THE TRAFFIC MANAGEMENT CAPABILITY MATURITY FRAMEWORK: AN FHWA TOOL TO HELP AGENCIES ADVANCE TRAFFIC MANAGEMENT CAPABILITY

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ABSTRACT

In 2013, the Federal Highway Administration (FHWA) initiated a project to develop a series of six capability maturity frameworks (CMF) based on the American Association of State Highway and Transportation Officials (AASHTO) transportation systems management and operations (TSMO) capability maturity model (CMM). The intent was for the CMFs to elaborate on, and be consistent with, the AASHTO TSMO CMM, but which provide more focused assessment and suggested actions in each of the following operations program areas: traffic management, traffic incident management, planned special events, work zone management, road weather management, and traffic signal control. The concept of a capability maturity model (CMM) for transportation operations emerged from Strategic Highway Research Program 2 (SHRP2) reliability projects L01 and L06, which promoted a process-driven approach to improve transportation systems management and operations (TSMO). The projects focused on the role of institutions and the necessary business processes to improve management of programs and projects. This paper discusses the process undertaken by FHWA to develop a capability maturity framework (CMF) for traffic management, directly linked to the CMM approach, and the potential benefits that can be realized by state and local agencies and stakeholder partners for their TSMO programs. Available online, the purpose of the framework is to build consensus among stakeholders regarding institutional changes at an agency or regional-level. The framework is utilized before any traffic management activities and strategies are implemented. It is not strategy-specific, but rather the framework is specific to process areas that are applicable to traffic management concerns.

Keywords: Traffic Management, Capability Maturity Framework, Operations, Business Processes, Transportation Management, Capability Maturity Model
BACKGROUND

This paper discusses the process undertaken by FHWA to develop a capability maturity framework (CMF) for traffic management, directly linked to the capability maturity model (CMM) approach from the information technology (IT) realm. The intent was to highlight the potential benefits that can be realized by state and local agencies and stakeholder partners for their transportation systems management and operations (TSMO) programs.

The concept of a CMM for transportation operations emerged from the Strategic Highway Research Program 2 (SHRP2) reliability projects L01 (1) and L06 (2), which promoted a process-driven approach to improve TSMO. The projects focused on the role of institutions and the necessary business processes to improve management of programs and projects.

The notion of CMM within the context of transportation operations rests on the following three tenets:

- Process matters: projects fail or do not achieve desired functionality for a variety of reasons unrelated to the technology;
- Prioritizing the rights actions is important: is an agency ready, how do they know, and what should they do next; and
- Focus on the weakest link: what is holding the agency back in becoming a leader in a particular area (3).

The origins of the CMM are in the IT industry and how it serves as a requirement for the development of software for clients (4). Its features of focusing on managing outcomes, a high level vision of capability, the importance of a small set of specific organizational dimensions and capability, and the evolutionary process for improving those capabilities make it a logical fit for transportation programs. This paper discusses the process undertaken by FHWA to develop a CMF for traffic management to assist state and local agencies and stakeholder partners in improving their TSMO programs.

To illustrate the context of the development of CMF for traffic management, the following sections provide a high level overview of the origins of the concept for the transportation operations community.

SHRP 2 Efforts

In 2011, SHRP2 released the results of a study that focused on integrating business processes to improve travel time reliability (TTR), a key performance measurement that agencies across the country are using as a significant benchmark for their systems (5, 6). The focus was on processes that have a direct impact on transportation network reliability and TTR in which operational functions are an integral part of the day-to-day business of the agency. The specific operational areas that have the greatest influence on reliability were identified as:

- Incident management;
- Work zone management;
- Planned special-event management;
- Road weather management; and
- Traffic control and traffic operations (5).
The project team identified integration points in business processes which directly link to improving TTR which were at both the operations level and at the institutional or programmatic level (5). By examining their business processes and identifying gaps and opportunities for improvement, agencies can develop action plans to work to improve TTR in their region. The SHRP2 L01 project developed a companion guidance document that outlines steps that an agency can take to implement and institutionalize specific business processes to help them reach reliability goals and objectives (6). The goal is to help agencies improve coordination and integration of the various processes they undertake across internal groups and with partnering agencies to improve overall regional reliability. The 7-step methodology in the document includes:

- Step 1: identify influences for action to improve business processes;
- Step 2: define the specific reliability goals for the agency and region;
- Step 3: identify and document current business processes to identify potential gaps or issues;
- Step 4: develop, change, and implement new or modified business processes on a formal or informal basis;
- Step 5: assess new or modified processes against goals;
- Step 6: document processes to identify roles, responsibilities, objectives, and expected outcomes; and
- Step 7: institutionalize processes to support long-term survival within organization (6).

This methodology can be applied at the operations level or at the institutional level to integrate changes to support reliability goals within the organization and across the region.

In 2012, SHRP2 released the results of a related study that focused on institutional architectures to advance operational strategies (7, 8). The objective of this project was to conduct an assessment of how agencies should be organized to ensure they have TSMO programs that improve TTR. The study, conducted in three segments, identified the more effective transportation agencies in terms of reducing non-recurring congestion, determined the technical and business process features that agencies use to support operations, and identified institutional characteristics that seem essential in the development, support, and sustainment of these business processes (7). The key outcome of the research was to recommend adapting the CMM to fit the transportation service context.

The SHRP2 L06 companion guidance document formally developed the CMM for transportation services to help agencies improve their overall capability for TSMO by helping them address the challenges and special demands of congestion management. The SHRP2 L06 CMM focused on support for strategies to address both recurring and non-recurring congestion and addressed the four components of institutional capability maturity—or dimensions—of culture/leadership, organization and staffing, resource allocation, and partnerships (6). It also established three levels for institutional capability maturity as (1) level 1—ad hoc, (2) level 2—rationalized, and (3) level 3—mainstreamed. Additionally, the guidance identified strategies for each dimension for an agency to advance levels and specific actions that can effect that advancement.

The AASHTO SOM Guidance

As the SHRP2 L06 reports were being published, the American Association of State Highway and Transportation Officials (AASHTO) supported the conversion of that research into a web-based
tool for user-friendly and easy access to the results and to foster seamless updates to the content so that users have the most current guidance available (4). The resulting AASHTO TSMO CMM targets the entire gamut of systems operations and management at a State or regional context. The framework can be applied at various levels of transportation operations and management depending on the specific needs of the agency or region. The target audience for the tool is transportation agency managers, policy makers, and other managers of systems operations related activities to help them identify the current agency capability associated with operations and management of the roadway system and identify actions to improve capabilities to enhance system performance (4).

The AASHTO TSMO CMM was a slight departure from the original SHRP2 L06 research. Primarily, the dimensions of capability for transportation agencies and their activities were expanded to six to include those illustrated in Table 1. Furthermore, the levels of capability were expanded to four as noted in Table 2.

**TABLE 1 AASHTO TSMO CMM Guidance Dimensions (adapted from 4)**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Sub-dimensions</th>
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<tbody>
<tr>
<td>Business Processes</td>
<td>Planning</td>
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<td></td>
<td>Scoping</td>
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<td></td>
<td>Programming/Budgeting</td>
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<td>Project Development/Procurement</td>
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<td>Systems &amp; Technology</td>
<td>Regional Architectures</td>
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<td></td>
<td>Project Systems Engineering/Testing and Validation</td>
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<td></td>
<td>Standards/Interoperability</td>
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<td>Performance Measurement</td>
<td>Measures Definition</td>
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<td></td>
<td>Data Acquisition</td>
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<td></td>
<td>Measures Utilization</td>
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<tr>
<td>Culture</td>
<td>Technical Understanding</td>
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<td></td>
<td>Leadership/Championship</td>
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<td>Outreach</td>
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<td></td>
<td>Program Status/Authorities</td>
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<td>Organization/Workforce</td>
<td>Program Status</td>
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<td>Organizational Structure</td>
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<td></td>
<td>Recruitment and Retention</td>
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<td>Staff Development</td>
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<td>Collaboration</td>
<td>Public Safety Agency Collaboration</td>
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<td></td>
<td>Local Government/MPO/RTPA Cooperation</td>
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<td>Outsourcing/PPP</td>
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TABLE 2 AASHTO TSMO CMM Guidance Levels of Capability (adapted from 4)

<table>
<thead>
<tr>
<th>Level</th>
<th>Characteristics</th>
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</table>
| 1     | Activities and relationships ad hoc  
Informal  
Champion driven  
Mostly outside mainstream DOT activities |
| 2     | Basic strategy applications understood  
Key support requirements identified  
Key capacities under development  
Limited internal accountability  
Uneven alignment with external partners |
| 3     | Standardized strategy applications implemented  
TSMO technical and business processes development and documented  
Integration into DOT  
Partnerships aligned |
| 4     | TSMO a full, sustainable core DOT program priority  
Established on the basis of continuous improvement  
Top level management status  
Formal partnerships |

THE TRAFFIC MANAGEMENT CAPABILITY MATURITY FRAMEWORK

In 2013, the Federal Highway Administration (FHWA) initiated a project to develop a series of six CMFs based on the AASHTO TSMO CMM. The intent was for the CMFs to elaborate on, and be consistent with, the AASHTO TSMO CMM, but which provide more focused assessment and suggested actions in each of the following operations program areas:

- Traffic Management;  
- Traffic Incident Management;  
- Planned Special Events;  
- Work Zone Management;  
- Road Weather Management; and  
- Traffic Signal Control.

The traffic management CMF (TM CMF), which is an interactive on-line support tool, was the first of the six CMFs to be developed. The TM CMF can help transportation agencies identify their current capability with respect to traffic management and to identify actions to improve that capability to better manage the complex transportation mobility challenges in their region. The following sections provide an overview of the development and validation of the TM CMF, and the delivery of a series of five workshops across the country to demonstrate the TM CMF to regional partners and stakeholders engaged in traffic management.

Traffic Management Baseline Assessment

The first step in developing the TM CMF was to assess the current state of traffic management in the country. Within the context of this project, traffic management was defined as encompassing the monitoring of traffic conditions, deploying various strategies and adjustments based on changing conditions, and sharing information based on conditions to maximize the available
capacity of the area-wide roadway system. State and local transportation agencies across the U.S. deploy various strategies and technologies to assist with their traffic management approach coupled with varying degrees of integration, coordination, and technological sophistication. While different areas structure their traffic management programs to suit their geographic and institutional needs, they typically cover the following functionality through a traffic management center (TMC) (9).

- Perform Monitoring—Monitor facilities in the TMC domain either visually or by field data equipment.
- Manage Events—Events can be random, planned, or recurring. Management of these items, typically by an established process of verification, coordination, and implementation of response strategies, is a critical function.
- Provide Services—Activities such as traveler information and service patrols fall into the service category. Other activities such as maintenance of intelligent transportation systems (ITS) devices may also fall into the services category.
- TMC Support—These are activities that keep the TMC running and include items such as staffing, management, agency communications, and more.

Achieving the above functionality frequently also takes the form of discrete programs within the management structure such as traveler information, traffic incident management, work zone management, road weather management, etc. Within this context, the project team conducted a thorough assessment of traffic management practices and needs with a view toward providing input into the development of the traffic management framework. The following sections provide a high-level overview of the assessment as it relates to the development of the TM CMF structure and content.

**Traffic Management Strategies**

Some traffic management strategies have become fairly standard and commonplace with available expertise, technology, and systems such as traffic signal coordination, road weather information systems, the display of travel times on dynamic message signs (DMS), and traffic incident management. The 2011 State Operations survey (10) reported the following strategy-specific results based on responses from 20-25 locations:

- The four most widely deployed operational strategies are travel time posting on DMS, traffic signals operating on a closed loop or central system, road weather information systems, and traffic incident management. Their deployment rates are over 90 percent, well over the other strategies.
- Real time traffic adaptive control signals, lane usage controls—high occupancy vehicle (HOV) lanes, managed lanes—electronic tolling, ramp metering, and lane usage controls (reversible) have been adopted by 30 to 50 percent of responding States.
- Operational strategies such as lane usage controls—reversible, lane usage controls—truck restricted, managed lanes—dynamic toll, managed lanes—high occupancy toll (HOT), bus only shoulder lanes, managed lanes—temporary hard shoulder use (peak hour only), and managed lanes—priced dynamic shoulder use are deployed by less than 30 percent.

FHWA Office of Operations calculates an Operations Efficiency Index (OEI), which is a composite index, that reflects the level at which the 41 largest metropolitan areas (by population)
are deploying management strategies. Strategies included in the measure include: Regional Traffic Signal Operations Programs, Variable Priced Facilities, Localized Congestion Hot Spot/Bottleneck Programs, Road Weather Management Strategies, Traffic Incident Management (TIM) Strategies, Travel Time on Dynamic Message Signs, and Work Zone Management Strategies. The index points to a level of deployment nationally that as of FY2012 stands at 68 percent, up from 63 percent the previous year for the included measures and marks the continued slow increase since the OEI was first conducted. Other strategies like dynamic lane control and dynamic speed control are just beginning to gain traction as agencies look towards more active traffic management. Table 3 below provides a high-level summary of the state of the practice across four of the most common traffic management strategies as a representative sample of the current trends in traffic management and emerging trends/approaches. This summary is not intended to be exhaustive. Rather, it serves as a snapshot of the state of the practice at the time that served as the baseline for the TM CMF.

### TABLE 3 Major Traffic Management Strategies State of the Practice

<table>
<thead>
<tr>
<th>Traffic Management Strategy</th>
<th>Current Trends</th>
<th>Emerging Trends/Approaches</th>
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</table>
| Traffic Signal Management    | • Traffic signal timing performance is not regularly measured in connection to objectives, resulting in outdated timing patterns that do not reflect current traffic and pedestrian needs.  
  • Signal timing policies and practices tend not to be documented.                                                                                     | • Adaptive signal control  
  • Transit signal priority  
  • Connected vehicle technology/data  
  • Multimodal intelligent traffic signal system (MMITSS)                                                                                                   |
| Traveler Information         | • Websites, DMS, and 511 are the top three distribution methods deployed by agencies to share traveler information with the public.  
  • Information type (pre-trip vs. en-route) and content (travel times, weather, parking, etc.) has evolved significantly.                                           | • Comparative travel times (across modes and facilities)  
  • Connected vehicle technology  
  • Enable advanced traveler information systems (ATIS)                                                                                              |
| Managed Lanes                | • Static/time of day lane controls  
  • HOV lanes                                                                                                                                                                                                   | • HOT lanes  
  • Active traffic management (ATM)  
  • Intelligent network flow optimization (INFLO)                                                                                                   |
| Incident Management          | • TIM is an integral component of traffic management programs with well-established partnerships across agency lines.                                                                                           | • Performance measures  
  • Quick clearance  
  • Response, emergency stating and communications, uniform management and evacuation (R.E.S.C.U.M.E.)                                               |
becoming increasingly clear. With the emphasis on planning for operations, leading State DOTs are developing robust practices to include operations strategies in planning, programming, and prioritization. State and local entities have established and defined processes to complete long-term, short-term, and need-based transportation management planning efforts as well as established procedural norms to conduct day-to-day traffic management activities. The State Operations Survey conducted by the Intelligent Transportation Society of America (ITSA) for the FHWA Office of Operations (10), albeit inconclusive, provided some indication of the national capability in this dimension. Of the 24 states that responded to the survey, 77 percent consider operational strategies during the development of the State Transportation Plan (STP) / Transportation Improvement Program (TIP), 62 percent consider operational strategies during the identification of alternative improvement strategies, and 38 percent consider operational strategies during visioning and goal setting. Traffic management strategies are considered a subset of operational strategies. Furthermore, there was a commitment of transportation agencies to invest more in their existing ITS capabilities necessary for traffic management as well as dedicating resources to expand their ITS capabilities.

Furthermore, in an internal assessment conducted by FHWA among Metropolitan Planning Organizations (MPOs), 75 percent of responding agencies noted that they have management and operations strategies included in their metropolitan transportation plan, and 74 percent have M&O strategies funded in their transportation improvement plan (TIP) (11). Agencies are beginning to reorganize, working smarter to focus resources on planning, operations, and maintenance and collaborating regionally to take advantage of distributed expertise and to compete for resources more effectively to improve their capabilities. Many agencies and states have initiated planning for operations efforts such as a Regional Concept for Transportation Operations (RCTO).

**Traffic Management Systems and Technology Deployment**

At the operations agency personnel and management level, there is an awareness of general strategies, the systems approach, and the use of architectures and standardization. Some strategies have become fairly standard and commonplace with available expertise, technology, and systems such as traffic signal coordination, road weather information systems, the display of travel times on DMS, and traffic incident management. While regional architectures have been developed, their use in project definition and scoping is ongoing. For larger projects, especially those that are federally-funded, systems engineering approaches are beginning to be used. However, nationally, procurement processes and level of agency-expertise with systems engineering required for traffic is still lacking. Significant progress on interoperability of traffic management systems through the standards development activities continues to be a major thrust area at the federal level (12). The use of the Traffic Management Data Dictionary (Version 3.0) in the San Diego integrated corridor management (ICM) project is a good example of the role of standards in developing interoperable and integrated data systems for center-to-center communications.

There has been a continuous increase of freeway management systems deployed, most notably a sharp increase in the number of dynamic message signs (DMS) deployed since 2007. This trend mirrors increased public demand for traveler information and travel time reliability as well as the evolution of detection technology and Smartphone applications that leverage traveler information. Other trends include significant investments in traffic management systems, which are being used to implement a wide variety of strategies aimed at reducing recurring and non-recurring congestion at facility, corridor, and regional scopes. Deployments include electronic surveillance,
ramp metering, DMS, highway advisory radio (HAR), incident detection algorithms, service patrols, and closed loop signalized intersections.

Traffic Management Performance Measurement
Federal legislation and direction are pointing towards an increased use of performance-based management. Washington State Department of Transportation (WSDOT) has become a national leader in the area of performance monitoring and accountability (e.g., http://www.wsdot.wa.gov/accountability); however, WSDOT’s “rise to the top” began with reprimands about accountability from the Washington state legislature. Other states are in similar situations. Moving Ahead for Progress in the 21st Century Act (MAP-21) was signed into law in July 2012 providing over $105 billion for fiscal years 2013 and 2014 for surface transportation (13). Performance management was a key element of MAP-21, and national performance goals were set for the following areas: 1) safety, 2) infrastructure condition, 3) congestion reduction, 4) system reliability, 5) freight movement and economic vitality, 6) environmental sustainability, and 7) reduced project delivery delays. MAP-21 required that performance measures be established in the areas listed below:

- Pavement condition on the Interstate System and on remainder of the National Highway System (NHS);
- Performance of the Interstate System and the remainder of the NHS;
- Bridge condition on the NHS;
- Fatalities and serious injuries—both number and rate per vehicle mile traveled—on all public roads;
- Traffic congestion;
- On-road mobile source emissions; and
- Freight movement on the Interstate System (13).

Additionally, the Fixing America’s Surface Transportation Act (FAST Act), signed into law in 2015, continues MAP-21’s overall performance management approach and focuses on states investing resources in projects that advance progress toward national performance goals (14). Currently, roadway level of service (LoS) continues to be used by a high percentage of agencies in spite of research reports and training that recommends the use of other measures. Although travel time and travel time reliability are of great interest to the public, their use is primarily limited to freeway facilities with reliability measures just starting to take on increased role due to the Strategic Highway Research Program 2 (SHRP2) initiatives. However, efforts to standardize them are still in early stages. Through the Planning for Operations (P4O) program, FHWA has promoted an objectives-driven performance-based approach which includes the adoption and tracking of Specific, Measureable, Agreed, Realistic, and Time-Bound (SMART) objectives. In a recent assessment conducted by FHWA among MPOs, 29 percent of those responding said they had established at least one SMART operations objective, with 12 percent noting they had one in progress. States, like Virginia, Florida, and Arizona, have developed performance dashboards to track performance measures.

Traffic Management Collaboration
The integration of operations into the formal transportation planning process was mandated by Federal law. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for
Users (Public Law 109-59; SAFETEA-LU) Section 6001(a) contains the following requirements for MPOs (15):

- **Promote Efficient System Management and Operations.** Transportation system management and operation (M&O) shall be considered in the metropolitan transportation planning process.

- **Include Management and Operations Strategies.** The Metropolitan Transportation Plan (MTP) shall include “operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods.”

- **Congestion Management Process.** For MPOs in areas with populations greater than 200,000, the transportation planning process “shall address congestion management through a process that provides for effective management and operation, based on a cooperatively developed and implemented metropolitan-wide strategy, of new and existing transportation facilities eligible for funding under this Title and Chapter 53 of Title 49, through the use of travel demand reduction and operational management strategies.”

Despite these requirements, by 2003, the Association of Metropolitan Planning Organizations (AMPO) observed that while 66 percent of MPOs included M&O programs or strategies in their long-range transportation plans (LRTP), this inclusion was “ad hoc” in 29 percent of the cases. Similarly, 64 percent of MPOs included M&O in their TIP, but when prompted to detail the nature of their programs or strategies, TIM activities were reported by only 23 percent of MPOs (11).

In the following years, this has been an area of emphasis and increasing capability in operations. Agencies recognize the importance of collaboration, especially at an operational and implementation level. While formal relationships are infrequent, there are implementation examples that illustrate a fairly high degree of coordination between enforcement, planning, and operations personnel. This is one of the stronger dimensions for traffic management readiness especially at a strategic planning level.

In a recent internal assessment conducted by FHWA among MPOs, it was found that almost roughly 59 percent of all MPOs have ongoing, multi-agency groups established that collaborate on regional operations. Breaking this down by MPO size, regional collaboration was much more prevalent in large MPOs (81 percent) compared to small MPOs (45 percent). In the same assessment, 43 percent of the responding MPOs noted that they measure their regional transportation system operations regularly. The ICM program is a primary showcase in terms of operational collaboration between agencies.

However, collaboration increasingly is not only with other operating or planning agencies. The role of the private sector in operations continues to grow both as a data provider and a service provider. Agencies are combining various traffic management and operations functions into “mega” contracts that involve a complex sharing of risk between the agency and the contracted provider. For example, Virginia Department of Transportation (VDOT) signed a $355 million contract to a single entity to operate all five of their traffic operations centers. The expected goals of this consolidation were to increase interoperability, conduct performance-based management, and support the deployment of advanced traffic management strategies such as ICM and ATM.
The concept of ICM recognizes that transportation corridors typically have capacity that is underutilized and that the facilities and services on corridors are frequently operated independently (16). The vision of ICM is for transportation networks and all of their services that focus on moving people and goods be optimized through a collaboration, aggressive, and proactive integration of the existing infrastructure with a multimodal framework. Thus, the cooperative involvement of transportation professionals to make multimodal operational decisions to benefit the corridor as a whole serves as the hallmark of ICM.

Lastly, an important element of collaboration for operating agencies is the traveling public itself. Recent developments in this strategy include both the emergence of Smartphones as a traffic condition collection and dissemination tool. For example, mobile crowdsourcing for traffic applications has become increasingly popular in recent years. Although the technology is new, the concept of sharing information with other drivers dates back to the 1970s. Commercial drivers have and continue to use Citizen Band (CB) Radios to transmit traffic information, such as speed traps and congestion, to reduce their trip lengths and increase travel time reliability. Today, all types of road users—with the help of their Smartphones—can provide each other with real-time traffic information via mobile crowdsourcing applications such as Twitter, Waze, and InrixTraffic. The acquisition of Waze by Google and incorporation into Google Maps (17) helped ensure that crowdsourced traffic information became more mainstream.

Traffic Management Organization, Workforce, and Culture

Organization, workforce, and culture-specific conditions are difficult to assess at a national level. Currently, existing deployments are certainly supported by the respective agency decision-makers, but constant engagement and communication is necessary to promote traffic management as a formal core program. Efficient execution of processes supporting effective programs requires appropriate combination of coordinated organizational functions and technical qualified staff with clear management authority and accountability. Staffing needs for TMCs have been studied and reported on by the TMC Pooled Fund Study groups in 2004 identifying the operator requirements and position descriptions (18). Surveys conducted in 2011 indicated that the size of the staff involved in systems management and operation functions (of which traffic management would be a part) varied from 15-70 staff members statewide (10). Amongst the most immediate training needs as reported by the States on the same survey include lessons learned from other agencies for the deployment of operational strategies, benefits/costs of operational strategies, technology application, and technology selection/procurement/specification development. A white paper by Tarnoff noted that while various federal, State and local initiatives have placed a significant emphasis on the training aspect of workforce development, other elements of workforce development such as attracting the workforce, enhancing agency personnel policies, and strengthening university programs require additional attention (19).

Developing the Framework

Once the project team completed the baseline assessment and identified the landscape of traffic management in the U.S., they developed a draft TM CMF specifically geared towards improving capabilities oriented around traffic management needs and objectives. A key motivation on the part of FHWA was to help agencies and regions determine the institutional elements that are important to have in place in order to successfully implement such innovative strategies as ICM and ATM.
The TM CMF is best described as a matrix defining process improvement areas and levels—from Level 1, (low-level) to Level 4, (optimized high-level)—of capability. Following a self-assessment process, specific actions are identified to increase capabilities across the desired process areas of relevance to traffic management. Table 4 provides an overview of the TM CMF, including the 6 dimensions, descriptions of those dimensions within the traffic management context, and sub dimensions that provide additional detail and refinement of the capabilities of agencies.

The purpose of the framework is to build consensus among stakeholders regarding institutional changes at an agency or regional-level. The framework is utilized before any traffic management activities and strategies are implemented. It is not strategy-specific, but rather the framework is specific to process areas that are applicable to traffic management concerns. Note that the resulting actions coming from the framework assessment are from a traffic manager’s perspective, and they do require input and coordination from others.

After reviewing the results of the baseline assessment of traffic management in the U.S., the project team developed a draft TM CMF for use by agencies to help optimize performance of operations on existing infrastructure. The initial structure of the TM CMF was a paper format for the purposes of reviewing, validating, and editing prior to development of the final tool. The structure and functionality of the initial framework included the following:

- A series of questions agencies answer to assess their current capability across the 6 dimensions of capability: business processes, systems and technology, performance measure, organization and workforce, culture, and collaboration;
- A score page that provides an overview to an agency of their capability in each of the 6 dimensions from level 1 to level 4; and
- A list of available actions for each dimension that an agency might select to advance from their current capability level to the next.

Once the project team developed the draft framework, they conducted 2 validation workshops: one in Philadelphia, PA and one in Los Angeles, CA to test the framework with partner agencies and to refine the questions, level descriptions, and possible actions agencies might select or undertake to improve their capability across the 6 dimensions. These workshops proved extremely valuable at refining the content to accurately reflect current practice, ideal capabilities, and the paths agencies might take to advance for their particular region.

Once the workshops were complete, the project team incorporated the recommended changes and finalized the basic structure and content of the TM CMF. Once the basic content was complete, the team commenced with the development of a web-based delivery platform for the tool along with detailed content for the action content to provide guidance to agency users on moving forward with actions to advance levels.
<table>
<thead>
<tr>
<th>Dimension or Process Improvement Area</th>
<th>Description</th>
<th>Sub dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUSINESS PROCESSES</td>
<td>Processes that assess the use of scoping, planning, programming, and budgeting practices</td>
<td>Planning/Scoping Programming/Budgeting/Procurement Traffic Management Decision-Making Process</td>
</tr>
<tr>
<td>SYSTEMS AND TECHNOLOGY</td>
<td>That which facilitates the proper design and implementation of systems.</td>
<td>Integration/Interoperability Regional Architectures Project Systems Engineering/Testing and Validation</td>
</tr>
<tr>
<td>PERFORMANCE MEASUREMENT</td>
<td>Measures that help determine program effectiveness, how changes affect performance, and guide decision-making.</td>
<td>Measures Definition Data Acquisition Performance Management</td>
</tr>
<tr>
<td>ORGANIZATION AND WORKFORCE</td>
<td>Staffing and organizational structure that supports efficient execution of the traffic management process.</td>
<td>Organizational Structure Recruitment and Retention Staff Development/Professional Capacity Building</td>
</tr>
<tr>
<td>CULTURE</td>
<td>An agency’s institutional and operational context and overall perception and attitude toward traffic management.</td>
<td>Understanding/Leadership/Champions Program Status /Authorities Outreach</td>
</tr>
<tr>
<td>COLLABORATION</td>
<td>The willingness and ability to facilitate improved coordinated performance of each partner in the process.</td>
<td>Operational Agency Collaboration Location Government/MPO/RPTA Cooperation Private/Sector Participation Data Sharing Research/Applied Research Interaction with Public</td>
</tr>
</tbody>
</table>
Online Framework Availability

Once the web-based site was completed, FHWA made the TM CMF available online through their website for agencies to use whenever they determine the need to move through the framework for overall traffic management improvement, specific projects, or any other activity that can benefit from the information provided (20). A screen shot of the TM CMF home page is illustrate in Figure 1.

Navigating the TM CMF

While the TM CMF is available online, a collaborative process is recommended for using the framework. Typically, a local agency champion will pull together the stakeholders for traffic management in the area for a day-long workshop to walk through the framework. In using the framework, the stakeholders first determine their capability level using the self-assessment. Then, through use of the web-based tools, stakeholders identify, filter, and compile a set of actions appropriate to the region or agency.

The outcomes of using the framework are consensus around the current capabilities across all the dimensions and an initial list of prioritized actions tailored to the region or agency (3). The champion might then convene future meetings or identify existing forums where the identified actions will be championed and implemented.

The framework is not intended as a benchmarking tool but rather as a resource for agencies to identify appropriate actions for improving management and operations of traffic management
systems. So while periodic assessments are not required, revisiting the tool when significant organizational change occurs or prior to major investments in the area is recommended.

As indicated in Figure 1, the user can move through a quick 1-minute assessment or a full assessment of capability. The 1-minute assessment includes only 6 questions—1 for each dimension—and results in a thumbnail sketch of an agency’s capabilities across the dimensions.

The full assessment includes a series of questions for each dimension to better define capability. An agency would move through the series of questions and answer each based on their current capability. Occasionally, an individual agency may determine that a question does not pertain to their activities. In that case, they are able to select “N/A” as an answer, which exempts the question from being used in assessing a dimension. Also, an individual agency may determine that they are between two specific answers or capabilities for a question. In this case, it is suggested that they select the lower capability to help identify the few actions they may need to undertake to move to the next level.

Once the user answers the questions in the full assessment, the TM CMF generates a score for the agency. As illustrated in Figure 2, the TM CMF highlights the assessed level and a description of that level for each dimension. The next step is for the user to choose actions from list to help an agency move from their current level to a higher one. The user is also able to look at actions for lower levels to determine if they may need to select some of those to further strengthen their current capability to facilitate faster advancement.

Once the user selects their actions, the TM CMF can generate a list of the individual questions and their answers as well as a list of actions they selected along with supplemental information for those actions. The action output for each dimension includes the following:

FIGURE 2 TM CMF Score Page
A description of the dimension and its importance with respect to traffic management;

- The improvement target for the dimension (e.g., lower level to higher level);

- Key sub-dimensions identified for the selected actions;

- A summary of each sub-dimension and its importance within the context of traffic management;

- Key actions selected for each sub-dimension; and

- A definition, rationale, and responsible party for each action.

The user can print the action output and use it for collaboration discussions with regional stakeholders to advance traffic management in the region.

The actions provided as output in the TM CMF are intended to help an agency advance across levels of capability. For example, an agency that is assessed at a level 2 for business processes, might have the following actions to advance from level 2 to level 3 as shown in Table 5.

**TABLE 5 Sample Actions for Level Advancement for Business Processes**

<table>
<thead>
<tr>
<th>Business Process Subdimension</th>
<th>Action to Advance from Level 2 to Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning / Scoping</td>
<td>• Create Regional Traffic Operations Forum where agencies can build consensus and plan operational improvements from a regional perspective.</td>
</tr>
</tbody>
</table>
| Programming / Budgeting / Procurement | • Establish baseline criteria for minimum level of equipment performance (i.e., state of good maintenance) agreeable to all regional agencies.  
• Establish a process to expedite emerging technologies so that an agency can assess, identify, test, and facilitate the implementation of new technologies.  
• Develop a multi-year maintenance plan that includes procurement cycles, warranties, replacement cycles, and preventative maintenance.  
• Provide in-depth training to agency staff/departments to utilize appropriate macro-, meso-, and microscopic modeling. |
| Traffic Management Decision-Making Process | • Establish center-to-center visibility between traffic management centers in the region.  
• Implement facility and corridor management approaches that promote route choice and detours among facilities.  
• Create an incident management tracking database at the regional level.  
• Establish center-to-center connectivity between traffic management centers in the region.  
• Identify and optimize connection points between jurisdictions (e.g., regional signal cooperation).  
• Formalize role of transit agencies in traffic management decision-making for regional traffic management. |
WORKSHOP DELIVERY

Once the online TM CMF was completed, the project team conducted a series of 6 workshops across the country to demonstrate the tool and work with regional stakeholders and partners to determine their current capability level and identify actions to advance across the various dimensions. Sites were selected based on either pending major projects, such as integrated corridor management (ICM) projects, or because of key regional efforts underway to advance transportation management. Table 6 provides a summary of the workshops held over a 6 month period.

### TABLE 6 TM CMF Workshop Delivery Sites

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Host</th>
<th>Theme</th>
<th>Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 2015</td>
<td>Buffalo, NY</td>
<td>NITTEC</td>
<td>I-190 ICM</td>
<td>8</td>
</tr>
<tr>
<td>Feb 2016</td>
<td>Portland, OR</td>
<td>Oregon Metro / ODOT</td>
<td>I-84 ICM / Region</td>
<td>13</td>
</tr>
<tr>
<td>Mar 2016</td>
<td>Newark, NJ</td>
<td>NJDOT / NJIT</td>
<td>NJNE ICM</td>
<td>18</td>
</tr>
<tr>
<td>Mar 2016*</td>
<td>New York, NY</td>
<td>NYSDOT*</td>
<td>ICM-495</td>
<td>38</td>
</tr>
<tr>
<td>Apr 2016</td>
<td>Broward County, FL</td>
<td>Broward MPO / FDOT</td>
<td>I-95 ICM</td>
<td>18</td>
</tr>
</tbody>
</table>

*Workshop funded through separate NYSDOT project funds.

Execution

In advance of each workshop, the project team held a webinar with the stakeholders and potential attendees to introduce and describe the context of the capability maturity framework, and to introduce the participants to the TM CMF in terms of the capability assessment process and the action item identification process. After the webinar, the stakeholders conducted a self-assessment of their respective agency’s traffic management capabilities and to provide them to the project team. Those initial assessments were then tabulated and served as the starting point for the workshop. During the workshop, the facilitator worked with the stakeholders to discuss the elements of the framework from a regional context, establish a consensus of the traffic management capability for the region as a whole through the group review of the questions in the TM CMF, and to identify actions to improve the region’s overall traffic management capabilities. The end result of the workshop was a set of prioritized actions for the regional stakeholders and enhancements to the framework for use in other agencies and regions around the U.S.

Participant Feedback

In general, the participant feedback from the workshops was favorable. Overall, participants had a positive reaction to the workshop and felt that they fostered a dialogue among the regional partners in terms of traffic management. The effort was helpful in identifying areas for improvement and actions, and they felt the presence of FHWA experts at the workshop was valuable. Collaboration across the participating partners in identifying actions was beneficial, though specific benefits may vary depending on the use of the CMF with respect to the timing of a particular project.

The project team also used the workshops to solicit feedback regarding enhancements participants might like to see in the TM CMF. Participants indicated that they would like to see information on lessons learned from the TM CMF process and success stories from other regions on action plan development, execution, and monitoring. They also would like more information on making investments in turning data into system-level performance measures and predictive tools. Additionally, information on action items in terms of potential outcomes and outputs was desired by the attendees, as well as recommendations on getting action information to upper management.
**FINAL REMARKS**

The TM CMF is intended for agencies or regions to assess current capabilities with respect to traffic management. The framework looks at the agency’s ability to monitor, manage, and control traffic and the agency’s ability to coordinate traffic information (3). Broadly, the framework assesses the capability to efficiently manage the movement of traffic on streets and highways and includes corridor management approaches. The capability levels and the actions are focused and defined from a traffic manager’s perspective. The actions may require other agencies to be the responsible party, which is intended to foster multi-agency collaboration and dialogue about traffic management at the regional level. A multi-stakeholder approach is recommended to review the framework and identify improvement actions. Typical stakeholders include city and state traffic managers in the region, selection of traffic operators, transportation planners, law enforcement representatives and transit operators. Other CMFs are also available for addressing capabilities in managing specific non-recurring congestion including road weather management, planned special events, traffic incident management, traffic signal management, and work zone management (21).

**REFERENCES**


