and we need strong systems in place to be able to use the data we collect.
- The **Local Agency Deployment Plan** will include information about different types of TSMO applications, when they are most effective, the challenges of implementation and examples of where they have been done before.
- The **Regional Technology Assessment** will be a picture of what activities the Atlanta region is doing well and where gaps are in comparison to other regions in the country. The **Strategic Plan** will use this information to make recommendations on what areas should be prioritized in the near term, mid-term and long-term.

Mid-America Regional Council and its Unified Planning Work Program

One of the challenges that planning organizations are faced with is the proliferation of various modal, strategic and transportation plans that are developed individually (admittedly with aspects of coordination). To that end, the Mid-America Regional Council used federal metropolitan planning funds documented in the Unified Planning Work Program to support the integration of TSMO into the various planning documents. Some of the key areas are presented in the list below.

Unified Planning Work Program

- Data collection, management and analysis
- Intergovernmental coordination and organization of TSMO
- Transportation performance management
- Transportation technology and planning including the ITS architecture
- Congestion Management Process

To improve integration of TSMO initiatives with the metropolitan transportation planning process, MARC has pursued the formation of a dedicated TSMO workgroup and development of a regional TSMO

plan. These efforts have been hampered by the difficulty in identifying the proper composition of the workgroup and its place in the already extensive MARC committee structure.

The difficulty of understanding where the TSMO workgroup fits within a committee structure is a microcosm for many DOTs grappling with how to fit TSMO into an organization structurally and procedurally. Thinking ahead for organization fit is as important as the contents of the TSMO plan.

Lesson Learned: TSMO workgroups within committee and organizational structures can be faced with difficulties integrating their work flows and objectives as the original committee and organizational structures were not created with a TSMO mindset. Therefore, thinking ahead for how TSMO strategies and committees will fit within an organization is as important as the contents of the TSMO plan.

Examples of TSMO integration into MARC's Metropolitan Transportation Plan and Congestion Management Process can be considered as best practices for all similar and tangential organizations to use as a starting point.

Metropolitan Transportation Plan (MTP)

Transportation Outlook 2040 is the metropolitan transportation plan for Greater Kansas City. It provides a policy framework for the investment of anticipated federal, state and local funds, based on expected needs and regional goals and objectives. MARC has included "**manage existing systems to achieve reliable and efficient performance and maximize the value of existing investments**" as **one of 10 goals** in the plan. The emphasis in the plan on TSMO impacts other elements such as performance measures, congestion management and evaluation methodologies for the transportation improvement program.

Key question: How does the identification of policies, processes and approaches of these individual TSMO components advance the mainstreaming of TSMO?

Congestion Management Process

The Congestion Management Process (CMP) is a systematic way of monitoring, measuring and diagnosing the causes of current and future congestion on a region's multi-modal transportation systems; evaluating and recommending alternative strategies to manage current and future regional congestion; and monitoring and evaluating the performance of strategies implemented to manage congestion. The MARC CMP is integrated with the MTP, TIP and ITS architecture. It includes a toolbox that identifies alternative strategies, including specific TSMO strategies for addressing congestion issues.

Although these foundational elements of the planning process are well established, a capability maturity model exercise conducted in 2017 identified weaknesses that the region must address. Areas in need of attention include:

- Level of service and modeling drive decision-making with reliability metrics being secondary.
- Improvement in data identification and coordination is needed.
- Design manuals and scoping processes used often ignore the systematic operating nature of signals and TSMO projects.
- TSMO is not well understood or received.

Pennsylvania Department of Transportation – TSMO Guidebook Series, Unified Work Planning and PennDOT Connects

Pennsylvania DOT (PennDOT) has taken a statewide approach to adopting and implementing TSMO. Intended to address all of the areas within the capital improvement process, the first step and part 1 of PennDOT's TSMO Guidebook Series is on planning[4]. The guidebook itself and in particular, part 1 is *intended for professionals responsible for transportation planning and operations within Pennsylvania*[5]. The document allows the various planning processes to be accessible for TSMO solutions. In addition, it allows planning processes to benefit from having a strong connection to the TIP and being prioritized during project planning.

Key highlight: PennDOT's TSMO guidebook and PennDOT's Connects allow for a holistic approach to planning and ensuring that all people are involved, from the community of professionals and consultants to the actual residents of Pennsylvania.

PennDOT also uses and refers to its Unified Planning Work Program (UPWP). As a recognition of the requirements set by Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) planning funds, TSMO planning needs are included in the UPWP with all of the associated and required details.

Collaborative planning to find creative solutions to sustain and expand mobility in Pennsylvania is the primary purpose of PennDOT Connects. As an effort to taking a more holistic approach to planning and considering community needs that reflect changing demographics and technological innovation, TSMO is a useful and collaborative concept/practice that provides strategies and tools to achieve program goals. The PennDOT Connects Policy[6] includes collaboration requirements and planning considerations that ensures partners are working together, which is the same collaborative environment that TSMO as a concept thrives on.

North Central Texas Council of Governments – Effective TSMO Goals and Policies

The North Central Texas Council of Governments through its long-range transportation plan and congestion management process, identified goals and policies that prioritized and reinforced TSMO principles. All of the associated DOTs, agencies and stakeholders accepted the goals and policies. The significance of the goals and policies, with a focus that matches TSMO principles, is a milestone for the region as it signals the acceptance of TSMO among the larger stakeholder community. The credit for this is not NCTCOG as a singular entity, but all of the champions, stakeholders and organizations that contributed to raising awareness and acceptance of TSMO.

Key highlight: Acceptance of long-range TSMO policies by the stakeholders of NCTCOG is a credit deserving to all of the champions, stakeholders and organizations that contributed to raising awareness and acceptance of TSMO.

[4] Pennsylvania DOT TSMO Guidebook – Planning, http://www.dot.state.pa.us/public/PubsForms/Publications/PUB%20851.pdf
[5] Pennsylvania DOT TSMO Guidebook – Planning, http://www.dot.state.pa.us/public/PubsForms/Publications/PUB%20851.pdf
[6] PennDOT Connects Policy - https://www.penndot.gov/ProjectAndPrograms/Planning/Pages/PennDOT-Connects.aspx

The NCTCOG did note that communicating the principles of TSMO is often better received and most effective when the acronym TSMO (or the spelled-out words) is not used directly, because it lacks the applicability needed in plans for the region. (It is not being argued not to use TSMO at all, but being mindful of when the acronym and defined words are used without context and in its general meaning.) Examples of the goals and policies from NCTCOG can be found below with the full list in Appendix B.

Mobility 2045: The Metropolitan Transportation Plan for North Central Texas

Mobility 2045: The Metropolitan Transportation Plan for North Central Texas goals support and advance the development of a transportation system that contributes to the region's mobility, quality of life, system sustainability and continued project implementation. A few sample TSMO policies outlined in the MTP are presented below. Additional MTP-related TSMO policies, programs and projects are available in Appendix B.

- **TDM3-002:** Support an integrated planning process that maximizes existing transportation system capacity before considering major capital infrastructure investment in the multimodal system.
- **TSMO3-002:** Require regional partners to coordinate during major special events or planned events to ensure minimal impact on the transportation system for individuals traveling to an event or through an event zone.
- **TSMO3-007:** Integrate all traffic operations systems between public sector entities, including sharing of data and videos.
- **TSM03-008:** Coordinate and share best practices to prevent copper wire theft supporting the operations and illumination of transportation infrastructure.

Lesson Learned: Focus on communicating the principles of TSMO, which is often better received as opposed to having others appreciate and remember the acronym or the spelled-out words.

Congestion Management Process for North Central Texas

The Congestion Management Process (CMP) seeks a "management" solution to a growing traffic problem by targeting resources for operational management and travel demand reduction strategies. Although major capital investments are needed to meet the growing travel demand, the CMP develops lower-cost strategies that complement major capital recommendations. CMP strategies focus on TSMO and Travel Demand Management (TDM) projects, policies and programs that encourage the use of alternative travel modes and improve the efficiency of the existing transportation system. The three CMP goals outlined below highlight the TSMO focus within the North Central Texas region.

- **Goal One:** Identify quick-to-implement, low-cost strategies and solutions to better operate the transportation system.
- **Goal Two:** More evenly distribute congestion across the entire transportation corridor.
- **Goal Three:** Ensure corridors have options and available alternate routes/modes to relieve daily congestion and during incidents and accidents.

Washington State Department of Transportation – From ITS to TSMO

The transition of any DOT from a primary focus of capital improvements to one that prioritizes and integrates TSMO is an organizational transition that typically takes several years. TSMO builds upon

many capital improvement successes and lessons learned with the goal of maximizing the use of the transportation system. Typically, the DOT has a highway infrastructure planning group, which in Washington state DOT's case has a specific funding program traditionally focused primarily on capital improvements. WSDOT had worked previously to integrate TSMO-related planning into each program's planning efforts with varying degrees of success, sometimes through champions and other times through policies and processes. WSDOT's policy approach is built off of its initial approach of integrating TSMO into multiple programs. The approach focuses on two areas:

- Policies that direct consideration of operational solutions as part of capital program planning efforts.
- Internal policies associated with agency strategic planning efforts. These direct that near-term operational focus be included in planning efforts.

The policies and activities of early TSMO efforts focused heavily on the deployment of ITS. TSMO has evolved by moving beyond this initial ITS deployment focus. At a certain point, a DOT can begin to plan around the actual operational scenarios and uses of the ITS that is currently deployed throughout its system. WSDOT is now initiating a TSMO-focused planning effort that incorporates using the ITS devices, but goes beyond that by harnessing the strategies, objectives, tactics and operations that become possible when a DOT fully activates TSMO.

Some challenges and lessons learned from WSDOT are:

- Operating funds have focused on implementation, making operational planning efforts challenging.
- TSMO-related programs typically have not included (or at best, under-funded) staffing needs to effectively engage in or lead planning efforts.
- Knowledge and tools to represent how to consider TSMO-related investments within agency planning efforts are valuable to other disciplines within the agency.
- The scope and scale of many TSMO-related investments, which are relatively low-cost, make planning and programming efforts challenging within the existing budget structure/s.

Key highlight: By successfully deploying, implementing and operating ITS devices, Washington DOT is able to plan around operational scenarios and initiate planning efforts that harness TSMO strategies, objectives, tactics and operations to fully activate TSMO.

Lesson Learned: TSMO operational planning and integrating TSMO planning with other disciplines within the agency need to be included and at the forefront of resource needs and resource identification activities.

Tennessee Department of Transportation – Using ITS Data in Planning and Building Relationships

Tennessee DOT's approach was to proactively reach out to the different planning groups within its DOT and share more than a slide deck on TSMO. The agency recognizes that data the TSMO group collects, utilizes and analyzes is within the same transportation system that is needed by the long-range planning staff and other groups within the DOT. (It is worth noting that data collection, management and analysis are seemingly simple, yet realistically nuanced and complicated at times.) With the intent of going to

other groups with data that can be utilized and shared and also to build lasting systematic relationships, Tennessee DOT succeeded in getting buy-in from those groups.

To get buy-in from and increase coordination with the long-range planning (LRP) staff, the TSMO group was able to:

- Make the case for the effectiveness of TSMO strategies.
- Increase consideration of performance data in the planning process by using the Every Day Counts initiatives and efforts.
- Engage TSMO/Traffic Operations Division staff in research projects funded by LRP.
- Share statewide probe data.
- Build relationships with LRP staff.

Key highlight: Stay abreast of new opportunities within the state DOT and state government as Tennessee DOT's Operations group did by forming a relationship with the Tennessee Strategic Transportation Investments Decision initiative.

Building relationships is difficult on a day-to-day basis. Tracking relationships over time is also difficult, especially trying to understand how effective the relationships are or gauge how engaged others might be. At one of the recent TSMO Regional Operations Forums in spring 2019, it was noted that planners were in attendance and well represented. While the sentiment of "good attendance by planners" may be seen as subjective and qualitative, it is an affirmation that the previously built relationships are sustaining and the planners are engaged.

One key group that the TSMO practitioners wanted to build a lasting and systematic relationship with is the Office of Community Transportation (OCT). The OCT has relationships with the local agencies, metropolitan planning organizations and regional planning organizations and allows the traffic operations group to be more involved in the TIP/ Statewide Transportation Improvement Program (STIP). The key goal here is to get TSMO solutions identified and selected in the TIP/STIP early in the planning stages through the relationships and value that TSMO brings.

Another opportunity that can be relatable to other practitioners is when the state DOT or even state government sets up a unique division, which for Tennessee DOT is the Tennessee Strategic Transportation Investments Division (STID). Recognizing that TSMO is by definition a strategic investment, the STID allowed for a natural relationship to form among the STID staff and the TSMO group. The benefit of working with the STID is to be able to have TSMO considered and selected for project scoping. This also means seeing projects to fruition and operation, further proving the value of TSMO.

Maricopa County Department of Transportation – Identify Future Needs

When a DOT is able to be comfortable with the ITS deployed and the agency culture and partners have adopted TSMO, the DOT is able to anticipate the strategic needs of the transportation system as a whole. The Maricopa County DOT through its Transportation System Plan[7] identified the future needs of the infrastructure rather than focusing on the traditional roadway classification prioritization.

[7] Maricopa County DOT Transportation System Plan - https://www.maricopa.gov/5132/Transportation-System-Plan-2040

Key highlight: Focusing on the future needs of the system that are impacted by developments in Maricopa County during the land development permitting process shifted improvements from individual projects to a collective process that continually improves the overall system.

The Transportation System Plan focuses its TIP and land development permitting process to meet the future needs of the systems instead of focusing on purely roadway classification and individual project impact. For many counties and local agencies, identifying the infrastructure improvements needed on a system basis and documenting them with clear feasibility analysis fundamentally shifts the improvements from individual projects and individual developments to a collective process. This continually improves the overall system in real-time.

Lessons Learned for Planning for TSMO

The following list compiles lessons learned shared by participants during this discussion session.

- Unified Planning Work Programs are contributing to the inclusion of TSMO at multiple DOTs and helping to break down silos.
- Planning for TSMO benefits greatly from strong relationships that can be institutionalized in processes.
- TSMO workgroups within committee and organizational structures can be faced with difficulties integrating their work flows and objectives as the original committee and organizational structures were not created with a TSMO mindset. Therefore, thinking ahead for how TSMO strategies and committees will fit within an organization is as important as the contents of the TSMO plan.
- Focus on communicating the principles of TSMO, which is often better received as opposed to having others appreciate and remember the acronym or the spelled-out words.
- TSMO operational planning and integrating TSMO planning with other disciplines within the agency need to be included. These should be at the forefront of resource needs and resource identification activities.

Questions from the Participants to the Participants - Planning

Question 1: In going through scoping, planning and budgeting, when a project manager is faced with delays, additional costs, etc., is TSMO easily deleted from these projects?

- Participant – The order to get cut for us is: 1) bike/pedestrian, 2) environmental sustainability and 3) TSMO.
- Participant – We mitigate that by bringing the project manager into scoping early to meet with everyone and gather input for the project on what can get cut and in what order.
- Two participants – For each project, the planning level budget is adjusted as design continues and, if need be, the project is phased to include rather than eliminate options by pushing phases and funds into the next year.
- Another opportunity is to include TSMO improvements into resurfacing programs to make improvements and save on the project.

Question 2: How do you track partners' progress through the development process – to keep things linked together when implemented by multiple organizations in neighboring geographic regions?

- Participant – Bring the neighboring organizations in from the beginning. Based upon improvements and needs during construction, the relationships will allow for needed upgrades and tweaks outside of the project limit that benefit the area.

Programming for TSMO – Aligning TIP, STIP (and more) and TSMO

Programming in the capital improvement process aligns TSMO with the necessary funding, resources and existing processes to allow for the selection of projects that include TSMO strategies and concepts. The alignment of TSMO goals, policies, and processes from the planning process allows for inclusive solutions across all modes of travel, community goals and evaluation frameworks.

The multitude of methods available for DOTs and organizations to successfully program TSMO make the discussion for this section a limited synthesis of best practices rather than a comprehensive nationwide scan on the methods of programming TSMO. The approaches offered by the participants include programming separate funding for TSMO, reorganizing the DOT to align TSMO, project evaluation frameworks, unique initiatives and notable approaches. We describe these below.

Program-separate funding for TSMO

Separate funding for TSMO is typically through a purpose-driven need that receives support across the organization through its specific business case. The best practices described below share the common characteristic of being a vital component to that DOT's TSMO program. Knowledge of the multiple funding streams and understanding funding source rules can help identify areas that are funded less or ad hoc. This can show which areas could benefit from a separate programmed funding allocation, as shown in the best practices below.

- The Washington State DOT, through its policies and Legislature, established separate operations programs consistently funded within its budget. Through the policies, there is direct consideration of operational solutions as part of capital program planning efforts that also dedicate funding for TSMO. Within the operations program budget, there also is a dedicated funding allocation to address low-cost emergent needs.
- The Tennessee DOT programs funding for TSMO through four distinct focus areas:
  - Programming of maintenance funds for ITS infrastructure
  - Programming of general funds for TMC facilities
  - HELP trucks replaced outside of general fleet (no competing priorities for vehicle replacement)
  - Traffic Operations Division-level funding – Since Tennessee DOT does not operate or maintain any traffic signals, this funding allocation was created to:
    - Partner with local agencies for spot improvements.
    - Allow the recommendations and concurrence of the Tennessee Traffic Signal User Group (TTSUG) to be eligible and considered for funding.
- The Mid-America Regional Commission includes programmed funds for operations support (traffic signal coordination and incident response), commuter resources and traffic flow improvements through the following funding sources:

  Surface Transportation Block Grant Program (STP)
  Operation Green Light – Cooperative arterial traffic signal coordination and incident response
    - Approximately $1 million regionally is set aside annually for operations support.

  Congestion Mitigation & Air Quality Program (CMAQ)
  Rideshare – Commuter resources for individuals and employers
    - $250,000 is allocated annually to support this

Key highlight: From MARC - Projects that add SOV capacity must demonstrate that other non-capacity strategies have been evaluated/employed.

program.

Traffic Flow Projects

- 37 percent of available funds (approximately $3.2 million annually) are distributed for eligible projects.

- Back in 1997, Delaware DOT created an integrated transportation management plan that establishing a dedicated funding allocation for TSMO. The dedicated funding has allowed the department to continually invest in its transportation management system and staff, and to achieve the goals of the DOT's strategic plan. The strategic plan includes various TSMO solutions including:
    - Installation of fiber optic cables
    - Strategic corridor upgrades
    - Development and maintenance of the DelDOT app
    - Dynamic message signs
    - Weather stations
    - Artificial intelligence

Reorganized to align and program TSMO through the capital improvement process

Organizational realignment can materialize many benefits from a streamlined and purpose-driven structure that meets the needs of the DOT's constituents for today and tomorrow. It is worth noting that reorganization by itself is a tool to be used by leadership to recognize and support a culture of TSMO, operations and innovation and it may have been spurred by a desire for change by the staff and teams within the DOT. Regardless of how or why the reorganization occurs, it is a milestone for DOTs that are embarking on culture change due to TSMO.

- Maricopa County DOT reorganized in 2015 to be more TSMO-focused by bringing planning, traffic engineering and capital improvement into one TSMO office. Having the previously siloed departments under one office produced the following advantages:
    - Programming of the ITS strategic plan components (which include signal systems, signal improvements, TMCs and smart work zones) is included in capital projects with funding identified and considered for the ITS components.
    - Everyone is able to strategically maintain communication and up-to-date knowledge of which system improvements are needed.
    - It created the ability to get buy-in and program stand-alone projects that benefit the system overall or are considered operational improvements.

Key highlight: Maricopa County DOT reorganized by bringing planning, traffic engineering and capital improvement into one TSMO office enabling programming of ITS strategic plan components, enhance strategic communications and ability to get buy-in and program projects that are operational improvements.

Notable Project Evaluation Framework Components

At the project level, competition is fierce given the limited availability of funds. With the right evaluation framework, TSMO projects and solutions can score well above the competition because of the alignment of the evaluation framework to maximize efficient use of the entire transportation system and minimize the assumption that an expanded roadway is the best solution.

- The Atlanta Regional Commission's Project Evaluation Framework is developed in a way to:
    - Include policy filters to encourage operations for roadway capacity projects.
    - Guarantee performance measures for projects are only compared against other projects within the same category (i.e., TSMO, roadway capacity, transit expansion) to ensure no one type of project is dominant.
    - Ensure performance measures are tailored to each type of project.
- The Mid-America Regional Commission's evaluation framework incorporates TSMO into the evaluation criteria used to allocate funding to projects in the region. Incorporating TSMO into the framework provides a real incentive for local governments and other transportation agencies to consider strategies outside of the traditional capacity addition and allows TSMO to be taken into consideration by:
    - Maintaining consistency with regional plans and programs including but not limited to:
        - Metropolitan Transportation Plan
        - Regional ITS architecture
        - Congestion Management Process/Toolbox
    - Impacts to the regional freight network
    - Impacts to system performance
    - Requiring projects that add single-occupant vehicle capacity must demonstrate that other non-capacity strategies have been evaluated or employed before the project can be approved.
- Michigan DOT's Trunkline Program Operations Template's intent is to "provide funding for an integrated program to optimize the performance existing multimodal infrastructure…" The two-pronged strategy focuses on:
    - First, TSMO strategies and solutions to provide a more efficient use of existing transportation resources. Second, developing operational improvements to the existing trunkline system that will optimize the capacity of a roadway.
    - As other templates exist, the Trunkline Program considers the Safety Template and Operations Template (which includes ITS and traffic signals that were not previously a part of their call for projects process).
    - The templates combine safety, ITS, freeway operations, signal modernization and non-freeway operations to obtain TSMO approvals that develop into a process for program development.

Figure 1: Michigan DOT's Trunkline Operations Template Program Development Process Flow

Lesson Learned: An operations-focused template, like Michigan DOT's Trunkline Template, allows for the inclusion of individual or one-off templates. Processes can be combined and the template allows programming and funding in a coordinated and concurrent manner.

Unique initiative

The Livable Center Initiative (LCI) from the Atlanta Regional Commission is a unique initiative based upon the desire to create a transportation system to support livability within the Atlanta region. The LCI delivers an innovative and unique initiative through its recognition and focus for funding transportation projects at the community level, allows for zoning restructuring and focuses on reducing single-occupancy vehicle (SOV) travel.

- "The Atlanta Regional Commission's Livable Centers Initiative (LCI) is a grant program that incentivizes local jurisdictions to re-envision their communities as vibrant, walkable places that offer increased mobility options, encourage healthy lifestyles and provide improved access to jobs and services.[8]"
- Funding is put aside for funding transportation projects for communities that complete a livability plan and restructure their zoning to encourage higher density, mixed-use development.

[8] Atlanta Regional Commission Livable Center Initiative - https://atlantaregional.org/community-development/livable-centers-initiative

The program specifically focuses on reducing SOV travel and is used frequently for operations funding.

Notable Approach Through Stewardship as a Part of Cultural Change

Changing an organization's culture for TSMO is a challenging process. A notable approach from Iowa DOT is to encourage its staff and partners to maintain a stewardship focus as a part of that culture change. Recognizing the role that DOT staff and partners have in being trusted stewards of their transportation infrastructure, the culture of Iowa DOT allows for notable advances in funding TSMO. Iowa DOT was able to have its Transportation System Management Office propose low-cost infrastructure projects of $1 million or less as a part of project consideration, giving the projects a higher chance of being funded. The low-cost infrastructure projects were able to be included for consideration with minimal resistance because of the resonating message from their culture of being stewards of the system.

Another notable approach from Delaware DOT mentioned in the earlier section is its policy of Dig Once. The policy restriction on opening the road for a set period of years after construction creates a mindset of inclusion that allows for foundational elements and future-focused efforts to be considered and decided upon comprehensively. Examples include such as fiber optic cables and full-width pavement for possible hard shoulder running. With a mindset of inclusion, the team works together to ensure that all departments are heard and considered, allowing a stewardship culture to emerge within the DOT. (Usually suggested improvements along the roadway are considered.)

Lessons Learned for Programming for TSMO

The following list compiles lessons learned shared by the participants during this discussion session.

- Early engagement in capital projects is a necessity.
- Formal processes help ensure engagement and consideration occurs.
- Non-infrastructure needs are challenging, including funding for operating systems and labor to effectively operate new or expanded systems.
- Programming separate funds for TSMO can contribute greatly to TMCs and safety service patrols that have unique needs.

Questions from the Participants to the Participants – Programming

Question 1: The programming of funds for TSMO strategies and tactics sometimes takes longer than the implementation itself. Is there a way to streamline the programming process? For example, TIP modification is a 6-month process from initiation until approval. After the TIP, we need a funding agreement approved by the DOT and FHWA; this takes a minimum of three months. Some TSMO strategies can be implemented within a few months.

- Participant – Sometimes local funds are used for short projects due to the process effort and time duration of federal funds.
- Participant – Dedicated funding for operations projects outside of traditional funding processes helps for these types of projects.
- Moderator note – Other DOTs have been able to use maintenance funds as they become available for some of the improvements but is highly dependent on a case-by-case basis.
- Moderator note – Some DOTs have the ability to modify their TIP much faster, but the DOTs present at the summit recognized the need for streamlining the strategies and tactics for short duration improvement projects.

Designing for TSMO – Connecting Concepts and Missing Links

The design stage of the capital improvement process is the next evolutionary step needed in the adoption of TSMO for the transportation industry. As a key step, the priority for designers is to make planning concepts and goals a reality. The assumption for designers is that most system needs and project goals have been identified. While this assumption is generally true for the majority of the project, unique aspects for TSMO, including both technology and non-technology considerations, need to be communicated to designers.

Internal Updates Needed for Design

Through discussion with the participants, several distinct actions that every DOT can take emerged. The primary action is to perform an internal audit of all of a DOT's manuals and design guides to ensure that TSMO considerations are included, especially in design manuals. Designers typically will follow the design guidebooks, as well as the indications, considerations and conditions to account for normal design parameters and atypical design situations. Beyond ITS, a key benefit to updating the design manuals beyond ITS that TSMO benefits from updating the design manuals are the non-technology TSMO aspects that need to be taken into consideration. We discuss these in the next section.

Lesson Learned: The design manual can be a good resource to increase collaboration with IT, reducing design problems related to communication methods of ITS devices.

Lesson Learned: Updating design manuals manages the perceived liability that designers would have to take on and reduces hesitation to design for TSMO.

Action Item: Report on the status of reviewing and updating the DOT's manuals to include TSMO.

NOCoE Action Item: Collect and share elements of state manuals that include TSMO as a reference and example for other DOTs.

PennDOT has instituted a robust design process guided by its design manual series, which it considers and treats as a dynamic document. The TSMO Guidebook series that was mentioned previously in the planning section as part 1 is also intended to have design as part 2 of the TSMO Guidebook. Through this process, PennDOT has been able to increase collaboration with the IT department to reduce design problems related to communication methods for ITS devices. Including TSMO early in the design phase and instilling a culture of considering TSMO in all projects even if it's not implemented is beneficial to the overall adoption of TSMO within a DOT. Tennessee and Iowa DOTs have also begun the process to review and update their internal manuals. During this process, Iowa DOT learned that the update to the design manual was needed so that the designers don't feel like they have to take on additional liability.

Non-Technology TSMO

An important discussion point about including TSMO into design is the focus on the inclusion of ITS and operational technology. The participants highlighted the need to incorporate more of the non-

technology TSMO that is needed and the design process should include considerations beyond the devices. A few examples from participants are described below.

- The NCTCOG had a lesson learned in the design of a thruway that neither accounted for nor allowed emergency responders to access the thruway during emergencies or evacuate motorists if needed. This required the NCTCOG to go back and improve access for emergency responders after the project was completed.
- Delaware DOT has improved upon its Dig Once approach and it is now understood that departments or stakeholders need to communicate during the project since roadways are not allowed to be "opened up" for at least five years. The Dig Once approach provides an incentive for departments to voice their needs during the entire capital improvement process, especially during design.
- Tennessee DOT continues to work with designers to include pull-offs and safe access areas for maintenance and operations people. Admittedly, these aspects are not always addressed by designers and they are difficult to add afterward. Not having proper maintenance considerations on the roadway can later become a safety hazard for a DOT's maintenance and operations crew.
    - One successful change in design parameters for Tennessee DOT is that reinforced shoulders are now designed into every roadway. A policy and design change such as this becomes beneficial in institutionalizing TSMO within a DOT.

Key highlight: A change in design parameters for Tennessee DOT is to have reinforced shoulders now designed into every roadway.

- Maryland DOT and Washington State DOT are also working to have maintenance and operations included early in the design process. However, one challenge is the availability of staff to represent and provide input in key activities during the design process.
- Maricopa County DOT recognized the value of reviewing all of the final designs and updating or assessing the impact to ensure successful implementation of the intended design. They include systems design and equipment procurement, the Operations and Maintenance Plan, systems evaluation and an ongoing operations and maintenance cycle that considers a short-term cycle within a larger cycle.

Lesson Learned: Not having proper maintenance considerations on the roadway during design can later become a safety hazard for a DOT's maintenance and operations crew. DOTs are including maintenance and operations early in the design process.

Supporting TSMO Indirectly During Design

Regional organization participants shared insight into how their roles do not necessarily end at the planning and programming phase. Through their commitment to TSMO, regional organizations have found additional methods and effective ways to support TSMO indirectly during design. Each regional organization's approach is described below.

Atlanta Regional Commission

Through the Project Evaluation Framework, the Atlanta Regional Commission requires a complete street design and projects are given additional points if they include multi-modal and safety operations applications. Although efforts in planning and programming seek to include all operational analysis needed before getting to design, some projects get to design without consideration of TSMO

alternatives. Instead of putting up barriers to stall these project, the Atlanta Regional Commission works to remove barriers.

Through the Congestion Management Program's requirement to perform an alternative analysis that includes operations (which may not have been completed), the Atlanta Regional Commission allows for the project sponsor to apply for study funding to be used for the operations analysis. Providing study funding removes barriers if the program sponsor and project manager are not familiar with TSMO analysis or didn't account for it in the scoping of the project, thereby underestimating the required funds to complete the project.

Mid-America Regional Council

MARC as an MPO owns and operates the wireless network of over 1,200 network devices that serves as the backbone of the Operation Green Light communications network. MARC also manages and operates the shared regional arterial advanced management system software (ATMS) and CCTV server with its 27 partner agencies. Having led design and construction projects for the network, MARC has been able to provide valuable feedback and lessons learned to its partners, especially during design.

In addition to the lessons learned within the team at MARC, the region's Technology Plan within Operation Green Light allow for the collaboration needed on network devices, CCTV cameras, traffic signals and software being used. The regional partners for Operation Green Light also work to incorporate various TSMO strategies such as incident response and traffic flow optimization that are considered during design.

North Central Texas Council of Governments

NCTCOG benefitted from having one of its strong partners in TSMO, Texas DOT, send a letter to district offices requiring all districts include TSMO in future projects. The letter and requirement allowed for better conversations within NCTCOG and with local partners. Although design is being completed for TSMO, a challenge arose with procurement of innovative technology for TSMO.

TSMO projects that include innovative technology often need and activate a different procurement process than traditional roadway project structures, timeframes and contract needs. NCTCOG partner agencies, mainly Texas DOT, have struggled with procurement of innovative technologies identified during the design process. NCTCOG was requested to take over the procurement for these types of projects and examples include 511, auto vehicle detection technology to apply an HOV discount on managed lanes, private sector carpooling and trip reduction programs. The ability for TSMO to leverage all of its partners is a testament to removing silos and barriers to further advance the transportation system.

Lessons Learned for Designing for TSMO

The following list compiles lessons learned shared by the participants during this discussion session:

- The concept is important – get everyone on the right page with the concept and you have something powerful. If you have the concept and the funding, you can do anything.
- Inclusion of operations and maintenance teams in the design process, especially the design reviews, is beneficial. However, it does add additional staffing responsibilities and personnel across the agency that may be difficult to sustain.

- Specific disciplines (TSMO, for example) need to have ownership of associated content regardless of where associated manuals and documents reside.
- Sustaining expertise, particularly in smaller regions for a state DOT, is challenging when funding constraints exist across all programs.
- Updating state DOT design manuals with operations and maintenance needs to protect roadway workers is an important step for DOTs to undertake.
- Coordination with the state DOT Traffic Operations Division on administration of CMAQ grant projects leads to better designs.

Construction and TSMO – Addressing TSMO in Inspections and Work Zone Management

Construction occurs frequently, simultaneously and across the entire transportation system within a DOT's jurisdiction. The circumstances to consider for one construction project, as they relate to system performance, include other construction, maintenance, and recurring and non-recurring congestion. Although work zone Traffic Management Plans (TMP) are created to address multiple activities on the roadway during construction, the TMPs are created ahead of actual construction time frames and circumstances may have changed with new or unforeseen conflicting priorities. As conflicting priorities emerge, operations and TSMO strategies are considered a viable path for resolving them.

Tennessee DOT leveraged its freeway management program to implement proactive incident management and congestion management strategies. These utilized the DOT's existing TSMO efforts in traffic incident management, as well as its HELP Program. The proactive strategies were implemented during the DOT's I-440 Design-Build project and helped to manage expectations, performance metrics and the overall system performance to a positive outcome.

Managing and operating the system during construction activities requires additional resources beyond the already identified breadth and depth of what TSMO practitioners and departments do. (This is further explained in previous sections.) Notable practices from the participants are shared below that expand on construction inspection, detours, work zone impact analysis, work zone coordination and lessons learned.

Construction Inspection

TSMO pushes the boundaries of what a DOT typically constructs and installs on the roadway and transportation system. Advanced technologies require a skill set possessed by construction inspectors who are not staffed regularly by DOTs; services are contracted out as resources become available.

Some participants indicated that the current TSMO and operations staff need to complement the construction inspection activities, which introduces another layer of responsibilities for the operations staff. What is becoming apparent is the need to increase internal staff for construction engineering and inspection, along with additional on-call consultant support. Most of the participating DOTs do supplement consultant support for TSMO projects.

- For example, Maryland DOT relies heavily on the traffic and transportation consultant community for the inspection of ITS devices but lacks additional resources beyond its current staff.
- As another example, the Michigan DOT US-23 Flex project needed additional staff throughout the DOT including help at other TOCs to help manage construction impacts.

- Tennessee DOT was able to add two positions to its ITS deployment office by having its traffic operations and construction offices work together to fill the gap in needed technical expertise. Tennessee DOT will still need consultant support, but now has much-needed resources and expertise within the agency.
- Washington State DOT uses state DOT employees for most of its inspection work. The work is accomplished by a combination of ITS maintenance and construction electrical inspection personnel who are provided by the respective offices within each region, and in conjunction with headquarters divisions when necessary. Through this state DOT approach, the support and training associated with construction inspection of TSMO-related investments is shared by capital and operating programs funded at the program level.

Research idea: Synthesis of TSMO best practices in construction engineering inspection.

TSMO Considerations for Detours

TSMO keeps our perspective on how the system performs on a constant basis. During construction, detours are an integral portion of how the public interacts with the DOT and its partners. Regional agencies support detours with TSMO considerations through examples such as:

- NCTCOG partnered with Texas DOT (TxDOT) and other local partners to identify construction and work zones utilizing 511DFW and WAZE. In addition, traffic signal retiming and toll reductions have been utilized for a full road closure and detour along the Interstate-30 corridor. Regional partners have staged tow truck operators for quick clearance of crashes. These pilots were mostly funded with Congestion Mitigation Air Quality funding and Regional Transportation Council Local Funds.
- One area where MARC is directly involved in construction discussions is through the Operation Green Light traffic signal coordination and incident response program. Operation Green Light works with 27 agencies, including the Kansas and Missouri DOTs. The program provides support for arterial management work zone traffic management, detours and mitigation of freeway work zone impacts.

Work Zone Impact Analysis

Work zone impact analysis is a key function that is typically the responsibility of the TSMO group within a DOT. While every construction project may get different levels of analysis based on the assumed impact during construction, when an impact analysis is needed, the responsibility and expertise needed are usually found within the TSMO group.

Washington State DOT within its set of policies will provide guidance documents to supplement manuals for work zone rules and restrictions. One example of where analysis is needed is in determining the work hours during different construction stages. This is developed by the traffic operations group through a work zone traffic impact analysis. The proactive analysis to understand the impacts of the different construction stages and the impact to the transportation system can also provide key information for a DOT's public information officer to prepare and plan for messages during different stages. TMCs and ITS devices provide a significant portion of the data needed for this analysis in real-time and on a constant basis, leading to a robust analysis utilized by multiple groups within the DOT.

Work Zone Coordination - Changing the approach from project base to regional or statewide

One of the earlier participant questions concerns how operational costs are increasing because of operational conditions needed during construction stages and multiple work zones. This places a new strain on a DOT as resources are limited. Tennessee DOT's solution and change in approach was to create a statewide work zone engineer position who reports to the state traffic engineer. The ability to have an individual who can improve the coordination needed during construction, manage multiple work zone considerations and integrate innovative TSMO solutions for work zones makes this position a positive change for the DOT, which doesn't have to reply on individual project managers to remember innovative TSMO work zone strategies. Other notable efforts are made by DOTs to have a collective approach using their TMCs as a focal point to coordinate work zone activities.

Lessons Learned for Construction and Work Zones in TSMO

The following list compiles lessons learned shared by the participants during this discussion session:

- NCTCOG recognized that every DOT doesn't enter construction the same way. Some DOTs provide advanced notification, while other DOTs provide notification as closures occur. NCTCOG is working to hire a construction coordination contractor to help agencies within the region better coordinate construction activity. This position will help coordinate road closures to reduce the number of parallel facilities under construction at the same time.
- Proactive work zone impact analysis uses data from TMCS and ITS devices and concurrently provides robust analyses that can be used by multiple groups within a DOT.
- Development of work zone strategies needs to occur early in the development of the project and involve multiple disciplines.
- Innovative work zone strategies take dedicated staff to develop and effectively implement, often starting as pilot projects before being integrated into the TIP.

Question 1: Projects are costing more because of more staging during construction to prevent operational failures. Any other examples or experiences?

- Participant – Depending on the amount of construction activity and the specific type of operations needed during that time, combining operations activity from construction funds may be more efficient.
- Participant – Relationships with affected partners and departments have helped to absorb increased operational costs through the construction project.

Operations – Organizational Transitions and Insights into Common Expenses

Operations is a unique function inside a DOT. Within the concept of TSMO, operations is typically the cornerstone of a TSMO project/division within a DOT. It is where TSMO lives and breathes. Loosely defined, operations within a DOT revolves around the Traffic Management/Operations Center, service patrol and system management (including assets like software, databases and centralized systems).

Growth in operations is relative to the benefits found from the organizational tools, resources and capabilities of operations in each DOT. Maryland DOT takes a metrics-based approach to make the business case for growing its operations personnel, fleet size and capabilities. However, this approach does inevitably reach a maximum imposed by external and existential limitations that are separate from operations. Growth after reaching the maximum limit is a question for further innovation and study.

Understanding how operational changes affect the funding and programmatic aspects within a DOT can require a new template and transition plan that allows the DOT to plan, program and fund operations. Michigan DOT, under its Trunkline Program Operations Template, sought and started to transition its existing mechanisms into an Operations Template that would assist in aligning eligible work activities with reliable and recurrent sources funding sources. The six funding and program categories of the Operations Template are:

- Operations Set-Aside
    - Fund state activities such as MichiVan, Freeway Courtesy Patrol and the Southeast Michigan and West Michigan Traffic Operations Centers.
- Intelligent Transportation Systems
    - Fund the Statewide Traffic Operations Center, connected vehicle, RWIS, DMS, CCTV and fiber optic cable installation, etc.
    - Program includes capital and ITS operations and maintenance costs
- Non-Freeway Reliability and Operations
    - Focus on improving travel reliability and safe flow of traffic on the existing permanent, through travel lanes along non-freeway state trunkline corridors.
    - Work activities such as new turn lanes, increased storage length, roundabouts, signal improvements and active traffic management strategies
- Freeway Operations
    - Focus on improving travel reliability and safe flow of traffic on Tier I (Interstate) and Tier II (Non-Interstate Freeway) state trunkline corridors.
    - Complement road rehabilitation and reconstruction and/or bridge projects (not expected to fully fund a previously mentioned project).
- Safety
    - Focus on reducing fatalities and serious injuries on the state trunkline system. Address both spot locations and systemic fixes.
- Traffic Signals
    - Focus on the modernization of existing traffic signals and the installation of new traffic signal devices at locations that meet established traffic signal warrants. Note: Operations and maintenance for traffic signals are not funded from this program.

A unique aspect of operations is how state DOTs and local jurisdictions have strong connections due to the mutual support they give each other during incident management, special events and other non-occurring congestion. In addition to these activities, which require personnel from multiple agencies to coordinate cohesively, the National Traffic Incident Management Responder training has also produced connections that are developed and sustained primarily by the operations personnel in a DOT.

During this summit, the participants were asked to list expenses that go into a DOT's operations budget (which was suspected to be drastically different than operations in the 1990s). The list of expenses are:

Operations Sample Expense List

- Personnel (largest cost)
- Software and analysis tools
- System software subscriptions
- Utilities for TMCs, operational facilities and telecommunications
- Database – data servers, probe data

- Equipment – Freeway/Safety service patrol, automatic vehicle location, snow plow, road weather management devices
- Decision support systems, central software and software maintenance
- Integration of system components
- Implementation costs not previously accounted for in roadway projects

Lessons Learned for Operations in TSMO

The following list compiles lessons learned shared by the participants during this discussion session.

- Growth of TSMO within a DOT depends on many factors, but can also be limited by statewide or DOT wide policies.
- New or revamped templates for capital projects funding and programming provide opportunities to ensure operations (capital, operations and maintenance) are also included accordingly from the beginning.
- Procurement for capital projects within DOTs does not typically usually include expenses for operations activities. Ensuring the proper funding for those expenses is important for the implementation of TSMO strategies and tactics.

Maintenance – ITS to Asset Management to What's Missing

The symbiotic relationship between TSMO and maintenance provides an opportunity for DOTs to achieve the next level of organizational capability for the near future. The ability of a DOT to operate and maintain any new technology or innovative method and to meet or exceed public expectations will rely heavily on the DOT's ability to maintain its respective roadway infrastructure.

While ITS device maintenance and management is a typical starting point, it is important for DOTs to start developing a robust Asset Management Plan for TSMO. The Asset Management Plan for TSMO allows for expanding the thinking beyond ITS devices since TSMO provides the context for which ITS assets will be needed and at what level. Approaching the Asset Management Plan for TSMO also includes non-ITS assets that need to be maintained and managed in order to manage and operate the system. The state DOTs that indicated they are either starting to or have developed an Asset Management Plan for TSMO are:

- Maryland
- Iowa
- Michigan
- Delaware
- Washington

Lesson Learned: Know the restrictions that come with using federal funds for maintenance. Be able to differentiate between preventative maintenance vs. recurring maintenance.

ITS maintenance and management can be one of the early steps for a TSMO-focused DOT to determine, measure and improve its organizational capability. Leading DOTs have indicated the need to consider life-cycle replacement timeframes, full system replacements instead of partial upgrades, and developing a workforce plan for ITS maintenance needs. Maryland DOT estimated approximately 30-40 percent of maintenance is in-house compared to 100 percent at Washington State DOT. Regardless of where ITS

maintenance personnel are employed, the need for more qualified ITS and TSMO maintenance personnel is growing as systems are upgraded and more devices are added.

Research idea: Synthesis and best practices report for asset management of TSMO that build off of expected FHWA resources currently being completed.

Similar to understanding operational expenses, summit participants provided insights into what TSMO maintenance expenses are and ideal ways for TSMO maintenance to be funded. Insights from the participants are shared below.

TSMO Maintenance Cost?

- Personnel costs, including vendors
- Equipment (including vehicles) replacement/maintenance, physical network
- Software maintenance
- Software agreements/annual fees/re-development
- Databases/data management (QA/QC)/data collection/data development
- Physical facilities
- Lane shields/buttons (might be TSMO or traditional)
- Traveler information/communications applications
- Potential CAT devices
- Training
- Public outreach

Funding Ideas and Suggestions

- Operations and maintenance is funded at the same time a project is funded and allocated automatically.
- Determine how to minimize or develop win-win scenarios with the IT department for TSMO-related IT maintenance expenses.
- Create separate funds that bundle operational and maintenance activities:
    - One for all TMCs
    - One for service patrol trucks
    - One for utilities
    - One for software and databases

Lesson Learned: TSMO programs are utilizing pavement resurfacing projects for maintenance needs along the resurfacing roadways.

Within the discussion of TSMO maintenance, participants provided some challenges that each DOT handles differently and usually in an ad-hoc manner. As all DOTs improve their TSMO capabilities, it's important to share challenges and situations that require resources and funds above and beyond normal and proactive maintenance. The participants provided a list of challenges that relate to maintenance, but are not typical, below:

What are we missing?

- Recoup costs after external party disrupts telecommunications network (i.e., fiber cuts, wireless interference)
- HAZMAT cleanup
- Emergency management funds
- Program losses
- Special event costs
- Weather-related risks
    - Technical aspects are being research and improved on, including a capability maturity framework from FHWA and AASHTO COP on road weather management.
    - Areas related to funding are needed to synthesize and produce more sophisticated models.

Participants noted the FHWA TSMO fact sheet on asset management,[9] which includes five core questions for this topic. The five core questions are:

1. What is the current state of physical assets?
2. What are the required levels of service and performance delivery?
3. Which assets are critical to sustained performance?
4. What are the best investment strategies for operations, maintenance, replacement and improvement?
5. What is the best long-term funding strategy?

Lessons Learned for Maintenance in TSMO

The following list compiles lessons learned shared by participants.

- Know the restrictions that come with using federal funds for maintenance. Be able to differentiate between preventative maintenance vs. recurring maintenance.
- TSMO programs are utilizing pavement resurfacing projects for maintenance needs along the resurfacing roadways.
- Operations and maintenance funding needs are identified and allocated at the same time a project is funded.

TSMO Education Highlight

The efforts of ITS Heartland were recognized during this TSMO summit about the value of advancing TSMO education. ITS Heartland created the TSMO University Educational Program[10] to deliver monthly webinars and in-person trainings to broaden the implementation and integration of TSMO among ITS Heartland members. Through Strategic Highway Research Program 2 funding, ITS Heartland along with its consultant HDR Inc. facilitated two phases of the TSMO University Education Program.

[9] FHWA- Enhancing Transportation: Connecting TSMO and Asset Management - https://ops.fhwa.dot.gov/publications/fhwahop18094/index.htm

[10] ITS Heartland TSMO University - https://itsheartland.org/tsmo-university/. NOCoE case study is also available at https://transportationops.org/case-studies/its-heartlands-tsmo-university-educational-program

IDENTIFYING BARRIERS TO INNOVATIVE TSMO SOLUTIONS

Identifying what barriers potentially exist in implementing innovative solutions for transportation projects was an important aspect and purpose for the summit. So on the second day, attendees worked in groups to address specific transportation projects and the challenges an agency might face in funding and planning for that project.

The projects were taken from the Transportation Technology Tournament[11], a competition where students worked with transportation agencies to solve real world problems. They laid out a specific concept of operations but were generally absent of considering funding resources, planning processes or maintenance and operations costs. The absence of funding and costs in the projects are partially by design given the purpose of the Transportation Technology Tournament. The participants of the summit were asked to take the projects and solutions from the next generation of TSMO practitioners and, along with the ideal practices from the first day of the summit, provide insight into funding challenges that these projects could potentially face. The projects represent typical TSMO projects that would be encountered as their problem statements were provided directly by transportation agencies.

The summit participants split into groups with each group working on an innovative TSMO solution that came from the tournament students' solutions. Summit participants proceeded to work through each of their respective projects to identify funding, process, implementation barriers and the respective solutions then present these to the larger group. Application of the desired changes in funding and capital projects as discussed in the previous sections to the real world problem statements allowed for additional lessons learned. Lessons were hypothetical yet grounded in the collective experience of the summit participants. The suggested improvements from the summit participants are grouped into common thematic elements described below.

Capital Projects and Process

- Integration with capital projects instead of stand-alone TSMO/ITS projects is a suggested approach for funding and implementation of projects.
- Solutions tend to focus primarily on deployment and capital (hardware, devices, etc.) of the TSMO solution with minimal consideration of other TSMO aspects such as maintenance and traffic incident management.

Design

- Maintenance access, system needs and life-cycle consideration of all of the equipment that is deployed need to be considered.
- Traffic incident management access and operations should be considered, especially if working in arterials that are commonly congested during peak hours.

Data Management

- The entire aspect of procuring, operating, updating and funding data-focused and database projects is very different from existing DOT processes and practices.

[11] The NOCoE and the U.S. DOT ITS JPO PCB program host an annual competition for students to work directly with public agencies to solve real-world transportation problems utilizing ITS and TSMO solutions. https://www.transportationops.org/transportation-technology-tournament

- Elements of ownership, support costs, changes to DOT internal policies and processes, staffing and cybersecurity are all associated with new costs and require DOTs to consider a different approach for technology projects.

Estimating TSMO elements during planning and CIP process

- The ability of a DOT to be able to estimate and incorporate TSMO elements depends on the update of manuals and/or appropriate data and studies to justify the implementation of TSMO solutions.
- Consistency amongst DOTs to share the benefits, policies and approaches used to estimate and incorporate TSMO elements in solutions is needed.

The individual projects that the summit participants worked on are described in further detail below.

Addressing Arterial Wrong-Way Driving on One-Way Streets

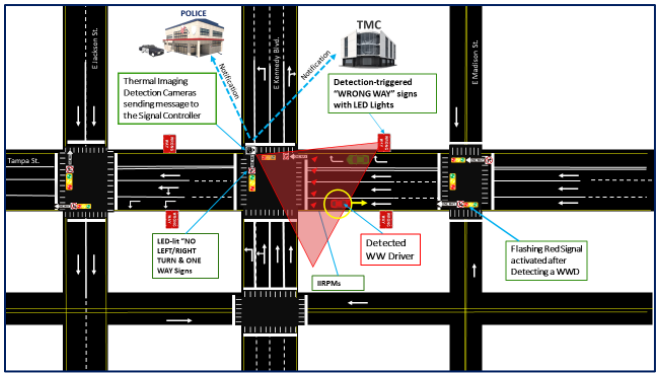
Project Description:

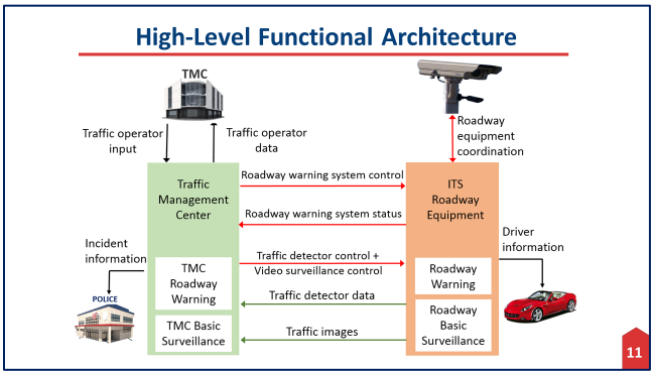
This project deployed a series of sensors, automated signage and in-road markers along several major corridors in Tampa to reduce wrong-way driving and to quickly inform drivers going the wrong direction on how to get off the road.

(Link to Project Presentation)

Implementation Challenges Identified:

- State Planning and Research Program (SPR) and HSIP costs may be used for initial build.
- Maintenance and life cycle costs will directly compete with the cost/benefit of the project over a 10-year span.
- Analysis and research costs need to be included to determine effectiveness of the implementation.
- Does emerging technology (CAV) replace the need for multiple ITS devices? Consider usage and applicability of ITS devices compared to CAV technology.




High-Level Functional Architecture
TMC
Traffic operator input
Traffic operator data
Roadway equipment coordination
Traffic Management Center
Roadway warning system control
Roadway warning system status
ITS Roadway Equipment
Incident information
Driver information
TMC Roadway Warning
Traffic detector control + Video surveillance control
Traffic detector data
Roadway Warning
POLICE
TMC Basic Surveillance
Traffic images
Roadway Basic Surveillance
11

Work Zone Database Creation and Maintenance

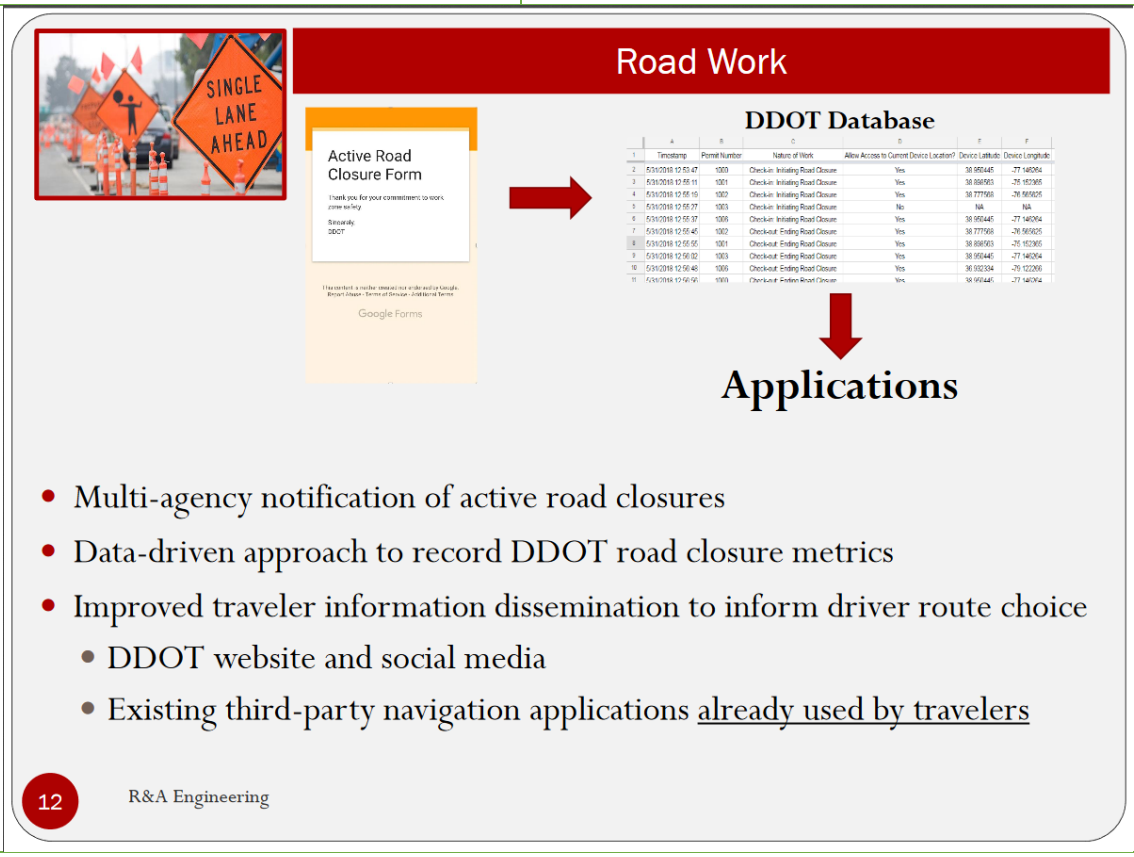
Project Description:

Developed for the District of Columbia DOT (DDOT), this project aimed to create a self-reporting database for work zone activities that would allow the district to work with Waze to divert traffic and mitigate congestion.

(Link to Project Presentation)

Implementation Challenges Identified:

- Who owns the app?
- Who maintains the app?
- How is it supported long term?
- Internal v. contractor support
- What is the cost of changes to business practice? (staffing, coordination with other groups, etc.)
- How do you ensure data quality? Who checks this?
- Are new staff needed to create this?
- Does the DOT have an ITS architecture already in place to support this? Or does this have to be set up?
- How frequently is this updated? Every second? Every few minutes?
- Can you use CMAQ funds?



Reducing Pedestrian Fatalities at intersections

Project Description:

This project aimed to deploy a series of ITS technologies and signage to reduce pedestrian fatalities at an intersection in Florida, including via sensors, cameras and potentially connected and automated transportation technologies.

(Link to Project Presentation)

Implementation Challenges Identified:

- While development and design costs might be funded by HSIP or a Surface Transportation Program Block Grant it will be difficult to plan for ongoing maintenance costs.
- Costs around data and software are currently unpredictable at many DOTs and outside contracting must be engaged.
- Inclusion of maintenance and life cycle costs for an estimated time frame into capital project costs may be possible.

Proposed Solution

Physical Architecture of the Proposed Technology

[1 and 3] Automated pedestrian detectors physical locations

[2] Dedicated short range communication (DSRC) (discussed later)

[4] Pedestrian detection zone

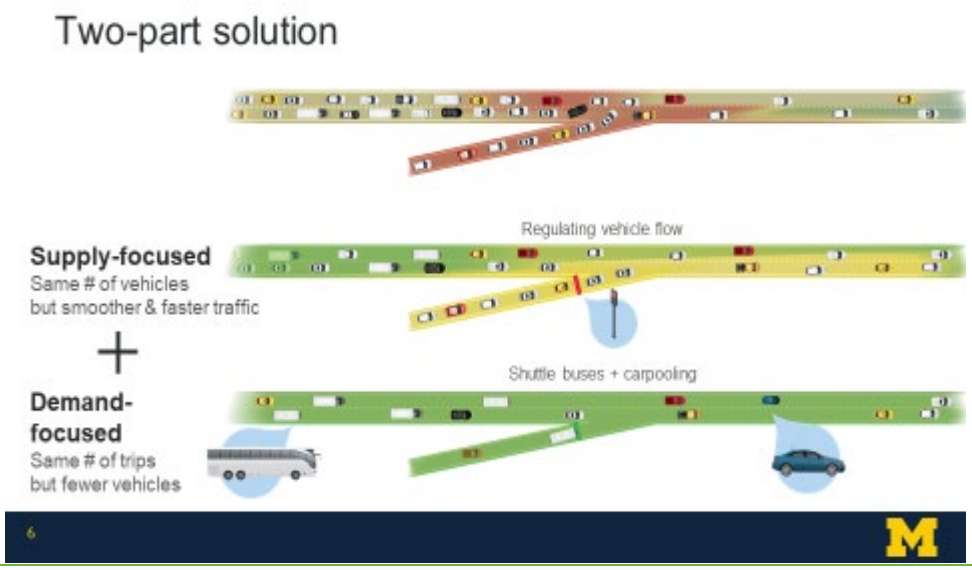
[5] Internally illuminated in-pavement marker location

[6] Connected vehicle transmission to the DSRC (discussed later)

[7] Traffic control cabinet, housing the signal system controller and the IIIPM controller

[8] Cross-walk 1 and [9] Cross-walk 2

7

Managing and Addressing Supply and Demand Challenges in a Corridor	
Project Description: This project deployed two strategies to help reduce congestion on a major corridor in Michigan. First, a Transit Demand Management Program, including the building of park and rides, developing a van pooling program, and ride sharing applications for commuters. Additionally, a signal timing evaluation and adjustment to better manage the corridor. (Link to Project Presentation)	**Implementation Considerations Identified**: • Federal Transit Administration and Federal Motor Carrier might be good sources of funding to supplement state and local funds. • Do signal timing costs include the cost to integrate with the corridor? • A phased approach as part of the larger corridor management program can help reduce costs. • Has the traffic incident management plan been identified? It can be a lower cost solution to reducing congestion.
	

ACTION ITEMS: RESEARCH AND RESOURCE NEEDS

Through the process of exploring and synthesizing current leading practices, summit attendees were also able to discuss major challenges and to identify research and resource needs for future funding of TSMO. Many of these challenges can be addressed by the knowledge needs, research ideas and NOCoE action items identified below.

Table: TSMO Knowledge Needs, Research Ideas and NOCoE Action Items

	Knowledge/Research Need	Details
TSMO Knowledge Needs	Examples of agency manuals that include TSMO	AASHTO CTSO and industry groups represent State DOTs and public sector organizations to update their DOT manuals to be TSMO inclusive. Some states have already started this. **NOCoE Action Item: As DOTs share their updated manuals and materials, NOCoE can provide a compiled landing page to share with the TSMO industry.**
	Data governance best practices to show multi-agency acceptance	Regional collaborations bring together state, regional and local agencies that also benefit from sharing data with each other. Data governance is becoming increasingly important to ensure agencies are able to gain multi-agency acceptance.
	Expand TSMO in design and construction	Collect, synthesize and transfer examples of the TSMO practice being emphasized and prioritized in the design and construction phases.
	How to handle digital projects, equipment and software in an agency's budget	Existing funding processes do not easily allow for digital projects. Confusion for responsibility around IT vs. ITS and TSMO departments account for part of this, as do ad hoc procurement processes. Being able to define an end-to-end funding plan and process for these projects would allow for more efficient development. It might also serve to update regulations among federal and state funding processes to allow for more easily acquired digital infrastructure. *Search for existing work and encourage knowledge sharing.*
	How to budget and program	A suggested activity to identify operations and

	Knowledge/Research Need	Details
	operations and maintenance (O&M) for projects	maintenance costs at the time of project funding necessitates a method to identify costs properly. Research around successful practices across a variety of funding models would enable agencies to ensure projects are properly funded for full operations and maintenance. *Search for existing work and encourage knowledge sharing.*
Research Needs	How to handle funding TSMO projects with short time frames	Absent a steady funding source for operations, many agencies struggle with how to develop projects that are low cost and within short time frames that don't mirror the standard process of planning, design and constructing. Various approaches include incorporating improvements into resurfacing projects, however this type of approach only suits certain projects and is largely dependent on maneuvering interagency processes. Are there other practices beyond establishing that steady funding source that would allow for TSMO projects? How can these practices leverage federal and local funds? *Possible NCHRP or other quick research opportunity (Existing ideas may have already been submitted by others.)*
	TSMO best practices in construction inspection	Construction inspection for roadway projects and in particular ITS implementation projects are evolving constantly as technology and processes change. Synthesizing current, leading and best practices would be beneficial for timely dissemination. *Possible opportunity to work with construction industry groups specializing in inspection*
	Asset management for TSMO	Several states are starting to develop asset management programs for their operations and ITS departments, however guidance in this area would be beneficial for efficient implementation.

	Knowledge/Research Need	Details
		NOCoE Action Item: 2020 peer exchange on asset management for TSMO scheduled.

NEXT STEPS

To implement these actions, NOCoE plans to take the following steps:

1. **NOCoE will present research needs to AASHTO's Committee on Transportation System Operations (CTSO) and Transportation Research Board's Operations Committees during 2020 evaluation cycle.** Utilizing the recently standardized process to collect, evaluate and promote operations research needs, NOCoE will lead the process to develop research needs statements around the areas identified above with assistance and input from summit attendees. NOCoE will then present, promote and submit these statements within the operations research community in hope of adoption for a research project.
2. **Expand upon action items that NOCoE can take, using examples of success stories found during the summit.**
3. **Connect funding process and challenges with workforce development efforts in the industry.**
4. **Develop online tool to capture state funding process and profiles.**
    a. Other states will be contacted around a similar structure as presented in this report.
    b. Check with participating agencies within three years to collect any changes, improvements and new challenges and to update this report accordingly.

APPENDIX A:

FUNDING SOURCES ELABORATION

2019 National NOCoE TSMO Summit on Funding and Policy & Planning Integration

Michigan Department of Transportation

Trunkline Program Operations Template

Definition of Operational Improvement

An Operational Improvement is any improvement that results in restoring or optimizing theoretical capacity and/or improves travel reliability and safe flow of traffic on the existing number of permanent, through travel lanes within the corridor.

Template Purpose

This template is intended to provide funding for an integrated program to optimize the performance of existing multimodal infrastructure by implementing systems, services and projects to maximize capacity and/or improve the security, safety and reliability of the transportation system.

The Michigan Department of Transportation (MDOT) employs a two-pronged strategy to accomplish this. First, the department utilizes Transportation Systems Management and Operations (TSMO) strategies and solutions to provide a more efficient use of existing transportation resources by implementing strategies, deploying technologies and integrating systems to address freeway and arterial congestion, improve safety and mobility, and encourage sustainability. TSMO solutions are specifically designed to address nonrecurring issues and include solutions that increase mobility, reliability and safety during incidents, bad weather, work zones and special events by better managing and operating roads that MDOT has already constructed. TSMO solutions are intended to require relatively little capital investment and are less expensive, less disruptive and much faster to implement.

Secondly, MDOT will develop operational improvements to the existing trunkline system that will optimize the capacity of a roadway and address recurring congestion issues. These types of improvements can be higher-cost fixes that can be coordinated with other projects that address condition and/or safety or can be stand-alone projects that only address operations.

The Safety Template is being brought under the framework of the Trunkline Program Operations Template to better coordinate operations and safety work and maximize the contribution towards improving the safety of the statewide transportation system. The Operations Template does not change the program goal, selection criteria, management or funding associated with the Safety Template. The Safety Template continues to support MDOT's safety goal of reducing fatalities and serious injuries on

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Michigan Department of Transportation (cont.)

Template Purpose

the state trunkline system in support of Michigan's Strategic Highway Safety Plan and the department's efforts of achieving the vision Towards Zero Deaths. The strategy of the Safety Program is to address correctable fatality and serious injury crashes, with cost effective safety improvements.

Intelligent Transportation Systems (ITS) and traffic signals are not currently part of the CFP, but are being brought under the Operations Template and the CFP approval process. There is no change to the program development and management of the Signs, Pavement Marking or Delineators programs.

The Fiscal Year (FY) 2024 Highway CFP was issued on April 4, 2018. A Congestion Mitigation/ Air Quality (CMAQ) Program for FY 2024 was included in this CFP but has since been rescinded and will no longer be a separate template category. Over the years, MDOT has been using CMAQ as a work program and selecting projects through the CFP process. However, CMAQ is a federal funding apportionment similar to IM, Surface Transportation Program (STP), National Highway Performance Program (NHPP), etc. with restrictions and requirements.

In order to more effectively utilize CMAQ funding within MDOT and better align its intended use, the funding (apportionment and associated obligation authority) will be used as a federal source for the Operations Template. Decisions and project selection for CMAQ funding would still meet federal regulations and eligibility requirements, however they would be governed by program development processes outlined in the following pages.

Proposed Funding Source(s)

Federal Surface Transportation Program, National Highway Performance Program, Highway Safety Improvement Program (HSIP), CMAQ, and state "M" funds.

Examples of Eligible Work Activities

- New Turn Lanes/Increased Storage Length
- Active Traffic Management Strategies
- Roundabouts/Signal Improvements
- On/Off Ramp Improvements
- Interchange/Intersection Improvements
- Traffic Operation Centers
- MichiVan
- Freeway Courtesy Patrol
- Geometric Improvement
- Horizontal Alignment

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Michigan Department of Transportation (cont.)

Examples of Eligible Work Activities

- Shoulder Widening
- Connected Vehicle Infrastructure
- Road Weather Information System (RWIS)
- Traffic Signal Intercom and Upgrades
- Dynamic Message Systems
- Closed Circuit Television (CCTV)
- Fiber Optic Cable Installation
- Camera Pole Construction

Operations Template Funding and Program Categories

The Operations Template will begin in FY 2019, transitioning to full implementation in FY 2024. The Operations Template would be comprised of the following program categories and initial funding allocation.

•Operations Set-Aside	•$14 Million	•(currently OTT CMAQ F.A.)
•Intelligent Transportation Systems (ITS)	•$16 Million	•(currently non-CMAQ F.A.)
•Non-Freeway Reliability and Operations	•$10 Million	•(currently MDOT CMAQ)
•Freeway Operations	•$40 Million	•(currently non-CMAQ F.A. and MDOT CMAQ)
•Safety	•$21.5 Million	•(currently non-CMAQ F.A.)
•Traffic Signals	•$18.6 Million	•(currently non-CMAQ F.A.

The plan is to fully implement the Operations Set-Aside, ITS, Non-Freeway Reliability and Operations, and Freeway Operations programs by FY 2024. The transition plan to accommodate full funding of $90 million for these programs is documented on pages 7-8 of this document.

Operations Steering Committee

An Operations Steering (OPS) Committee, composed of the Operations Set-Aside, ITS, Non-Freeway Reliability and Operations, Freeway Operations, Safety and Signals System managers and the region TSMO champions listed below, would coordinate the programs under the Operations Template. Their primary responsibility will be to ensure that this comprehensive set of programs are coordinated and contribute to the safety, reliability and operations of MDOT's state trunkline system. In doing this, they will ensure that the individual programs' goals and selection criteria are aligned and contribute to specific, overall template goals for safety and reliability. Furthermore, they will ensure that the projects selected across the template are maximizing the value that the individual programs contribute to the overall safety and reliability of the statewide transportation system. They would also be responsible for reviewing and recommending approval, as appropriate, the programs that go through the Integrated Highway Call for Projects process to the CFP Approval Committee.

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Michigan Department of Transportation (cont.)

Region TSMO Champions

To assure that TSMO solutions are considered in program development, especially the Integrated Highway CFP, TSMO champions have been designated in each region. These champions will be involved in the development of each region's programs and look for opportunities to implement TSMO in the region's CFP submittal. The region TSMO champions are listed below.

CMAQ Eligibility Team

As identified earlier, federal CMAQ funds are intended to be one of several sources of funding for the Operations Template. CMAQ has specific requirements that must be considered prior to a project being eligible for funding. In order to correctly assess funding availability and project eligibility, a CMAQ Eligibility Team will be established. Project level CMAQ eligibility would be determined prior to a program being submitted to the CFP Approval. The CMAQ Eligibility Team will be led by the CMAQ Program Manager, Matt Galbraith.

Program Categories

- **Operations Set-Aside – $14 Million**
  System Manager – Collin Castle
  This program will fund statewide activities such as MichiVan, Freeway Courtesy Patrol, and the Southeast Michigan and West Michigan Traffic Operations Centers. These activities have traditionally been CMAQ eligible, therefore we propose to continue to finance this work with CMAQ funds, if still eligible under the new CMAQ requirements. It is anticipated that this program would require increased funding over time as activities are expanded and/or ongoing operations and maintenance (O&M) is increased.

  Program needs would be solicited by the system manager. The system manager will review and prioritize the requests consistent with the constrained budget and program direction. The recommended program will be submitted to the CMAQ Eligibility Team to determine which projects are eligible for CMAQ funding. If the project(s) is deemed CMAQ eligible and funding is available, it would receive CMAQ funding; otherwise it would be programmed with another more appropriate federal or state funding source. The program would then be forwarded to the Statewide Transportation Planning Division (STPD) for final constraint and strategic direction review. STPD submits the recommended Operations Set-Aside program to the Operations Set-Aside System manager for final approval. The Program Development Process Flow is illustrated on page 9.

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Michigan Department of Transportation (cont.)

Program Categories

- **ITS – $16 Million**
  System Manager – Collin Castle
  This program will fund the Statewide Traffic Operations Center (STOC), connected vehicle infrastructure and integration; RWIS; DMS; CCTV; communication, power, and maintenance; camera pole construction; fiber optic cable installation; etc. This program includes capital and ITS O&M costs. O&M costs that are no longer CMAQ eligible, but are required to support the program, will be funded from other federal or state funds.

  Program needs should be identified by each region and project candidates submitted to an ITS subcommittee annually. The subcommittee will also review and recommend projects and ensure the program/project is meeting goals, strategic direction and funding targets. Candidates will be prioritized, and recommendations forwarded to the Operations Steering Committee for review. If CMAQ funding is being requested, the CMAQ Eligibility Team will review the project for funding eligibility. If the project(s) is deemed CMAQ eligible and funding is available, it would receive CMAQ funding; otherwise it would be programmed with another more appropriate federal or state funding source. Because ITS is now part of the CFP process, recommended candidates will be forwarded to the CFP Approval Committee for approval with final selections announced by MDOT's chief administrative officer (CAO) and chief operations officer (COO). The Program Development Process Flow is illustrated on page 10.

- **Non-Freeway Reliability and Operations – $10 Million**
  System Manager – Jason Firman
  This program will focus on improving travel reliability and safe flow of traffic on the existing permanent, through travel lanes along non-freeway state trunkline corridors. This would be a statewide competitive program primarily focusing on Tier 3 (non-freeway National Highway System [NHS]) and Tier 4 (non-NHS trunkline) corridors, although it does not preclude operational improvement on Tier I or II freeway corridors.

  Eligible work activities under this program would include new turn lanes, increased storage length, roundabouts, signal improvements, interchange and intersection improvements, and active traffic management strategies. At a minimum, a benefit/cost threshold would be required for projects eligible for this funding.

  Project selection will occur through the annual Highway CFP process. A Non-Freeway Reliability and Operations subcommittee of the CFP would be established to review and recommend projects and ensure the program/project is meeting goals, strategic direction and funding targets.

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Michigan Department of Transportation (cont.)

Program Categories

The subcommittee composed of central office and region members will develop criteria for project evaluation. Regions should submit candidate projects for consideration annually as part of the CFP. The subcommittee submits the program to the Operations Steering Committee for review. Concurrent with this review, the CMAQ Eligibility Team will review the proposed program prior to submission to the CFP Approval Committee. If projects are deemed eligible and CMAQ funding is available, they would be programmed accordingly; otherwise they would receive the appropriate federal or state funding. The recommended candidates should be forwarded from the Operations Steering Committee to the CFP Approval Committee for approval with final selections announced by MDOT's CAO and COO. The Program Development Process Flow is illustrated on page 10.

- **Freeway Operations – $40 Million**
  System Manager – Jason Firman
  This program will focus on improving travel reliability and safe flow of traffic on Tier I (Interstate) and Tier II (Non-Interstate Freeway) state trunkline corridors. This program will be part of the annual Highway CFP and run competitively statewide with selection based primarily on the benefit/costs of the project. It is anticipated that funding would complement MDOT Road Rehabilitation and Reconstruction (R&R) and/or bridge projects, rather than fully funding a project. A Freeway Operations CFP Subcommittee will be established with members from central office and the regions. The subcommittee would develop criteria for project evaluation.

  The Statewide and Urban Travel Analysis Section of the Bureau of Transportation Planning will work with the region systems managers and planners to identify travel issues within their geographic areas. The region requesting funding will submit a scoping document and application/funding request to the Freeway Operations CFP Subcommittee for consideration during the annual CFP. The Freeway Operations subcommittee will review the candidate projects and make recommendations consistent with the programs goals, strategic direction, and funding. The subcommittee submits the program to the Operations Steering Committee for review. Concurrent with this review, the CMAQ Eligibility Team will review the proposed program prior to submission to the CFP Approval Committee. If projects are deemed eligible and CMAQ funding is available they would be programmed accordingly, otherwise they would receive the appropriate federal or state funding. The recommended candidates should be forwarded to the CFP Approval Committee for approval with final selection and announcement made by MDOT's CAO and COO. The Program Development Process Flow is illustrated on page 10.

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Michigan Department of Transportation (cont.)

Program Categories

- **Safety – $21.5 Million System Manager – Mark Bott**
  The focus of this program is to reduce fatalities and serious injuries on the state trunkline system. Projects that address both spot locations and systemic fixes are encouraged. The safety program is well established and has been part of the Highway Call for Projects for many years. This program is also a means for MDOT to support the goals of the Michigan Strategic Highway Safety Plan. Regions are allocated funding and a small statewide discretionary fund is also available on a competitive basis. Funding targets are set based on vehicle miles traveled and lane miles in relation to the percentage of fatalities and serious injuries in each region.

  Proposed projects must be supported by the region's Toward Zero Deaths Implementation Plan and meet specified Time of Return requirements. Projects are identified by the regions and submitted to the subcommittee for consideration during the annual CFP. The Safety subcommittee will review the candidate projects and make recommendations consistent with the programs goals, strategic direction and funding. The subcommittee submits the program to the Operations Steering Committee for review. The recommended candidates should be forwarded to the CFP Approval Committee for approval with final selection and announcement made by MDOT's CAO and COO. The Program Development Process Flow is illustrated on page 10.

- **Traffic Signals – $18.6 Million System Manager – Hilary Owen**
  The Traffic Signals program is focused on the modernization of existing traffic signals and the installation of new traffic signal devices at locations that meet established traffic signal warrants. Operations and maintenance for traffic signals is not funded from this program. For the signal modernization portion of the program, Lansing Operations Field Services Systems Operations Section identifies signal locations that are eligible for modernization funding and sets statewide priorities. The regions and Transportation Service Centers (TSCs) are consulted during the selection of the devices that will be modernized to better coordinate signal work with other capital programs in the region. To better coordinate this work with the rest of the MDOT, the Traffic Signal Modernization Program is included in the annual Integrated Highway CFP.

  <u>Signal Modernization</u>
  Project candidates for modernization projects will be identified using the current process. A Signal subcommittee of the CFP will be established to review and recommend projects and ensure the

2019 National NOCoE TSMO Summit on Funding and Policy & Planning Integration

Michigan Department of Transportation (cont.)

Program Categories

program/project is meeting goals, strategic direction and funding targets. The subcommittee submits the program to the Operations Steering Committee for review. The subcommittee will include central office and region members. The CMAQ Eligibility Team will review the proposed program prior to submission to the CFP Approval Committee. When funding is available, projects deemed eligible for CMAQ funding would be programmed accordingly, otherwise they would receive the appropriate federal or state funding. Signal modernization is part of the CFP process and recommended candidates should be forwarded to the CFP Approval Committee for approval with final selections announced by MDOT's CAO and COO. The Program Development Process Flow is illustrated on page 10.

New Signals

The installation of new traffic signals is identified through requests from various sources that are filtered through the TSCs. These requests are then forwarded to the Office of Field Services (OFS) for further study to see if particular locations meet one or more of the various traffic signal warrants and qualify for the installation of a traffic signal. Due to the more random nature of this type of work, it is recommended that the installation of new traffic signals remain outside the Integrated Highway CFP process.

Operations Transition Plan

MDOT currently has several investment templates and project commitments that support funding and operations of state trunklines. To facilitate an orderly transition from these existing mechanisms to the new Operations Template, the transition plan in the table below will be implemented. The uncommitted funding is anticipated to be utilized for new projects submitted through the CFP process beginning in FY 2019.

The FY 2018 Highway Program contains $20 million for additional operations work. To date this funding is uncommitted. These funds will be allocated to the new Operations Template in the following manner: $5 million to the Non-Freeway Reliability and Operations Program and $15 million to the Freeway Operations Program. In order to provide sufficient time to develop and select projects for the Non-Freeway Reliability and Operations Program, funding for FY 2018 ($5 million) may need to be combined with FY 2019 funding ($5 million) and the first year of implementation begin in FY 2019. To provide enough time to develop and select projects for the Freeway Operations Program, funding for FY 2018 ($15 million) and FY 2019 ($22 million) may need to be combined with FY 2020 ($30 million) and the first year of implementation begun in FY 2020.

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Michigan Department of Transportation (cont.)

Operations Transition Plan

Projects that are proposed to have operations funding supplement other funding sources will have to be submitted to both the Operations Steering Committee and the other program subcommittees for approval. Since Operations funding is competitive statewide, projects seeking full or partial funding from the Operations Template will need approval in advance of other funding templates, similar to the Freeway Resurfacing Program. Proposed operations projects should be approved before the preliminary submittal for other programs.

The FY 2024 Highway CFP was issued on April 4, 2018. A CMAQ Program for FY 2024 was included in this CFP but has since been rescinded and will no longer be a separate template category. Over the years, MDOT has been using CMAQ as a work program and selecting projects through the CFP process. However, CMAQ is a federal funding apportionment similar to IM, STP, NHPP, etc., with restrictions and requirements. In order to more effectively utilize CMAQ funding within MDOT and better align its intended use, the funding (apportionment and associated obligation authority) will be used as a federal source for the Operations Template. Decisions and project selection for CMAQ funding would still meet federal regulations and eligibility requirements, however they would be governed by program development processes outlined in the previous pages.

The Operations Transition Plan would not impact funding of the Safety or Traffic Signals programs. They will continue with the funding established by the existing Highway Investment Strategy.

Funding Transition

	2018 New Funding	2019	2020	2021	2022	2023	2024
Current CMAQ Commitments	-	$23M	$13M	$23M	$19M	$16M	$0
Set-Aside	-	$14M	$14M	$19M	$19M	$19M	$19M
Intelligent Transportation Systems	-	$16M	$21M	$21M	$21M	$21M	$21M
Non-Freeway Reliability and Operations	$5M ⟺	$5M	$7M	$5M	$6M	$7M	$10M
Freeway Operations	$15M ⟺	$22M ⟺	$30M	$22M	$25M	$27M	$40M
Totals		**$80M**	**$85M**	**$90M**	**$90M**	**$90M**	**$90M**

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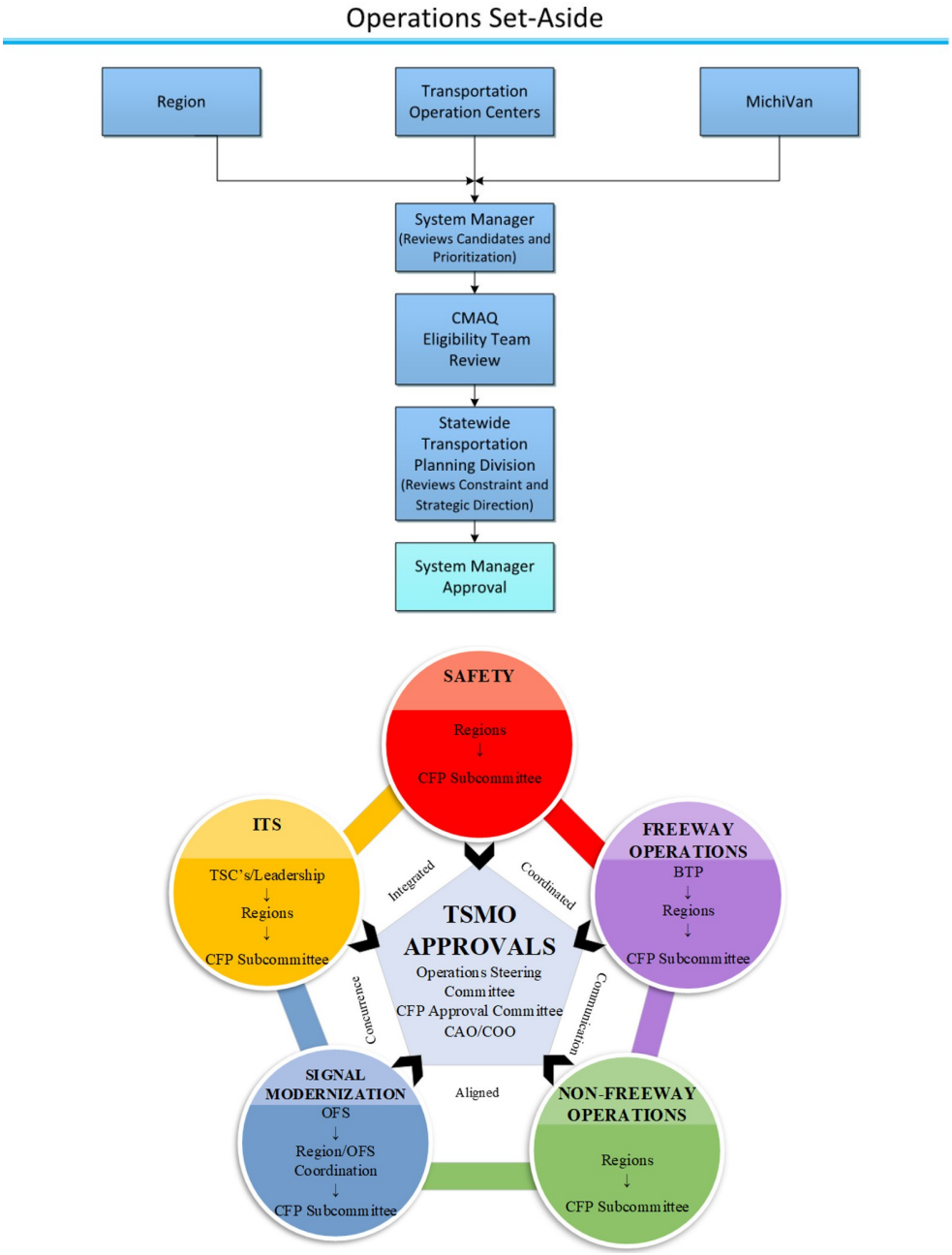
Michigan Department of Transportation (cont.)

Program Development Process Flow



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Pennsylvania Department of Transportation

Integrating TSMO into Programming

INFO	•PA has 11 Engineering Districts, 24 MPO/RPOs. •The 24 regions have individual TIP (Transportation Improvement Program), TYP (12 Year Program), and LRTP (Long Range Transportation Plans) •Each region prepares programs based on guidance provided by PennDOT Central Office (CO)
FUNDING	•PA updates STIP (Statewide Transportation Improvement Program) / TIP / TYP every two years based on financial guidance which provides regional funding allocations for federal & state capital funds •Positions within the PennDOT Program Center to utilize SPR (State Planning & Research program) to do a lot of our programming functions •TSMO Funding Initiative: set-aside capital federal funding to incentivize regional TSMO projects; has helped to advanced statewide initiatives
POLICIES	•Current FFY 2019 STIP Executive Summary is available at: https://www.talkpatransportation.com/assets/docs/2019/2019-2021-STIP.pdf •Draft FFY 2021 Financial and General & Procedural Guidance documents can be found at: https://www.talkpatransportation.com/perch/resources/2021stipguidance.zip •TSMO Guidebook Part I: Planning
LESSONS LEARNED	•Transportation needs exceed available funding •Competing priorities for available funding and potential overlap with multiple benefits (i.e., Highway Safety efforts) •PA has taken steps to integrate TSMO into guidance documents to ensure given consideration for programming

2019 National NOCoE TSMO Summit on Funding and Policy & Planning Integration

Pennsylvania Department of Transportation (cont.)

Integrating TSMO into Planning

INFO	•PA has 11 Engineering Districts, 24 MPO/RPOs. •Each district has a planning & programming manager •Most districts have a planner •Each region prepares programs based on guidance provided by PennDOT Central Office (CO)
FUNDING	•Utilizes SPR (State Planning & Research program) funds for program center and district funding •Utilize SPR funds as part of Regional UPWP •Utilize federal and state capital TIP funds for planning studies •Utilize SPR funds for planning studies
POLICIES	•PennDOT Connects •UPWP (Unified Planning Work Program): agreement between PennDOT and the MPO/RPO for the activities that they will undertake during a two-year period •Regional LRTP guidance document is in the process of being updated •Statewide LRTP is being updated; this set the direction for the Regional LRTPs / TIPs / TYPs •TSMO Guidebook Part I: Planning •Develop a ROP (Regional Operation Plan) for each of the four RTMC (Regional Transportation Management Centers)
LESSONS LEARNED	•Working towards creating position in each district to help as a liaison between the engineering staff and the MPO/RPO, and to help integrated PennDOT Connects •Work to build stronger relationships between Central Office operations and planning staff •Utilize TSMO Funding Initiative to supplement operating funds to support INRIX data usage

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Pennsylvania Department of Transportation (cont.)

Integrating TSMO into Design

INFO	•Have a robust design process in PA guided by our Design Manual series, which is a dynamic document •Additional documents are issued on specific topics to support federal requirements •PA primarily uses consultants for the design of ITS / TSMO
FUNDING	•Program design as part of the TIP, which is federal & state funding •TSMO Funding Initiative to promote stand-alone ITS / TSMO projects
POLICIES	•TSMO Guidebook Part II: Design
LESSONS LEARNED	•Increased collaboration with IT to reduce design problems with communication methods for ITS devices •Identified that TSMO needs to be considered early in the design phase •Need to insure that TSMO is considered in all projects, even if not implemented •Don't want to miss an opportunity to include TSMO on a project even if it was not initially considered for the project

2019 National NOCoE TSMO Summit on Funding and Policy & Planning Integration

Pennsylvania Department of Transportation (cont.)

Integrating TSMO into Construction

INFO	•Goal of +$2 billion in lettings for construction projects •PA primarily uses contractors for the construction of ITS / TSMO •Some emergency projects could utilize Department forces
FUNDING	•Program construction as part of the TIP, which is federal & state funding •TSMO Funding Initiative to promote stand-alone ITS / TSMO projects
POLICIES	•Pub 408, which includes construction items for TSMO •AWZE (Automated Work Zone Enforcement)
LESSONS LEARNED	•Moving towards consideration / implementation of TSMO on all Capital Construction Projects

APPENDIX B: TSMO IN CAPITAL IMPROVEMENT PROCESS

NOCoE
National Operations Center of Excellence

Integrating TSMO Into Planning

Atlanta Regional Commission

-ARC is currently in the process for creating a Regional TSMO Plan
-Task list includes:

1. Develop a Regional TSMO Vision
2. Document Current TSMO Inventory
3. Research Data Governance Best Practices
4. Regional ITS Architecture Update
5. Identify Pilot Concepts for Advanced Technology Deployment
6. Develop Local Agency Deployment Guide
7. Develop Regional Technology Assessment and Strategic Plan

1. **Overall Vision:** Transportation systems across the Atlanta region are managed and operated to optimize safe, reliable and efficient travel for all system users – people and freight – contributing to sustainable economic growth and a high quality of life. Goals: Optimizing safety, reliable travel times, efficient and seamless travel, equitable access.
2. **Inventory included:** Fiber, connected traffic signals, cameras, warning systems, transit assets, etc.
3. **Data Governance** is included to recognize the reality that TSMO applications are becoming more connected and we need strong systems in place to be able to use the data we could collect.
4. **ITS Architecture:** The last update happened in 2004. The new architecture is now available to view in draft form as a website. It also includes connected vehicle assets.
5. **Pilot Ideas:** Regional partners submitted pilot project ideas for us to gauge the interest in transportation technologies in the region. We are using those ideas to rethink our Project Evaluation Framework to help make it work for varied project types that are considered TSMO, including CV and app projects.
6. **The Local Agency Deployment Plan** will include information of different types of TSMO applications, when they are most effective, the challenges of implementation and examples of where they have been done before.
7. **The Regional Technology Assessment** will be a picture of what activities the Atlanta region is doing well and where are gaps in comparison to other regions in the country. **The Strategic Plan** will use this information to make recommendations on what areas should be prioritized in the near-term, mid-term and long-term.

-ARC also has many modal and subject area plans that include TSMO recommendations as well, including Walk Bike Thrive, The Bike/Ped Safety Action Plan, Freight Parking Study, etc.
-As part of the Congestion Mitigation Process, ARC collects and analyzes congestion data to identify strategies, of which operations is always preferred.
-Partnering with state and local partners when creating plans helps ensure coordination and fill in any funding gaps.

Maricopa County

TIP:
Transportation Systems Plan – 2040 strategic needs;
Strategic Plan feeds into TSP;
Feasibility analysis of identified needs in the TSP;
Infrastructure/technology options considered;
Infrastructure determined by future needs vs. roadway classification.

Developments – Permitting process:
Infrastructure determined by future needs vs. roadway classification – savings to ITS developer and maintenance to agency.

Funding:
HURF – Operating budget

Mid-America Regional Council

As the designated Metropolitan Planning Organization (MPO) for the Kansas City region, the Mid-America Regional Council (MARC) is responsible for carrying out a continuing and comprehensive transportation planning process in cooperation with the states of Kansas and Missouri and the region's public transportation operators.

Several planning products developed through this process address and integrate TSMO.

Unified Planning Work Program
Federal metropolitan planning funds support:
- Data collection, management and analysis
- Intergovernmental coordination and organization of TSMO
- Transportation performance management
- Transportation technology and planning including the ITS Architecture
- Congestion Management Process

To improve integration of TSMO initiatives with the metropolitan transportation planning process, MARC has pursued the formation of a dedicated TSMO workgroup and development of a regional TSMO plan. These efforts have been hampered by difficulty in identifying the proper composition of the workgroup and its place in the already extensive MARC committee structure.

Metropolitan Transportation Plan (MTP)
Transportation Outlook 2040 is the metropolitan transportation plan for Greater Kansas City. It provides a policy framework for the investment of anticipated federal, state and local funds, based on expected needs and regional goals and objectives. MARC has included "manage existing systems to achieve reliable and efficient performance and maximize the value of existing investments" as one of 10 goals in the plan. The emphasis in the plan on TSMO impacts other elements such as performance measures, congestion management and evaluation methodologies for the transportation improvement program.

Mid-America Regional Council (cont.)

Congestion Management Process

The Congestion Management Process (CMP) is a systematic way of monitoring, measuring and diagnosing the causes of current and future congestion on a region's multi-modal transportation systems; evaluating and recommending alternative strategies to manage current and future regional congestion; and monitoring and evaluating the performance of strategies implemented to manage congestion. The MARC CMP is integrated with the MTP, TIP, ITS architecture and includes a toolbox that identifies alternative strategies, including specific TSMO strategies for addressing congestion issues.

Although these foundational elements of the planning process are well established, a capability maturity model exercise conducted in 2017 identified weaknesses that the region must address. Areas in need of attention include:

- Level of service and modeling drive decision-making with reliability metrics being secondary.
- Improvement in data identification and coordination is needed.
- Design manuals and scoping processes used often ignore the systematic operating nature of signals and TSMO projects.
- TSMO is not well understood or received.

North Central Texas Council of Governments

TSMO is integrated into the planning process through the long-range transportation plan and the congestion management process. There are TSMO policies as part of the long-range transportation plan that are documented below and MTP policy bundles. For more near-term implementation, the congestion management process is utilized. Through the CMP, corridors are evaluated and corridor deficiencies are identified. Based on the deficiencies, strategies are selected to improved deficiencies. Below are some of the long-range plan goals, objectives, policies and programs.

The CMP goals and objectives are aligned with the overall Mobility 2045: The Metropolitan Transportation Plan for North Central Texas goal themes. Mobility 2045 goals support and advance the development of a transportation system that contributes to the region's mobility, quality of life, system sustainability and continued project implementation. The three CMP goals are:

- **Goal One:** Identify quick-to-implement low-cost strategies and solutions to better operate the transportation system.
- **Goal Two:** More evenly distribute congestion across the entire transportation corridor.
- **Goal Three:** Ensure corridors have options and available alternate routes/modes to relieve daily congestion and during incidents and accidents.

North Central Texas Council of Governments (cont.)

Mobility 2045 TSMO policies:

TDM3-001: Support the congestion management process which includes explicit consideration and appropriate implementation of Travel Demand Management, Transportation System Management and Intelligent Transportation Systems strategies during all stages of corridor development and operations.

TDM3-002: Support an integrated planning process that maximizes existing transportation system capacity before considering major capital infrastructure investment in the multimodal system.

TDM3-003: Request local agency staff and North Central Texas Council of Governments staff to meet with all major employers (defined as employers of 250 or more employees) to discuss and encourage the implementation of voluntary employer trip reduction programs.

TSMO3-001: Installation of pedestrian facilities by local agencies as part of intersection improvement and traffic signal improvement programs shall provide access to usable walkways or sidewalks.

TSMO3-002: Require regional partners to coordinate during major special events or planned events to ensure minimal impact on the transportation system for individuals traveling to an event or through an event zone.

TSMO3-003: Require regional partners to coordinate with the U.S. Department of Transportation on connected vehicle development and identify new Transportation System Management and Operations technologies that can be considered for deployment.

TSMO3-004: Priority funding consideration will be given to projects that meet the regional Intelligent Transportation Systems deployment initiatives as outlined in the Dallas-Fort Worth Regional Intelligent Transportation Systems Architecture.

TSMO3-005: Intelligent Transportation Systems projects must be consistent with the architecture and standards described in the Dallas-Fort Worth Regional Intelligent Transportation Systems Architecture.

TSMO3-006: Encourage, evaluate, and deploy new energy-efficient, low-cost technologies for Intelligent Transportation Systems and Transportation System Management and Operations projects.

TSMO3-007: Integrate all traffic operations systems between public sector entities, including sharing of data and videos.

TSM03-008: Coordinate and share best practices to prevent copper wire theft supporting the operations and illumination of transportation infrastructure.

Mobility 2045 TSMO programs:

TDM2-100: Employer Trip Reduction Program

TDM2-200: Regional Vanpool Program

TDM2-300: Park-and-Ride Facilities

TDM2-400: Transportation Management Associations

TSMO2-001: Intersection Improvement Program

TSMO2-002: Signal Improvement Program

TSMO2-003: Bottleneck Improvement Program

TSMO2-004: Special Events Management Program

TSMO2-005: Bottleneck Program for Regional Corridors

North Central Texas Council of Governments (cont.)

TSMO2-006: Intelligent Transportation Systems Implementation Program
TSMO2-007: Regional Intelligent Transportation Systems Architecture Program
TSMO2-008: Advanced Traveler Information System Implementation Program
TSMO2-009: Advanced Traffic Management System Implementation Program
TSMO2-0010: Advanced Public Transportation System Implementation Program
TSMO2-0011: Intelligent Transportation Systems Interoperability Program

Tennessee Department of Transportation

- Long Range Planning (LRP)
  - TSMO strategy buy-in:
    - TSMO incorporated early on
  - Performance data considered in planning process
    - Every Day Counts (EDC) research
  - TSMO/Traffic Operations Division involvement in research projects funded by LRP
  - Statewide probe data
  - TSMO mainstreaming and relationship building with LRP staff
- Office of Community Transportation (OCT)
  - OCT and Traffic Operations Division developing and maintaining relationships with local agencies, MPOs and RPOs
  - Traffic Operations becoming more involved in TIP/ STIP
  - TSMO mainstreaming and relationship building with OCT staff
- Strategic Transportation Investments Division (STID)
  - Creation of this division demonstrates the TDOT commitment to TSMO strategic thinking for planning and project initiation
  - TSMO considered during STID project reviews and scoping
  - TSMO mainstreaming and relationship building with STID staff
- TSMO Regional Operations Forum (ROF) Seminars held spring 2019
  - Good attendance and participation from planning staff

Washington State Department of Transportation

Agency highway infrastructure planning has a specific funding program that has traditionally focused primarily on capital improvements. Planning occurs otherwise within infrastructure preservation and safety programs. TSMO-related planning has been a part of each program's planning efforts to varying degrees. Past operational planning has been ITS-focused. WSDOT is now initiating a TSMO-focused planning effort.

How it's funded

- Funding is established by the Legislature to conduct formal planning studies;
- Programs have some ability to conduct planning related activities associated with the objectives of each program;
- Operating funds are used to develop near term operating plans, operational planning efforts have been ad hoc.

Policies

- There are policies that direct consideration of operational solutions as part of capital program planning efforts;
- Internal policies associated with agency strategic planning efforts direct near-term operational focus be included in planning efforts.

Lessons Learned

- Operating funds have focused on implementation, making operational planning efforts challenging;
- TSMO related programs have not included or at best under-funded staffing needs to effectively engage in or lead planning efforts;
- Knowledge and tools to represent how to consider TSMO related investments within agency planning efforts are valuable to other disciplines within the agency;
- The scope and scale of many TSMO related investments (relatively low-cost) make planning and programming efforts challenging within our existing budget structure/s.

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Integrating TSMO Into Programming

Atlanta Regional Commission

-Project Evaluation Framework
  -Policy filters for roadway capacity encourages operations
  -Project performance measures are only compared against other projects within same category
  -Each project type has performance measures tailored to that type of project
  -Deliverability and benefit cost measures applied after
  -Currently studying potential updates to TSMO performance measures

-Livable Center Initiative (LCI)
  -A program where funding is put aside for funding transportation projects for communities that complete a livability plan and restructure their zoning to encourage higher density, mixed-use development. The program specifically focuses on reducing SOV travel and is used frequently for operations funding.

-Future Programming Options
  -May create a funding program out of existing federal funding types, similar to LCI, for transportation technologies or TSMO in general

Current performance measures used in project evaluation:

Table RT1 – Roadway TSM&O Project Evaluation Scheme

Vision	Criteria	Measures
World Class Infrastructure	Mobility/Congestion	1) Corridor Congestion Intensity 2) Change in Congestion Extent
	Reliability	Worst Hour Travel Time Reliability
	Network Connectivity	Supports the Regional Policy Networks
	Multimodalism	Multimodal Accommodations
	Asset Management & Resiliency	-
Healthy Livable Communities	Safety	Improved Safety
	Air Quality & Climate Change	1) Project Emissions 2) Near Road Emissions Exposure
	Cultural & Environmental Resources	Impact on Culturally and Environmentally Sensitive Land Uses
	Social Equity	Addressing Social Equity
	Land Use Compatibility	-
Competitive Economy	Goods Movement	Supporting the Freight Economy
	Employment Accessibility	Supporting Regionally Significant Locations

Maricopa County

Annual Evaluation – LOS, resident input, safety analysis, intersections, partnerships, jurisdictional input, maintenance needs;
Preliminary solutions – infrastructure, TSMO technology;
Priority rating system and scoring;
Apply for regional funding

Funding:
HURF – Operating budget CMAQ – ITS technology

Mid-America Regional Council

The following discussion focuses on two separate but related components, the project selection process and the larger Transportation Improvement Program.

Project Selection Process
As the Metropolitan Planning Organization (MPO) for the greater Kansas City region, the Mid-America Regional Council (MARC) uses a competitive selection process to distribute funds sub-allocated to the region. This process is conducted every two years and typically awards approximately $40 million annually.

MARC supports the following TSMO projects and programs through the allocation of funds set aside from the competitive selection process. Additional system management and operations projects compete for funding against other eligible projects.

Surface Transportation Block Grant Program (STP)
Operation Greenlight – Cooperative arterial traffic signal coordination and incident response
- Approximately $1 million regionally set aside annually for operations support

Congestion Mitigation & Air Quality Program (CMAQ)
Rideshare – Commuter resources for individuals and employers
- $250,000 annually to support this program

Traffic Flow Projects
- 37 percent of available funds (approximately $3.2 million annually) are distributed for eligible projects

Mid-America Regional Council (cont.)

Evaluation criteria used in the competitive process address a wide range of considerations, including the following with connections to TSMO:

- Consistency with regional plans/programs, including but not limited to:
  - Metropolitan Transportation Plan
  - Regional ITS architecture
  - Congestion Management Process/Toolbox
- Impacts to the regional freight network
- Safety
- System performance

Transportation Improvement Program

MARC is also responsible for preparing the regional Transportation Improvement Program (TIP) in cooperation with the state departments of transportation, transit operators and local governments. Although MARC does not necessarily own or operate infrastructure related to system management and operations, the 2018-22 MARC TIP includes funding for:

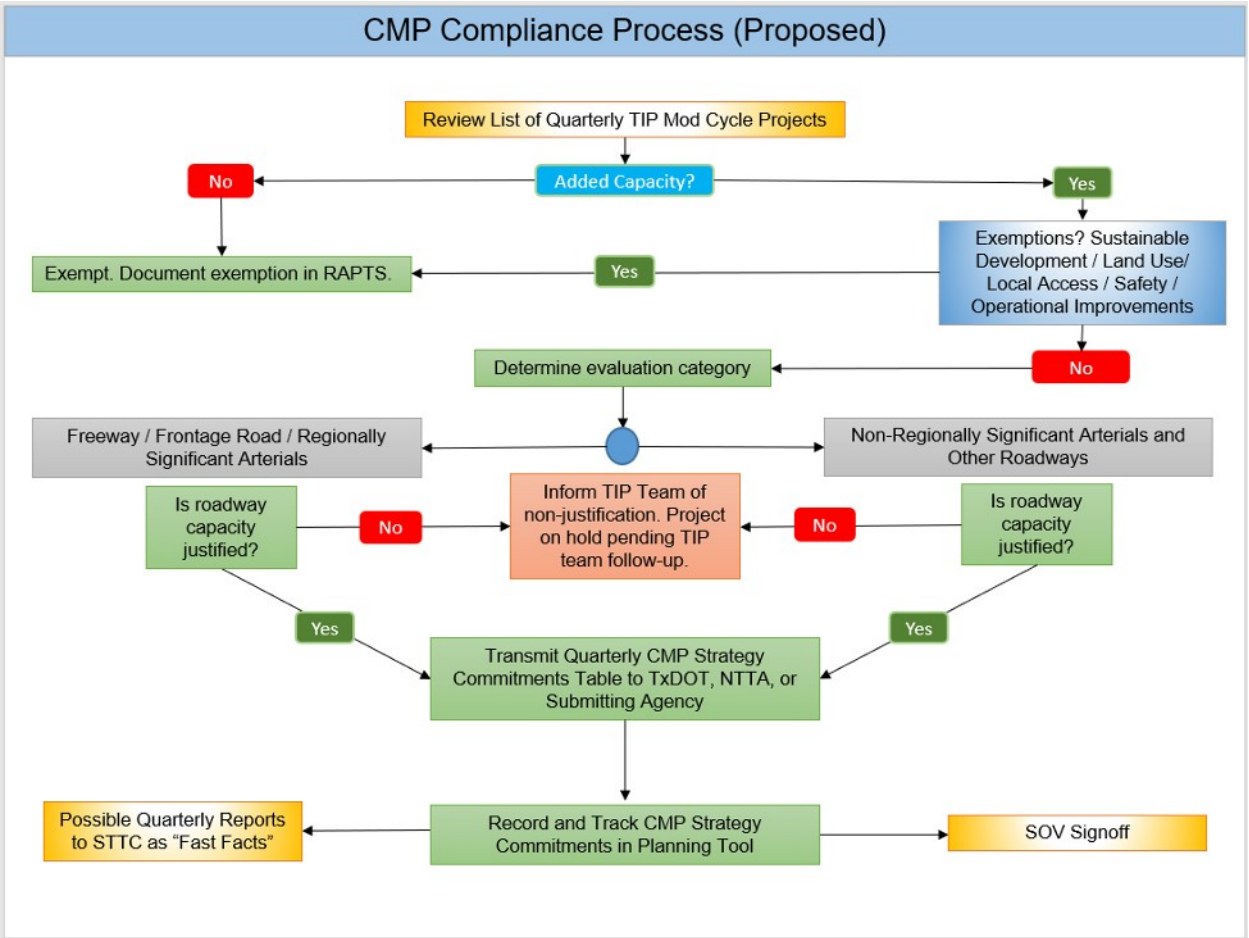
- Traffic management system operations, asset maintenance and expansion for both the freeway and arterial systems.

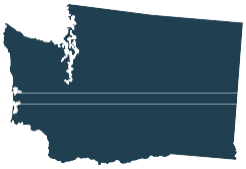
Tennessee Department of Transportation

- ITS Expansion in 3-Year Highway Program – 16 projects
- IMPROVE ACT
- Programming of maintenance funds for ITS Infrastructure
- Programming of general funds for TMC facilities
- HELP Trucks replaced outside of general fleet (no competing priorities for vehicle replacement)
- TSMO Mainstreaming – building relationships
- TDOT commitment to technology, safety, mobility
- TSMO Regional Operations Forum (ROF) Seminars held spring 2019
  - Good attendance and participation from program development staff

North Central Texas Council of Governments

TSMO is integrated into programming through a few functions within NCTCOG; the Congestion Management Process and Transportation Improvement Program are integrated as illustrated in the diagram below. As additional capacity projects are added to the TIP, the CMP justifies the added capacity and identifies other strategies to be considered. NCTCOG is working on linking the TIP projects together since different agencies implement different CMP strategies. The proposed CMP compliance process for capacity expanding project being included in the TIP is shown below:





Washington State Department of Transportation

TSMO-related activities and/or investments are reflected (to different degrees) across agency funding programs. The lead program typically has scoping processes, by which TSMO engagement and associated TSMO investments are considered.

How it's funded

•Scoping is funded by the program associated with funding the design and construction of the project;
•The lead for the associated funding program determines whether TSMO investments will be funded by the program they represent;
•The TSMO program has a partnership with Capital Program Management to proactively identify operations related investments that can be addressed either through a capital project or using operating funds;
•Within the operating program there is funding to address low cost emergent needs.

Policies

•The Legislature has established specific capital and operating programs, including the Traffic Operations Program (Operating);
•There are policies that direct consideration of operational solutions as part of capital program project planning efforts;
•Within the operating program there is funding to address low-cost emergent needs.

Lessons Learned

•Early engagement in capital projects is a necessity;
•Formal processes help ensure engagement/consideration occurs;
•Non-infrastructure needs are challenging, including funding for operating systems and labor to effectively operate new or expanded systems.

Integrating TSMO into Design

Atlanta Regional Commission

-Project Evaluation Framework
    -Policy filters for roadway capacity require complete street design.

Maricopa County

TIP:
Scoping:
Project manager reaches out to all disciplines to help develop Project Work Plan – includes ITS/technology.
Identify infrastructure to include in scoping to support operations;
Final Scoping Report refers back to planning for updating project scoring and prioritization.

Final Design: Develop details from scoping recommendations.

Funding: HURF – TIP budget

ITS Projects:
Scoping:
Develop Project Management Plan;
Use Systems Engineering Process to develop:
- System Engineering Management Plan;
- Concept of Operations;
- High-Level Systems Requirements.

Final Design:
Systems Design and Equipment Procurement;
Operations and Maintenance Plan;
Systems Evaluation;
Ongoing operations and maintenance cycle – short term cycle within larger cycle.

Funding:
HURF – TIP budget: infrastructure;
HURF – Operating budget: Systems procurement/evaluation;
CMAQ – Infrastructure and systems;
Federal Grants – Infrastructure and systems;
CMAQ /federal grants – limited operations – seed money

Mid-America Regional Council

As a Metropolitan Planning Organization (MPO), MARC does not necessarily own or operate infrastructure. This makes integration of TSMO by MARC into the design of transportation projects in the region more advisory and ad-hoc in nature.

One area where MARC is directly involved in design discussions is through the Operation Greenlight (OGL) traffic signal coordination and incident response program. OGL works with 27 agencies including the Kansas and Missouri departments of transportation. For arterial management, the program provides job special provisions and generic plans for design projects to allow for CCTV, network communication elements to incorporate the traffic signal into the regional traffic signal management program. Funds to do this can be part of the design budget if OGL is brought early into the process. This timing remains an area of difficulty.

As noted under the planning and programming discussions, MARC often plays an indirect role in the design of transportation facilities. By working with implementing agencies to identify and consider TSMO strategies, these elements are often included in projects where once they were overlooked. The incorporation of TSMO into the evaluation criteria used to allocate funding to projects in the region provides a real incentive for local governments and other transportation agencies to consider strategies outside of the traditional capacity addition.

MARC is also supportive of efforts made by other organizations to advance TSMO education. The ITS Heartland Chapter of ITS America, of which MARC and both the Kansas and Missouri Departments of Transportation are members, has developed a multistate training program around TSMO. ITS Heartland offers a train-the-trainer program that focuses on how information about TSMO can be delivered to various groups from executive level leaders in their agencies to operations staff, designers, contractors and maintenance personnel.

North Central Texas Council of Governments

CMP can help with design.
TDM3-002: Support an integrated planning process that maximizes existing transportation system capacity before considering major capital infrastructure investment in the multimodal system. Some of these items are covered above.

In addition, TxDOT also initiated a letter to the district offices requiring all districts include TSMO in future projects. TxDOT has a TMSO plan statewide and is working on district plans. The Dallas-Fort Worth region has three districts; we are working with TxDOT to see if we can do one plan for both districts.

North Central Texas Council of Governments (cont.)

As projects are entered in the TIP, NCTCOG requires all agencies to provide a Congestion Management Process summary of projects and the identification of strategies. As these projects are designed, NCTCOG tries to work closely with agencies to ensure these elements are included, but NCTCOG is not always at the table.

Where does procurement fit in? Some TSMO projects include innovative technology, which is a different procurement process then traditional roadways projects. NCTCOG partner agencies, mainly the DOT, has struggled with this procurement. In which, NCTCOG was requested to take over the procurement for these types of projects. Examples include 511, auto vehicle detection technology to apply an HOV discount on managed lanes, private sector carpooling and trip reduction programs.

Tennessee Department of Transportation

- TSMO strategies incorporated early in design process
  - Consideration of operations and maintenance for ITS Expansion Projects
  - Design and Traffic Operations work together to identify needs for relocation of ITS infrastructure and opportunities to add ITS infrastructure early on in design process
- ITS Design Office and ITS Deployment Office work closely with TMC manager (TSMO champion at region level) on all ITS Expansion projects
- Traffic Engineering Office works closely with region traffic engineers on all signal design projects
- Traffic Operations Division does all traffic signal design
  - Coordination with local agencies on signal design
- Coordination with Traffic Operations Division (ITS Design Office and ITS Deployment Office) for Value Engineering efforts (not formal process)
- Created statewide work zone engineer position – works closely with state traffic engineer – incorporate TSMO strategies for WZ management
- TSMO mainstreaming and relationship building with design staff
- Local Programs Division
- ITS Design Office and Traffic Engineering Office (Signal Design Section) review all Local Program projects
- Coordination with Traffic Operations Division on administration of CMAQ Grant Projects
- Local Programs and Traffic Operations Division developing and maintaining relationships with Local Agencies
- TSMO mainstreaming and relationship building with Local Programs Division staff
- TSMO Regional Operations Forum (ROF) Seminars held spring 2019
- Good attendance and participation from design, Local Programs staff

Washington State Department of Transportation

The design of TSMO related infrastructure investments are typically completed by TSMO staff within the region associated with the project.

How it's funded

•Staff funding for the design elements of projects are funded by the program funding the construction of the project;
•In smaller regions TSMO staff positions often contain duties associated with both design and operating functions, with partial funding from multiple programs used to fund the position/s;
•Funding for design support and training for capital projects is shared by both capital and operating programs.

Policies

•Agency policy manuals (i.e., Design Manual, Traffic Manual, Construction Manual) contain direction and supporting information relative to standards and agency practices;
•HQ divisions are responsible for updating their respective manuals.

Lessons Learned

•Right sizing and funding support functions is challenging, given each associated program's objectives are implementation-related.

Integrating TSMO into Construction

Maricopa County

TIP Projects:
Smarter Work Zone:
Pilot project included into roadway construction;
Sub-contract as full-service contract.

ITS infrastructure as component of TIP project.

Funding:
Highway User Revenue Fund– TIP budget

ITS Projects:
Systems/Technology/Equipment/Incident Management.

Funding:
HURF – Operating budget;
CMAQ;
Federal grants;
Sponsorships.

Mid-America Regional Council

As a Metropolitan Planning Organization (MPO), MARC does not necessarily own, operate or construct infrastructure. This makes integration of TSMO by MARC into the construction of transportation projects in the region more advisory and ad-hoc in nature.

One area where MARC is directly involved in construction discussions is through the Operation Greenlight (OGL) traffic signal coordination and incident response program. OGL works with 27 agencies including the Kansas and Missouri Departments of Transportation. The program provides support for arterial management work zone traffic management, detours and mitigationof freeway work zone impacts.

As noted under the planning and programming discussions, MARC often plays an indirect role in the construction of transportation facilities. By working with implementing agencies to identify and consider TSMO strategies, these elements are often included in projects where once they were overlooked. The incorporation of TSMO into the evaluation criteria used to allocate funding to projects in the region provides a real incentive for local governments and other transportation agencies to consider strategies outside of the traditional capacity addition.
MARC is also supportive of efforts made by other organizations to advance TSMO education. The ITS Heartland Chapter of ITS America, of which MARC and both the Kansas and Missouri Departments of Transportation

Mid-America Regional Council (cont.)

are members, has developed a multistate training program around TSMO. ITS Heartland offers a Train-the-trainer program that focuses on how information about TSMO can be delivered to various groups from executive level leaders in their agencies to operations staff, designers, contractors and maintenance personnel.

Sources of Funding

- Advertisement
- Sponsorships
- Regional taxes
- State Planning and Research Funds
- Safety Funds (usually for TIM)
- CMAQ
- Federal grants
- HSIP
- Tolls
- Fuel Tax (trace the money as much as you can to your department budget)
- General Fund (could be state or local general funds)
- Metropolitan Planning Funds
- Agency Indirect Funds

North Central Texas Council of Governments

TSMO strategies used in construction work zones: NCTCOG has partnered with TxDOT and other local partners to identify construction work zones utilizing 511DFW and WAZE. In addition, traffic signal retiming and toll reductions have been utilized to a full road closure and detour along the Interstate-30 corridor. Regional partners have staged tow truck operators for quick clearance of crashes.

These pilots were mostly funding with Congestion Mitigation Air Quality funding and Regional Transportation Council Local Funds.

Lessons Learned: Everyone doesn't enter construction the same way. Some do advanced notification; others enter as closures occur. NCTCOG is working to hire a construction coordination to help agencies within the region better coordinate construction activity. This position will help with better coordination of road closures to reduce the number of parallel facilities under construction at the same time.

North Central Texas Council of Governments (cont.)

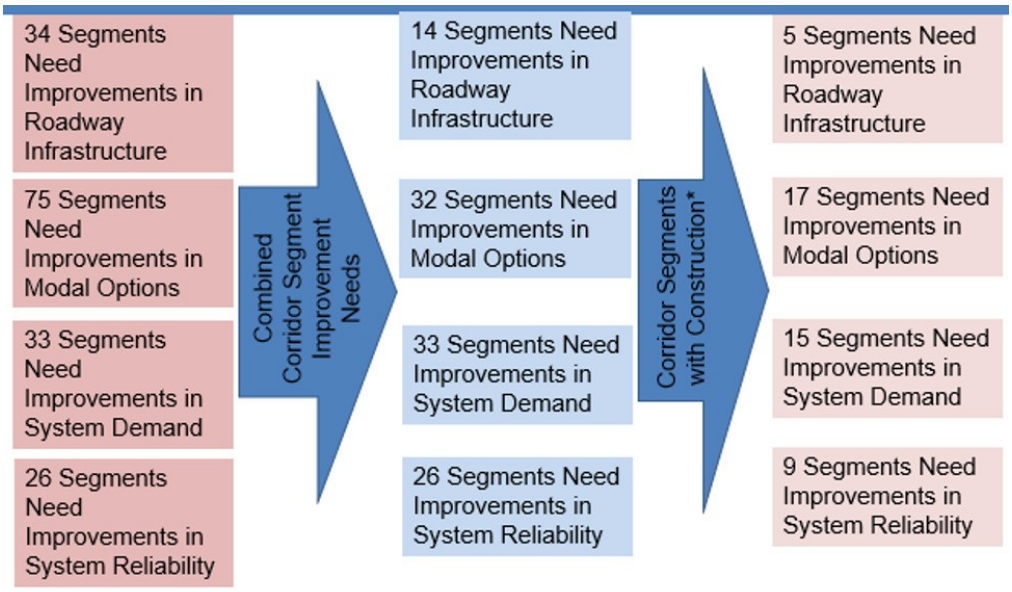
Another items we have thought about is winter weather mapping of clear roads. One year, the region experienced cobblestone ice that took several days to clear the roads; a map for drivers to see the roads that have been clear and road conditions would be useful.

In addition, there is room for more TSMO strategies to be implemented in construction work zones. We currently do not have policies related to this, but over the next few years we will begin to develop.

NCTCOG does have a policy regarding implementation of ITS and other technology as part of the added capacity project. Please reference the MTP policies above. Agencies have been doing this for a while now.

Our region has had theft related to copper wire and have shared best practices to reduce theft that takes these systems down. NCTCOG does have a policy for this item above as well.

CMP Corridor Evaluation by Category Need and Construction



*Current, Funded and Recently Completed Construction

Tennessee Department of Transportation

- Construction Engineering and Inspection (CEI)
  - Traffic Operations and Construction Office worked together to fill the gap in technical expertise to support CEI of construction projects and ITS maintenance contracts
  - Two positions added to ITS Deployment Office
  - CEI Consultant On Call contracts advertised fall 2019
  - Traffic Operations support of construction project manager for ITS maintenance contract administration
  - ITS Deployment Office work with Construction Office to provide technical support to construction project manager for roadway construction projects: value engineering, material submittals, change orders, etc.

  - Leverage Freeway Management, TIM, HELP Programs for Work Zone Management
    - Proactive Incident Management strategies (I-440 DB example)
    - Proactive Congestion Management strategies (I-440 DB example)
  - Coordination with Traffic Operations Division on administration of CMAQ Grant Projects
  - Local Programs and Traffic Operations Division developing and maintaining relationships with local agencies
  - TSMO mainstreaming and relationship building with Local Programs Division staff
- TSMO Regional Operations Forum (ROF) Seminars held spring 2019
  - Good attendance and participation from construction and maintenance staff

Washington State Department of Transportation

The construction of TSMO-related infrastructure investments is overseen by construction project engineers. Exceptions to this are low-cost enhancements funded by the operating program, which are typically implemented by maintenance personnel. As needed, technical expertise and support is provided by the respective offices within each region or by associated HQ divisions when necessary. Inspection of ITS-related infrastructure is typically accomplished by a combination of ITS maintenance and construction electrical inspection personnel. System acceptance involves TSMO staff that reside within the associated region.

How it's funded

- Project funding from the associated program are used to fund staff directly involved in overseeing construction;
- Support and training associated with construction inspection of TSMO-related investments is shared by capital and operating programs, and funded at the program level;
- Traffic control strategies, plan development, and deployment are funded by the budget program associated with the project.

Washington State Department of Transportation (cont.)

Policies

•Agency policy manuals (i.e. Design Manual, Traffic Manual, Construction Manual) contain direction and supporting information relative to standards and agency practices;

•Guidance documents are used to supplement manuals and are typically developed by the associated program discipline (such as work hours and work zone traffic impact analysis which is developed by Traffic Operations).

Lessons Learned

•Sustaining expertise across all regions is challenging, particularly within smaller regions;

•Development of work zone strategies needs to occur early in the development of the project, and involve multiple disciplines;

•Innovative work zone strategies take dedicated staff to develop and effectively implement.

NOCoE
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SUMMIT ATTENDEE LIST

Name	Organization
Lee Smith	Tennessee Department of Transportation
Edward Fowler	Michigan Department of Transportation
Jason Firman	Michigan Department of Transportation
Bob Younie	Iowa Department of Transportation
Don Tebben	Iowa Department of Transportation
Joey Sagal	Maryland Department of Transportation
Janet Frenkil	Maryland Department of Transportation
John Nisbet	Washington State Department of Transportation
Jay Alexander	Washington State Department of Transportation
Kristin Mulkerin	Pennsylvania Department of Transportation
Frank Cavataio	Pennsylvania Department of Transportation
Shante Hastings	Delaware Department of Transportation
Nicolaas Swart	Maricopa County Department of Transportation
Natalie Bettger	North Central Texas Council of Governments
Raymond Webb	Mid-America Regional Council
Marc Hansen	Mid-America Regional Council
Maria Roell	Atlanta Regional Commission
Tracy Scriba	Federal Highway Administration
Pamela Heimsness	FHWA Tennessee Division
Melissa Furlong	FHWA Tennessee Division
Pat Zelinski	AASHTO
John Conrad	Consultant
Niloo Parvinashtiani	NOCoE
Adam Hopps	NOCoE
Patrick Son	NOCoE