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**A synthesis of the “State-of-the-Practice for Advancing
Planning and Operations Integration Opportunities within
Transportation Agencies”**

Final Report

Prepared For

Systems Planning Office
Florida Department of Transportation

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DISCLAIMER

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation or the U. S. Department of Transportation.

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EXECUTIVE SUMMARY

Linking Planning and Operations is vital to improving transportation decision-making and overall efficiency of transportation systems management. The Linking Planning and Operations Initiative undertaken by Florida Department of Transportation aims to mainstream operations considerations into agency's planning and business processes, help ensure that transportation investment decisions reflect full consideration of all available strategies and approaches, foster greater consideration and understanding of the role and value of operations in meeting transportation vision and goals, and provide a platform to collaborate and support planning and operations activities that link demand with supply to enhance transportation system performance and reliability.

This synthesis summarizes current state of knowledge and practices in Planning and Operations Integration, and identify key elements in Linking Planning and Operations, as well as potential knowledge gaps, limitations, and challenges of existing practices and approaches. This project also serves as the foundation for the Linking Planning and Operations Initiative.

Section I of this report provides background information and an overview of national guidelines and major milestones in this area, followed by a summary of current practices. Section II describes the three key components in the efforts of linking planning and operations, and provides timelines of concept development evolution. Section III provides a comprehensive scan of nationwide case studies, in terms of the linkage opportunities, approaches, and challenges. Section IV presents the findings and recommendations for consideration by the Department, and also serves as a roadmap for the next phases.

References are provided in section V, which covered major reports and studies from FHWA website as well as various studies from other sources. The reference NO.s are kept consistent with the report IDs in the summary tables. Additional summaries of individual report and case studies are provided in the appendixes.

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SECTION I CURRENT STATE OF KNOWLEDGE

A BACKGROUND AND DEFINITIONS

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) requires that metropolitan transportation plans (MTP) 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”¹. This calls for a strategic approach to integrating transportation system management and operations (M&O) strategies into the planning process, as well as innovative tools that can facilitate the analysis and assessment of M&O strategies within the planning context.

To address the challenges in meeting SAFETEA-LU requirement, a joint effort between the FHWA Office of Operations, Office of Planning and FTA's Office of Planning was initiated to promote multimodal planning practices that support 21st century M&O strategies.² The initiative defined planning for operations as: “a set of activities that takes place within the context of an agency, jurisdiction, and/or regional entity with the intent of establishing and carrying out plans, policies, and procedures that enable and improve the management and operation of transportation systems”. The key goal is to integrate operations considerations into the planning of infrastructure projects.

Under this initiative, a series of guidebooks and reference manuals have been developed to provide guidance on linking planning and operations through various aspects in conceptualization, institutional coordination, implementation approaches, and analysis tools. Three major components in the efforts are identified as: 1) regional transportation operations collaboration and coordination (RTOCC), 2) M&O considerations in the planning process, and 3) the opportunities to link the above two.

Following those guidebooks, a number of states and regions around the country have begun to apply the “planning for operations” principles and elements in their practices, including New York, Colorado, Pennsylvania, California, Arizona, Virginia, and Delaware, etc.³ This section intends to provide a nationwide scan of existing literature including national guidelines, current practices and experiences, and emerging tools.

¹ “Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU),” Section 6001(i), 2005.

² U.S. Department of Transportation Planning for Operations. <http://www.plan4operations.dot.gov/about.htm>

³ “The How: Case Studies Advancing Planning for Operations”.
<http://www.plan4operations.dot.gov/casestudies/benefits.htm>

B NATIONAL GUIDELINES

Figure 1 below presents the three major elements in an integrated framework for linking planning and operations.

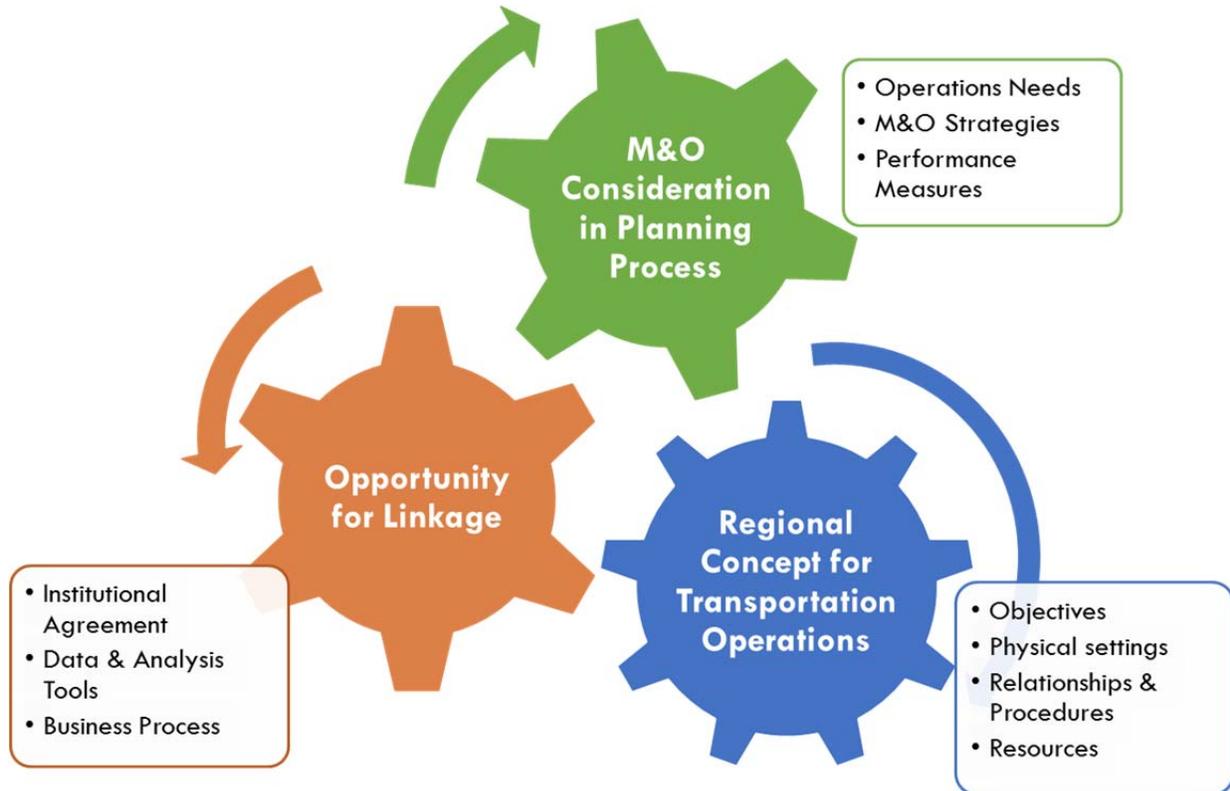


Figure 1 Three major elements in the integrated framework.

One of the earliest efforts in Planning for Operations can be traced back to a primer developed in 2003, which defined five key elements that are associated with successful regional operations collaboration and coordination activities – structure, process, products, resources, and performance measures to gauge success (1). The report provided guidance on the key elements as well as examples of successful case studies and a collaboration self-assessment. In the following year, the idea of “Regional Concept for Transportation Operations” was introduced and framed in a white paper developed by FHWA. The white paper also laid out plans for subsequent work to further explore its implications and develop its scopes (2).

Later that year, another report produced by FHWA was released, which identified nine opportunities – such as data sharing, funding and resource sharing, and performance measures – to strengthen the connections between planning and operations functions. A self-assessment guide was also provided to help agencies gauge current process in

linking planning and operations (3). These documents reflect the first steps in shaping the Planning for Operations initiative.

Figure 2 below presents a timeline starting from 2003 to present in regards to how the efforts in linking planning and operations have evolved overtime. Each tab represents one document in this area with a key word indicating the nature of this report. Texts above the lines describe key contributions of this report in the efforts. Figure 2 shows three major lines of progress – the blue tabs represent efforts focusing on the regional concept for transportation operations (RCTO), the orange tabs indicate critical studies in the area of linkage opportunities, and the green tabs reflect major focuses in the area of taking operation considerations in the planning process.

It can be observed that the efforts generally started with a framing and definition of the main concepts and ideas in each of the three focus areas, and transitioned to specific and practical guidelines and reference manuals, and then moved on to the applications of those ideas and practices in specific program areas, such as project design and development, regional ITS architecture, and traffic incident management (TIM) in the planning process.

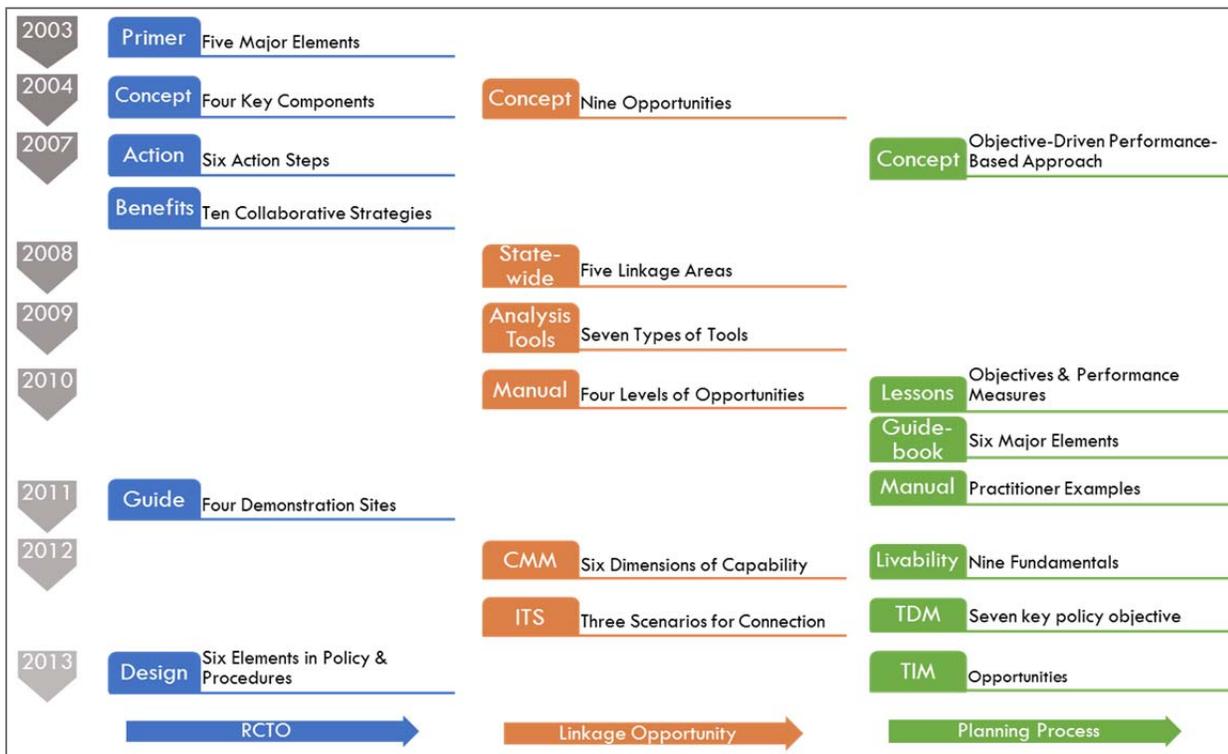


Figure 2 The major milestones in the efforts of linking planning and operations.

C CURRENT PRACTICES

The U.S. Department of Transportation Planning for Operations Web Site serves as a repository for all resources in this area. This website provided most of the documents that formed the foundation for this synthesis. Various other programs and websites were also explored including the FHWA Livability initiative⁴, Sustainable Communities⁵, the State Smart Transportation Initiative (SSTI)⁶, and the National Association of Regional Councils (NARC)⁷.

Table 1 through Table 3 provide a summary of all relevant reports identified from the above sources. Table 1 presents major studies that directly focus on the efforts in linking planning and operations. The reports are categorized as guidelines (providing guidance), concept (introducing a concept or idea), framework (establishing and characterizing a framework), case study (applications), reference (as a quick resource with examples), and tools based on the nature of the reports. A brief summary is provided for each report. The table also indicates which specific element each report contributes to in terms of integrating planning and operations – RCTO, TSM&O considerations in the planning process, and opportunities for linkage. The last column identifies whether empirical examples or case studies are provided in the reports, and the regions where the applications took place if any.

Table 2 provides a summary of projects in various areas that also contribute to the linkage between planning and operations, such as CMP, regional ITS architecture, and regional TSM&O. Table 3 presents additional studies that could contribute to the purpose of this research from other perspectives, such as livability initiatives, etc.

A number of resources were explored to identify relevant studies overseas, we did not find any documents or projects with specific focus on integrating planning and operations, partly due to language barriers. The websites explored include:

- The International Transport Forum <http://www.internationaltransportforum.org/Pub/resreports.html>
- The Korea Transport Institute <http://english.koti.re.kr>
- The Victoria Transport Policy Institute <http://www.vtpi.org/>
- The Dutch Agency of the Ministry of Infrastructure & the Environment http://www.rws.nl/en/highways/v_con/

⁴ FHWA Livability Initiative. <http://www.fhwa.dot.gov/livability/>

⁵ Partnership for Sustainable Communities. <http://www.sustainablecommunities.gov/>

⁶ State Smart Transportation Initiative. <http://ssti.org/>

⁷ National Association of Regional Councils. <http://narc.org/>

Table 1 Major Studies on the Three Main Elements in the Integrated Framework

ID	Title	Source	Scale	Type	Year	Summary	Area	Empirical Examples
1	Regional transportation operations collaborations and coordination: A Primer for Working Together to Improve Transportation Safety, Reliability, and Security	FHWA	Regional	Guidelines	Jan-03	Directed at transportation professionals and public safety officials responsible for day-to-day management and operations within a metropolitan region, as well as agencies already involved in regional collaborative efforts. The document provides guidance on the five key elements that are associated with successful regional operations collaboration and coordination activity – structure, process, products, resources, and performance measures to gauge success. Includes a collaboration self-assessment and examples of successful case studies.	RCTO	X
2	Regional concept for transportation operations, a tool for strengthening and guiding regional transportation operations collaboration and coordination	FHWA	Regional	Concept	Aug-04	This white paper is the first step in introducing and framing the idea of a Regional Concept for Transportation Operations. Subsequent work is planned, involving many stakeholders and interest groups to explore its implications and more fully develop its scope in various settings. The result will be more detailed guidance for developing and using a Regional Concept for Transportation Operations	RCTO	
3	Getting more by working together, opportunities for linking planning and operations: A Reference Manual	FHWA	Regional	Guidelines	Nov-04	Helps transportation planning and operations managers understand the value of working together and the benefits of pursuing regional M&O strategies. Identifies nine opportunities – such as data sharing, funding and resource sharing, and performance measures – to strengthen the connections between planning and operations functions. A self-assessment guide helps agencies gauge current process in linking planning and operations.	Linkage	
4	A holistic transportation planning framework for management and operations	ITE Journal	All Levels	Framework	May-05	Describes a holistic process with five dimensions of the transportation planning context. It also indicated the characteristics in the process that are relative to management and operations. The institutional barriers and required cultural changes are discussed.	Planning Process	
5	Regional concept for transportation operations, the blueprint for action	FHWA	Regional	Concept	Jun-07	Introduces the Regional Concept for Transportation Operations, a management tool to help agencies think through, plan, and implement management and operations (M&O) strategies in a collaborative and sustained manner.	RCTO	
6	The Collaborative Advantage: Realizing the Tangible Benefits of Regional Transportation Operations Collaboration	FHWA	Regional	Guidelines	Aug-07	Examines collaborative strategies to improve transportation system performance and a process to assess the benefits of collaboration. Nine case studies of collaborative efforts demonstrate tangible benefits.	RCTO	X
7	Management & Operations in the Metropolitan Transportation Plan: A Guidebook for Creating an Objectives-Driven, Performance-Based Approach	FHWA	Metropolitan	Guidelines	Nov-07	Provides a basis to integrate transportation system management and operations (M&O) into the metropolitan transportation planning process and to assist MPOs in meeting Federal requirements under SAFETEA-LU calling for M&O strategies to be incorporated into the metropolitan transportation plan (MTP). It highlights effective practices that result in an MTP with a more optimal mix of infrastructure and operational strategies, founded on the inclusion of measurable, performance-based regional operations objectives.	Planning Process	
8	Statewide Opportunities For Linking Planning and Operations A Primer	FHWA	Statewide	Guidelines	Jun-08	Highlights the benefits of linking planning for operations at the state level. Identifies and describes five major types of opportunities and provides case studies of successful practices. Also includes a self-assessment questionnaire to help State DOT planning and operational staff understand how well they are currently linking planning and operations.	Linkage	X
9	Capital district transportation committee Albany, New York, Placing	FHWA	Metropolitan	Case Study	Apr-09	Presents six case studies of regions around the country where agencies are applying elements of an objectives driven, performance-based approach to planning for operations. Presents six case studies	Planning Process	Albany, NY

ID	Title	Source	Scale	Type	Year	Summary	Area	Empirical Examples
	the congestion management process in the context of metropolitan planning goals and objectives					of regions around the country where agencies are applying elements of an objectives driven, performance-based approach to planning for operations.		
10	The Denver region traffic signal system improvement program, planning for management and operations	FHWA	Metropolitan	Case Study	Apr-09		RCTO	Denver
11	Delaware valley regional planning commission Philadelphia metropolitan region, planning for congestion management and tracking process	FHWA	Metropolitan	Case Study	Apr-09		Planning Process	Delaware
12	Metropolitan transportation commission San Francisco Bay Area, Developing regional objectives and performance measures to improve system operations	FHWA	Metropolitan	Case Study	Apr-09		Planning Process	San Francisco
13	Regional concept for transportation operations fosters planning for operations in the Tucson Metropolitan Area, Operator-focused planning for operations	FHWA	Metropolitan	Case Study	Apr-09		RCTO	Tucson
14	Wilmington area planning council New Castel county, Delaware and Cecil county, Maryland, A performance-based approach to integrating congestion management into the metropolitan planning process	FHWA	Metropolitan	Case Study	Apr-09		Planning Process	Wilmington
15	Applying Analysis Tools in Planning for Operations	FHWA	All Levels	Tools	Sep-09	Examines the use of software and analytical tools as well as basic analysis methods to support planning for operations. Tools and methods include traffic signal optimization tools, simulation tools, sketch planning tools, and archived operations data. Accompanying case studies help planners and operations professionals' better use existing analysis tools and methods to analyze, evaluate, and report the benefits of investments in M&O strategies.	Linkage	X
16	Applying Analysis Tools in Planning for Operations: Case Study #1- Operations Strategy Impact Reference and Deployment Guidance	FHWA	All Levels	Case Study	Sep-09	Provides reference and resource materials that will help planners and operations professionals to use existing transportation planning and operations analysis tools and methods in a more systematic way to better analyze, evaluate, and report the benefits of needed investments in transportation operations.	Linkage	X
17	Applying Analysis Tools in Planning for Operations: Case Study #2- Incorporating Highway Capacity Manual Procedures into Long-Range Transportation Planning	FHWA	All Levels	Case Study	Sep-09		Linkage	X
18	Applying Analysis Tools in Planning for Operations: Case Study #3 - Using Archived Data As a Tool for Operations Planning	FHWA	All Levels	Case Study	Sep-09		Linkage	X

ID	Title	Source	Scale	Type	Year	Summary	Area	Empirical Examples
19	Applying Analysis Tools in Planning for Operations: Case Study #4 - Application of Microsimulation in Combination With Travel Demand Models	FHWA	All Levels	Case Study	Sep-09		Linkage	X
20	The Use of Operations Objectives and Performance Measures in Private and Public Organizations	FHWA	All Levels	Guidelines	Feb-10	This paper examines lessons and insights from private companies and public organizations that may apply to agencies in the United States working to advance transportation planning for operations using a strategic approach. In particular, this paper examines the use of measurable objectives and performance measures by private and public organizations to improve service delivery to their customers over physical infrastructure such as toll roads or electrical lines.	Planning Process	
21	Advancing metropolitan planning for operations, an objectives-driven, performance-based approach	FHWA	Metropolitan	Guidelines	Feb-10	Presents an objectives-driven, performance-based approach for integrating M&O strategies into the metropolitan transportation plan (MTP) to maximize performance, fulfill Federal planning requirements, and meet customer needs.	Planning Process	
22	Advancing metropolitan planning for operations, the building blocks of a model transportation plan incorporating operations	FHWA	Metropolitan	Guidelines	Apr-10	Offers MPOs and their State and local partners a menu of options for incorporating operations into their plans. Provides an organized collection of sample operations objectives, performance measures, and excerpts of a metropolitan transportation plan incorporating operations.	Planning Process	
23	Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan Incorporating Operations - A Desk Reference	FHWA	Metropolitan	Reference	Apr-10	The Desk Reference contains more than 200 examples of customizable operations objectives that can be incorporated into transportation planning documents.	Planning Process	X
24	Statewide Opportunities for Integrating Operations, Safety and Multimodal Planning: A Reference Manual	FHWA	Statewide	Reference	Jun-10	Provides "how-to" information to assist State DOTs in integrating these functional areas to produce better investment decisions. Identifies and describes opportunities at various levels of decision-making –statewide, regional, corridor, and project – and the benefits of these approaches. Describes the benefits, challenges, stakeholders, and implementation actions for each opportunity. Also includes toolkits, case study examples, and self-assessment checklists at each level of decision-making.	Linkage	X
25	Developing Decision maker Support for Management and Operations at MetroPlan Orlando	FHWA	Metropolitan	Case Study	Nov-10	Presents a story of Institutionalize M&O at the MPO with dedicated annual funding, an M&O subcommittee, and a MetroPlan System Management & Operations Department.	Planning Process	Orlando
26	Outcomes-Based, Performance-Driven Planning at Metro Portland	FHWA	Metropolitan	Case Study	Nov-10	Describes the process of establishing an outcomes-based planning approach.	Planning Process	Portland
27	The Use of an Objectives-Driven, Performance-Based Approach at the Champaign County Regional Planning Commission	FHWA	Metropolitan	Case Study	Nov-10	Presents the integration of an objective-driven, performance-based approach into the RTP development.	Planning Process	Champaign
28	Congestion management process, a guidebook	FHWA	Metropolitan	Guidelines	Apr-11	Describes a flexible framework of eight congestion management actions as part of an objectives driven, performance-based approach. Also highlights the role of the congestion management process (CMP) in supporting livability, multimodal transportation, environmental review, collaboration, demand management and operations strategies, documentation, and visualization.	Linkage	

ID	Title	Source	Scale	Type	Year	Summary	Area	Empirical Examples
29	The regional concept for transportation operations, a practitioners' guide	FHWA	Regional	Case Study	Jul-11	This practitioner's guide is a collection of the observed successes and lessons learned from four metropolitan regions as they developed Regional Concepts for Transportation Operations (RCTOs). RCTOs are a management tool used by planners and operations practitioners to define a strategic direction for implementing effective regional transportation management and operations in a collaborative manner.	RCTO	X
30	The Role of Transportation Systems Management & Operations in Supporting Livability and Sustainability, a Primer	FHWA	All Levels	Guidelines	Jan-12	This primer describes the role of transportation systems management and operations (M&O) in advancing livability and sustainability. The document highlights the connections between M&O and livability and sustainability objectives and the importance of a balanced, comprehensive approach to M&O in order to support those objectives. The document describes nine key elements for managing and operating transportation systems in ways that support livability and sustainability. The document also provides a vision of how the regional transportation system could look in the future if M&O strategies were comprehensively implemented to advance livability and sustainability goals. Case examples throughout and a section on implementation will help practitioners to get started on implementing M&O to support livability and sustainability in their communities.	Planning Process	X
31	Creating an Effective Program to Advance Transportation System Management and Operations Primer	FHWA	All Levels	Guidelines	Jan-12	Offers high-level guidance on key program, process, and organizational capabilities that are essential to effective transportation system management and operations within agencies. It is aimed at program and activity-level managers responsible for M&O related activities in State, regional, and local transportation agencies. The "capability maturity" approach presented here identifies the key areas that impact program effectiveness: business processes, systems and technology, performance measurement, culture, organization and workforce, and collaboration.	Linkage	
32	Applying a regional ITS architecture to support planning for operations, a primer	FHWA	Regional	Guidelines	Feb-12	This primer offers transportation planners and operations managers a menu of opportunities for applying the regional ITS architecture to enhance planning for operations. It provides specific entry points for leveraging the regional ITS architecture in integrating operations into the planning process. This primer centers on the use of an objectives-driven, performance-based approach to planning for operations; an approach that can leverage regional ITS architectures given the approach's emphasis on operational objectives and performance measures and the architecture's use of data and services to address operational needs. Additionally, the primer leads planners and operators through techniques to make a regional ITS architecture relevant and more accessible to practitioner needs in planning for operations.	Linkage	
33	Operations Benefit/Cost Analysis Desk Reference	FHWA	All Levels	Tools	May-12	Provides practitioners with relevant guidance on how to effectively and reliably estimate the benefits and costs of operations strategies. This Desk Reference is supported by an Operations B/C decision support tool, called the Tool for Operations Benefit/Cost (TOPS-BC). This spreadsheet-based tool is designed to assist practitioners in conducting benefit/cost analysis by providing four key capabilities	Linkage	
34	Integrating Demand Management into the Transportation Planning Process: A Desk Reference	FHWA	All Levels	Reference	Aug-12	Serves as a desk reference on integrating demand management into the transportation planning process. The desk reference is organized around two fundamental aspects of transportation planning – policy objectives and scope of the planning effort. The report discusses how demand management relates to seven key policy objectives that are often included in transportation plans, such as congestion and air quality. It then discusses how demand management might be integrated into four levels of transportation planning from the state down to the local level. The report also includes information on tools available for evaluating demand management measures and on the known	Planning	

ID	Title	Source	Scale	Type	Year	Summary	Area	Empirical Examples
						effectiveness of these measures.		
35	Designing for transportation management and operations, a primer	FHWA	All Levels	Guidelines	Feb-13	Focuses on the collaborative and systematic consideration of management and operations during transportation project design and development. This is termed "designing for operations." Effectively designing for operations involves the development and application of design policies, procedures, and strategies that support transportation management and operations. The consideration of operations needs during the design process requires transportation design professionals to work closely with those with expertise in transportation operations, intelligent transportation and transportation technology staff, planning, transit, freight, traffic incident management, and other practitioners from multiple agencies to fully identify, prioritize, and incorporate operations needs into the infrastructure design. This primer introduces the concept for designing for operations and describes tools or institutional approaches to assist transportation agencies in considering operations in their design procedures as well as pointing out some specific design considerations for various operations strategies.	RCTO	
36	Making the Connection: Advancing Traffic Incident Management in Transportation Planning A Primer	FHWA	Metropolitan	Guidelines	Jul-13	Informs and guides TIM professionals and transportation planners to initiate and develop collaborative relationships and advance TIM programs in the metropolitan planning process, through TIM-focused objectives, performance measures, and TIM strategies and projects. Examples from across the country are provided to illustrate effective practices in linking TIM and planning.	Planning Process	X
37	Programming for Operations: MPO Examples of Prioritizing and Funding Transportation Systems Management & Operations Strategies	FHWA	Metropolitan	Case Study	Sep-13	Discusses how metropolitan planning organizations have incorporated transportation systems management and operations projects into the programming phase of transportation investment decision-making in metropolitan areas.	Planning Process	X

Table 2 Specific Programs and Initiatives Providing Potential Linkage Opportunities

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
38	Congestion Management System Practices	TTI	Current Practice	Jan-02	This report describes the summary of Congestion Management System (CMS) processes currently in use around the United States. The primary objectives of the activities described in this report were to: 1) update the 1999 CMS Improvement Process Report, 2) understand how they use their CMS processes, and 3) review Federal Highway Administration (FHWA) material on examples of successful CMS processes in place.	CMP	
39	Mitigating Traffic Congestion Strategies: The Role of Demand-Side	FHWA	Guidelines	Oct-04	Mitigating Traffic Congestion outlines a framework for understanding the full scope of demand-side strategies, and provides a wealth of case studies, both brief and in-depth, that illustrate where and how these strategies are already underway. The document is organized around these primary five sections: The Demand-Side Framework, Summary of Case Study Experience, Conclusions & Future Developments, Additional Resources & References, and The Case Studies	CMP	
40	A Guidebook for Including Access Management in Transportation Planning	TRB	Guidelines	Dec-05	This guidebook is a resource for incorporating access management into the transportation planning process. It provides guidance on specific actions that the reader can take, and points the reader to the appropriate resources for more detailed information. The guidance has been developed through a research project funded by NCHRP.	CMP	
41	Congestion Management Process (CMP) Innovations: A Menu of Options	ICF	Guidelines	Feb-06	The Menu is organized under two main topics: Approaches to Address Required CMP Elements; putting CMP to Broader Uses. This topic explores potential broader application of the CMP, including ways to more effectively incorporate the CMP in transportation planning and programming processes, and ways to utilize the CMP to address transportation goals beyond managing congestion.	CMP	
42	Using CMP Tools to Advance NEPA Documentation	FHWA	Case Study	Jul-06	In 2001, the Mid-America Regional Council (MARC), the MPO serving the greater Kansas City area, developed an enhanced congestion management system (CMS) designed to integrate with the Regional Transportation Plan (RTP), Transportation Improvement Program (TIP), and corridor evaluations, including the Major Investment Study (MIS) planning processes. At this time, MARC adopted a policy that its CMS Toolbox of strategies will be considered when the purpose and need for an environmental study includes congestion management. The agency wanted to directly demonstrate how any suggested capacity improvements had been evaluated using the congestion management process.	CMP	Kansas City, Missouri
43	Linking Congestion Management to Operations: Hampton Roads Planning District Commission	FHWA	Case Study	Jul-06	Congestion is mounting in many metropolitan areas, but capacity increases are often not feasible. In order to increase transportation system performance without adding capacity, many MPOs are increasingly assessing the use of operations strategies as a way to achieve greater efficiency. The Hampton Roads Planning District Commission (HRPDC) serves a 16-jurisdiction planning area in southeast Virginia with a large number of water features, bridges, and tunnels. Therefore, proactive congestion management strategies have been required for this region. HRPDC began developing operations strategies a number of years ago and has taken a leadership role on these strategies. This case study presents an example of HRPDC's approaches for improving congestion management by strengthening the relationship between CMP and operations.	CMP	Virginia

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
44	The Relationship Between Congestion Management and the Planning Process	FHWA	Case Study	Jul-06	Congestion Management Systems (CMS) have been required for Metropolitan Planning Organizations (MPOs) designated as Transportation Management Areas (TMAs) since 1991, when the Intermodal Surface Transportation Efficiency Act was passed. This case study featuring the work of three MPOs investigates best practices of how congestion management processes (CMP), formerly known as CMS, are related to the transportation planning process. The perspectives of the planning process explored in this case study are data presentation, project prioritization, and stakeholder involvement.	CMP	Three MPOs
45	An Interim Guidebook on the Congestion Management Process in Metropolitan Transportation Planning	FHWA	Guidelines	Feb-08	This guidebook provides information on how to create an objectives-driven, performance-based congestion management process. While the focus of this guidebook is on the CMP, the principles of objectives-driven, performance-based planning can also be applied to other aspects of regional concern (safety, economic development, environment, etc.) in a MTP. The CMP represents the “state-of-the-practice” in responding to the growing challenge of congestion on urban transportation networks.	CMP	
46	Atlanta Regional Commission	FHWA	Case Study	Dec-10	Although the CMP does not have specific, discrete steps, ARC staff recognize five primary elements: (1) monitor and evaluate performance, (2) identify causes, (3) identify and evaluate alternative strategies, (4) provide information supporting implementation, and (5) evaluate the effectiveness of implementation. The activities directly associated with the CMP are primarily monitoring and evaluating system performance while most of the activities that comprise the other CMP elements are performed under other titles or programs.	CMP	Atlanta, Georgia
47	Capital Area Metropolitan Planning Organization	FHWA	Case Study	Dec-10	Engaged in congestion management planning since 2001 with continued improvement over the past decade. A primary element of the current CMP is a database that includes information on travel times, crashes, and transit performance; it serves the region for many purposes. In addition, CAMPO provides a yearly “State of the System” report, and integrates the most recent data into each update of the MTP. The CMP, like many other CAMPO planning activities, is a collaborative effort. The members and staff rely heavily upon the use of committees and working groups to lead transportation decision making.	CMP	Austin, Texas,
48	Capital District Transportation Committee	FHWA	Case Study	Dec-10	Congestion reduction objectives must be balanced with multiple planning objectives. The New Visions plan calls for a strong livability agenda – land use planning, urban reinvestment, transportation choices, and community values. The region’s focus on livability has placed strong emphasis on M&O strategies as a key approach for congestion management. M&O strategies are seen as supporting livability goals by minimizing construction of new pavement and addressing travel time reliability problems that travelers have identified as their greatest congestion concern.	CMP	Albany, New York
49	Delaware Valley Regional Planning Commission	FHWA	Case Study	Dec-10	The CMP itself consists of four main phases that are completed cyclically, along with other ongoing coordination activities. The four phases are (1) planning, (2) analysis, (3) action, and (4) evaluation. The CMP is particularly well integrated with the metropolitan transportation plan (MTP) and Transportation Improvement Program (TIP) processes, and plays a significant role in project selection. DVRPC also uses the CMP as an educational tool for localities in their transportation planning.	CMP	Philadelphia, Pennsylvania
50	Puget Sound Regional Council	FHWA	Case Study	Dec-10	The Puget Sound Regional Council’s (PSRC) Congestion Management Process (CMP) is fully integrated into its overall transportation planning process and is a truly multimodal effort. PSRC’s CMP covers the following activities: measuring multimodal transportation system performance, identifying the causes of congestion, developing and evaluating alternatives, selecting solutions, implementing solutions, and monitoring system performance. Because the CMP is so thoroughly integrated in the overall planning process, PSRC staff do not view it as a separate process with distinct steps.	CMP	Seattle, Washington

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
51	Southwestern Pennsylvania Commission	FHWA	Case Study	Dec-10	The CMP is organized around five key elements: (1) planning and system definition, (2) data collection and analysis, (3) strategy evaluation, (4) strategy implementation and project programming, and (5) monitoring strategy effectiveness. Of particular note in the process are the extensive data collection program, efforts to tie CMP strategies into project selection, use of case studies for monitoring strategy effectiveness and encouraging future projects, and use of the Internet for storing, organizing, and presenting CMP data and analysis products.	CMP	Pittsburgh, Pennsylvania
52	Wilmington Area Planning Council	FHWA	Case Study	Dec-10	The Wilmington Area Planning Council (WILMAPCO) follows a seven-step Congestion Management Process (CMP) consisting of (1) system analysis and definition, (2) congestion performance measures, (3) strategy evaluation, (4) Regional Transportation Plan project pipeline and needs inventory, (5) project and problem prioritization, (6) project implementation and programming, and (7) system monitoring and project effectiveness. This process is conducted annually and is closely tied to the project selection process of the Transportation Improvement Program (TIP). WILMAPCO gathers data from a variety of sources and uses them to analyze congestion in the region, identify potential mitigation strategies, identify high-priority project locations, and inform the public through various media (reports, static and interactive maps, and Web site).	CMP	Wilmington, Delaware
53	Florida's ITS Planning Guidelines: Integration of ITS unto the Transportation Planning Process	Florida DOT	Guidelines	Jun-00	Issues and general direction to achieve mainstreaming ITS into planning process were developed in cooperation with the FHWA Division Office in Tallahassee and the Metropolitan Planning Organization Advisory Council and are presented in the Department's ITS Strategic Plan and in the Integration of ITS into the MPO Transportation Planning Process Issue Paper. These ITS Planning Guidelines represent a further effort to refine the previous work providing direction to integrate ITS into all aspect of Florida's transportation planning and growth management process. The purpose of the ITS Planning Guidelines is to provide general direction to local and state planners for why, when, and how to consider ITS, even what ITS applications to consider.	Regional ITS	Florida
54	Incorporating ITS Solutions into the Metropolitan Transportation Planning Process: Overcoming Institutional Barriers	US DOT	Guidelines	Nov-00	There are three conditions that help bring ITS solutions into the metropolitan transportation planning process: Endorsement of ITS by Elected Officials and Transportation Managers, Improved Communication and Coordination Across Geographic Boundaries and Between Agencies, Collection of Data and Use of Information. There are four strategies that are most commonly used: Create an ITS committee involving regional stakeholders, Educate elected officials and transportation executives, Include ITS in MPO planning documents, Develop a program of regional ITS projects	Regional ITS	
55	Intelligent Transportation System Architecture and Standards: Final Rule	FHWA	Guidelines	Jan-01	The purpose of this document is to issue a final rule to implement section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21), enacted on June 9, 1998, which required Intelligent Transportation System (ITS) projects funded through the highway trust fund to conform to the National ITS Architecture and applicable standards. Because it is highly unlikely that the entire National ITS Architecture would be fully implemented by any single metropolitan area or State, this rule requires that the National ITS Architecture be used to develop a local implementation of the National ITS Architecture, which is referred to as a "regional ITS architecture." Therefore, conformance with the National ITS Architecture is defined under this rule as development of a regional ITS architecture within four years after the first ITS project advancing to final design, and the subsequent adherence of ITS projects to the regional ITS architecture. The regional ITS architecture is based on the National ITS Architecture and consist of several parts including the system functional requirements and information exchanges with planned and existing systems and subsystems and identification of applicable standards, and would be tailored to address the local situation and ITS investment needs.	Regional ITS	

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
56	Institutional and Organizational Factors for the Successful Deployment of Intelligent Transportation Systems (ITS): International Comparisons	FHWA	Case Study	Jun-02	This paper compares European and US experiences to explore critical institutional and organizational factors contributing to successful deployment of ITS. ITS deployment has three primary aspects not found in traditional transportation solutions: 1) advanced technology insertion, interoperability and maintenance; 2) system approaches at the planning, operational and service connectivity levels; and 3) private industry products and services linked to public infrastructure and services. All three aspects have ramifications across agencies and sectors as well as within a transportation agency. To better understand what these are and how they can be effectively addressed, the researchers conducted a comprehensive internet /literature search on the status of ITS programs in Europe and the U.S., interviewed principals involved in ITS deployment both at the policy and project levels, in the public and private sectors, and developed four case studies of successful ITS deployment.	Regional ITS	European and US
57	Regional ITS Architecture Guidance: Developing, Using, and Maintaining an ITS Architecture for Your Region	US DOT	Guidelines	Jul-06	Rapid advances in information processing and communications technology have created new opportunities for transportation professionals to deliver safer and more efficient transportation services, and to respond proactively to increasing demand for transportation services in many areas and mounting customer expectations from coast to coast. To encourage and enable effective coordination between organizations - at both an institutional and technical level, the USDOT has developed the National ITS Architecture and related tools to help identify and exploit these opportunities for cost-effective cooperation. This document is one such tool that describes how to develop a regional ITS architecture, which will be a cornerstone of planning for effective interagency coordination and for deployment and operation of technology-based projects.	Regional ITS	
58	A Regional HOV System Planning Approach Involving Multiple Agencies	TTI	Case Study	2001	To address mobility and air quality concerns the Austin District of the Texas Department of Transportation (TxDOT) has embarked upon a planning process for developing a system of HOV facilities that incorporates multiple regional agencies. This paper presents TxDOT's HOV planning framework for the Austin region, highlighting both the technical and the policy-related elements of the process. Included in the paper are descriptions of a number of features of the process: a multi-agency intermodal agreement for HOV system planning; a regional HOV Task Force comprised of technical staff from participating agencies to support and compliment Major Investment Studies (MIS) on specific corridors; inter-agency review teams for each MIS; and the use of research results from other communities as a basis for technical decisions and for the development of public education/awareness tools.	RTSM&O	Austin, Texas
59	Statewide Multimodal Transportation Planning Proceedings: 2004 Peer Exchange	TRB	Reference	Jul-04	The primary purpose of the peer exchange was to facilitate an open exchange of information on experiences, concerns, and opportunities related to addressing both cost estimating and safety within the statewide and metropolitan transportation planning processes. A secondary purpose of the peer exchange was to identify a near-term action agenda for improving the state of the practice for addressing safety in transportation planning.	RTSM&O	
60	Transportation Management and Security During the 2004 Democratic National Convention	US DOT	Case Study	Jan-05	The transportation operations plan for the 2004 Democratic National Convention (DNC) in Boston, Massachusetts, was not a typical transportation plan driven by goals such as mobility and air quality. The DNC was the first national political convention to be held since September 11, 2001. Therefore, it was the first such event for which security priorities took preference over mobility considerations. This report primarily focuses on how transportation officials responded to the security concerns of local, state, and federal safety officials, and how they designed and managed the operations of the transportation system during the convention.	RTSM&O	Boston, MA

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
61	Planning and Operations Fall 2005 Analysis Tools User Survey Initial Results		Tools	Nov-05	This survey looks at what operations analysis tools are being used during the planning process. What additional resources may be needed to improve/expand the analysis of operations within in the planning process	RTSM&O	
62	Planning Analysis Tools for Operations/ITS Evaluation: GAP Study	TTI	Tools	Nov-05	Identify the user needs for evaluating operations and ITS projects in the planning process. Provide recommendations for modifying software tools to assist planners and decision-makers in quantifying the impacts and assessing the benefits of operations-oriented improvements in the LRTP and TIP planning processes.	RTSM&O	X
63	Creating an Effective Program to Advance Transportation System Management and Operations: Primer	FHWA	Guidelines	Jan-12	The purpose of this Primer is to raise awareness of the opportunities for improving the effectiveness of State and local Transportation System Management and Operations (TSM&O) activities. The Primer provides high-level guidance focused on key program, process, and organizational capabilities that are essential to the development of more effective TSM&O strategy applications. It is aimed at program and activity-level managers responsible for TSM&O related activities in State, regional, and local transportation agencies.	RTSM&O	
64	Florida Transportation Systems Management and Operations Strategic Plan	FDOT	Guidelines	2013	This TSM&O Strategic Plan presents the high-level structure for establishing and maintaining FDOT's TSM&O Program. Through all of the recommended activities listed in the TSM&O Functional Plan, this Strategic Plan ensures that implementation will occur concurrently through FDOT Operations and Planning, high-level Policy recommendations, and the Project Development Cycle.	RTSM&O	Florida

Table 3 Additional Programs Relevant to Linking Planning and Operations

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
65	Creating livable communities: an implementation guidebook	FHWA Livability	Guidelines	2010	This guidebook identified tools and practices that local governments and regional planning organizations can use to plan and create livable communities across a variety of topics, like funding and financing, communication, model policies, performance measures, etc. this effort resulted in 15 case studies from a region and local perspective, and highlighted plans and projects that supported livability.	Livability	X
66	Livability in transportation guidebook	FHWA Livability	Guidelines	2010	The primary purpose is to illustrate how livability principles have been incorporated into transportation planning, programming, and project design, using examples from state, regional, and local sponsors. The guidebook explores how transportation planning and programs can improve community quality of life, enhance environmental performance, increase transportation and housing choice while lowering costs, and support economic vitality.	Livability	
67	Creating livable Communities: how the transportation decision making process can support more livable community outcomes	FHWA Livability	Guidelines	Oct-11	This booklet provides strategies on how to effectively consider and incorporate livability objectives in transportation investment decisions,	Livability	
68	Integrating climate change into the transportation planning process	FHWA Livability	Guidelines	Jul-08	The objective of this study is to advance the practice and application of transportation planning among state, regional, and local transportation planning agencies to successfully meet growing concerns about the relationship between transportation and climate change. This report explores the possibilities for integrating climate change considerations into long range transportation planning at state DOTs and MPOs.	Livability	
69	FHWA scenario planning guidebook	Sustainable Communities	Guidelines	Feb-11	The guidebook presents the six key phases that agencies are likely to encounter when implementing the scenario planning process. For each phase, the guidebook provides questions, considerations, steps, and strategies to help guide agencies in managing and implementing a comprehensive scenario planning effort. The guidebook also describes potential outputs from each phase. While this guidebook focuses on regional-scale scenario planning processes, it recognizes that scenario planning is flexible and can be used for a statewide, corridor level, or neighborhood-scale approach.	Scenario Planning	
70	Southeast Florida express lanes regional concept for transportation operations	Florida DOT	Guidelines	Mar-14	The purpose of the design discussion is to provide guidance to project designers, who are responsible for developing individual projects, which will eventually be part of an interconnected ELN in Southeast Florida. The deployment of express lanes requires coordination of numerous operational components. Integrated system, with multiple agencies, requires even more planning and coordination. The RCTO evaluates the key issues that must be resolved relating to how to organize these tasks and what tasks and decisions should be coordinated on a network level. The key areas associated with the operations of the Southeast Florida ELN include: pricing and toll rate, TMC operations, operations organization, enforcement options, toll system operations, and lane management and vehicle eligibility. Communication, both in real-time, along the facility and in advance, through educational outreach can improve safety and operations on the roadway as well as gain support for EL projects.	FDOT ML	Florida

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
71	Priced managed lane guide	Florida DOT	Guidelines	Oct-12	This guide presents a wide range of information on priced managed lanes. The purpose of this guide is to assist transportation professionals as they consider, plan, and implement priced managed lanes projects. The guide addresses a wide range of policy, outreach, and technical issues associated with the implementation of priced managed lanes, focusing on the knowledge and experience gained from the new projects that have advanced in the past decade, the guide also provides detailed profiles of 21 priced managed land projects that are either operational or nearing completion	FDOT ML	Florida
72	USDOT ITS strategic planning workshop	USDOT	Guidelines	Jun-14	This plan defines the strategic direction for the USDOT's ITS research program for the next five years. The ITS Strategic Research Plan is designed to achieve a vision of a national, multi-modal surface transportation system that features a connected transportation environment among vehicles, the infrastructure and passengers' portable devices. This connected environment will leverage technology to maximize safety, mobility and environmental performance.	ITS	
73	Guide to effective freeway performance measurement: final report and guidebook	NCHRP	Guidelines	Aug-06	This guidebook was structured to answer four primary questions about freeway performance: 1) what measures should be used; 2) how can the measures be developed with data and models; 3) how should freeway performance be communicated; and 4) how can freeway performance measures be used in decision-making. This category includes measures related to typical congestion levels, travel-time reliability, and throughput. This guidebook also cover some additional aspects of freeway performance, it include freeway safety, operational efficiency, ride quality, environmental, customer satisfaction.	PM	
74	Performance measures of operational effectiveness for highway segments and systems	NCHRP	Practices	Mar-03	This synthesis summarizes the practices used by state DOTs, MPOs, and local governments concerning highway operational performance measures and associated data collection. This synthesis reports specifically on: uses of performance measures, the intended audiences for performance measures, reporting techniques for performance measures, data collection techniques in support of the performance measures, the relative strengths and weaknesses of commonly used performance measures, and examples of successful practices for performance measures.	PM	
75	Transportation planning capacity building: planning for a better tomorrow	FHWA Planning	Reference	Oct-03	This report describes a range of examples of applications of performance measures for systems planning at statewide, metropolitan area, and public transit levels. These applications of performance measures including: Strategic planning to measure the cost and performance of alternative packages of investments and strategies in long-range vision or scenarios for states or metropolitan areas; Selection of alternative investments to compare, prioritize, and select alternative modal investments or strategies; Monitoring the performance of transportation organizations, as well as operations of the multimodal system; Accountability within transportation agencies or between agencies and other, particularly elected official, the public , and stakeholders; Communications with elected officials, the public, and stakeholders to provide an understanding of the performance of the transportation system, and critical choices involving that system.	PM	X

ID	Title	Source	Type	Year	Summary	Area	Empirical Examples
76	Analysis, Modeling, and Simulation (AMS) Tested Preliminary Evaluation Plan for Active Transportation and Demand Management (ATDM) Program	FHWA Operations	Research	Nov-13	AMS Test beds can make significant contributions in identifying the benefits of more effective, more active systems management, resulting from integrating transformative applications enabled by new data from wirelessly connected vehicles, travelers, and infrastructure. To this end, the Dynamic Mobility Applications (DMA) and Active Transportation and Demand Management (ATDM) Programs have jointly sponsored the planning of multiple AMS tested to support the two programs in evaluating and demonstrating the system-wide impacts of deploying application bundles and strategies in an AMS environment.	ATDM	
77	Guide for Highway Capacity and Operations Analysis of Active Transportation and Demand Management Strategies: Analysis of Operational Strategies Under Varying Demand and Capacity Conditions	FHWA Operations	Framework	Jun-13	This Guide provides a conceptual analysis framework, recommended measures of effectiveness, and an initial recommended methodology for evaluating the impacts of ATDM strategies on highway and street system demand, capacity, and performance. The Guide presents practitioners with methods to analyze the varying demand and capacity conditions that facilities operate under and methods to apply a limited but broad set of transportation management actions to respond to those conditions. Thus, the methodology represents, in a macroscopic sense, the effects of ATDM at a level suitable for planning and investment decision-making but not real-time operations.	ATDM	
78	A Performance-Based Approach to Addressing Greenhouse Gas Emissions through Transportation Planning	SSTI	Guidelines	Dec-14	This publication is a handbook designed to be a resource for State DOTs and MPOs engaged in performance-based planning and programming to integrate greenhouse gas performance measures into transportation decision-making. It discusses key approaches for integrating GHG emissions into a PBPP approach, considerations for selecting an appropriate GHG performance measure, and using GHG performance measures to support investment choices and to enhance decision-making.	GHG Emissions	
79	Statewide Transportation Planning For Healthy Communities	SSTI	Case Study	Jan-14	This white paper presents insights and a flexible model for State Departments of Transportation (DOTs) that choose to integrate public health considerations into their transportation planning and decision-making. It draws from five case studies of innovative DOTs and their partners, and builds on the project team's previous white paper in this series, Metropolitan Area Transportation Planning for Healthy Communities (2012). The white paper shows how DOTs can consider health across their wide range of activities, which includes transportation planning, programs, and interagency initiatives.	Planning	X
80	Streamlining Cross-Linking Transportation And Evacuation Planning: A Resource Guide	NARC	Guidelines	Oct-11	A document geared towards Metropolitan Planning Organizations (MPOs), Regional Councils (RCs) and their local government officials to assist in either creating or enhancing coordinated transportation or evacuation planning and response efforts at the regional level based on peer-to-peer exchanges and expert analysis.	Evacuation	

SECTION II THE KEY ELEMENTS - CONCEPTS DEVELOPMENT

D RCTO

The concept of RCTO was first introduced and framed in a white paper produced by FHWA in August 2004 (2), which was followed by a number of documents that further explained the concept, including reference manual, blueprint for action, case studies, and practitioners' guide, etc. Figure 3 below presents the development timeline focusing on the RCTO.

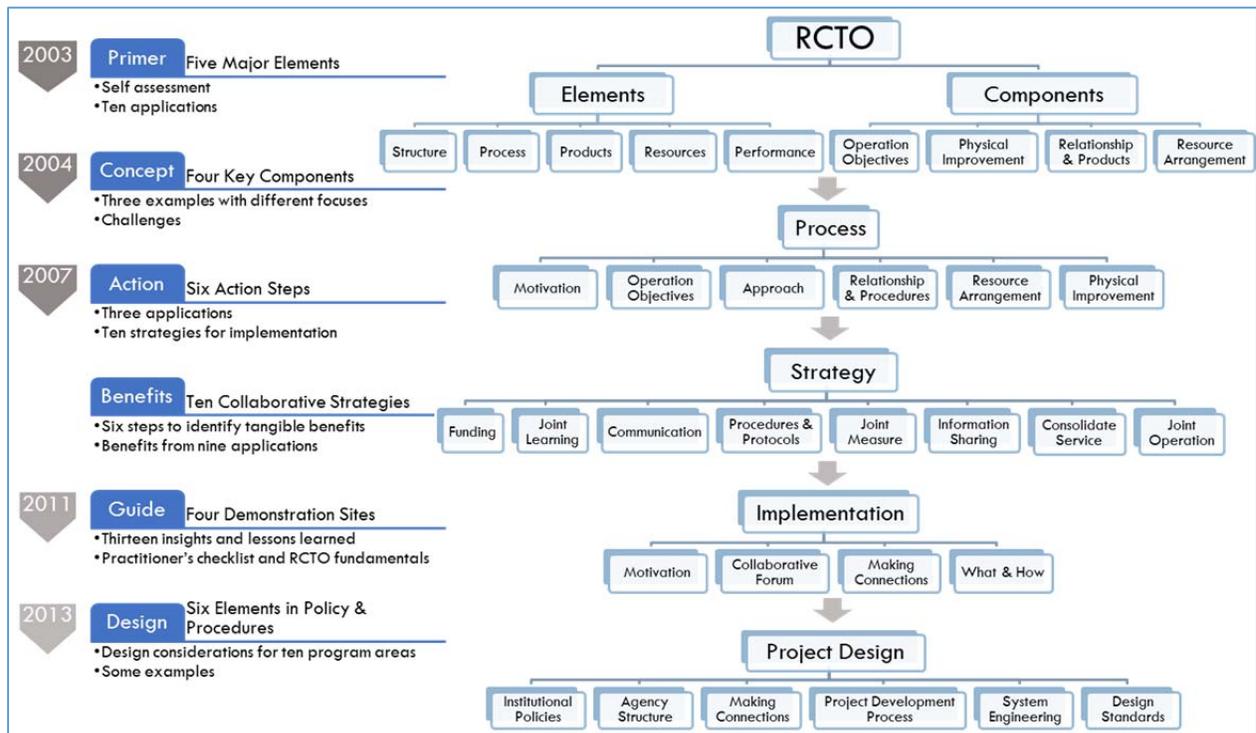


Figure 3 Major studies and events that shaped the efforts in RCTO.

RCTO represents a mutual operations vision and direction, brings together varied perspectives from different agencies and jurisdictions, and facilitates collaborative activities. The five major elements contributing to successful regional operations coordination identified in the 2003 Primer (1), and the four key components in regional concept of operations defined in the 2004 white paper (2) merged into a blueprint for actions in 2007 (5), which described six action steps in the process of promoting RCTO, including:

- Motivation – Reasons for developing an RCTO based on regional needs, goals, or operational concerns.

- Operation Objectives – Desired near-term outcomes in terms of transportation system performance.
- Approach – Overall description of how the operations objective will be achieved.
- Relationship and Procedures – Institutional arrangements, MOUs, protocols, information sharing, etc.
- Resource Arrangement – Facilities, equipment, systems, etc.
- Physical improvement – Sources and use of funding, staff, equipment, etc.

The RCTO can be used to translate outputs of the planning process into specific operations objectives, short-term strategies, and project specifications to be included in the MTP and TIP, as illustrated in Figure 4.

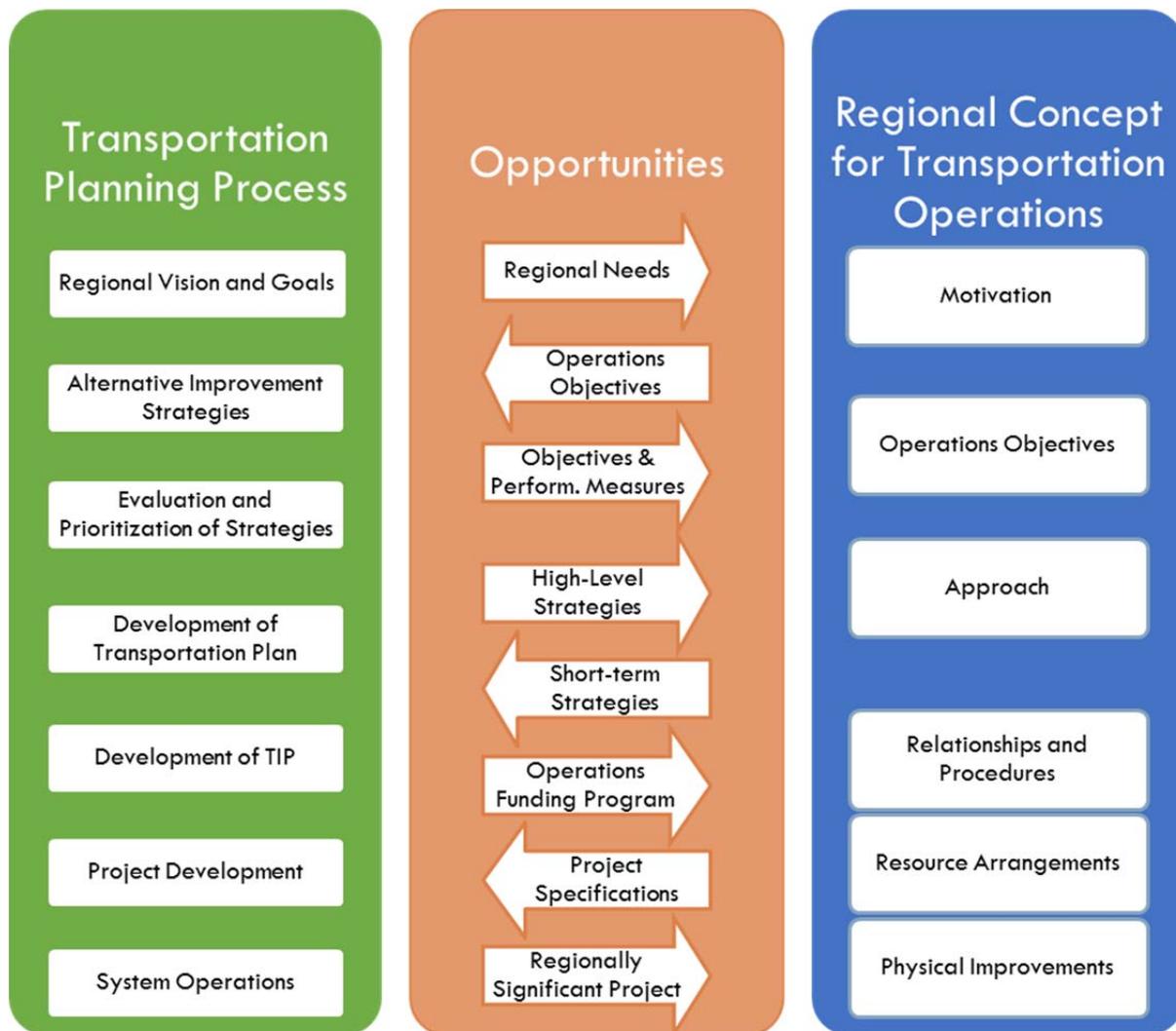


Figure 4 RCTO and the transportation planning process. (5)

Later in the same year of 2007, another study (6) examined the collaborative strategies to improve transportation system performance and proposed a process for agencies to assess the benefits of collaboration. Nine case studies of collaborative efforts were also presented in the report to demonstrate tangible benefits that could be achieved through regional transportation operations collaboration. These ten strategies for regional collaboration include:

- Collaborative pursuit of funding
- Sharing expertise and joint learning through advance operational capabilities, retain best employees, and avoid re-inventing the wheel
- Coordinating communications and giving a consistent message
- Developing common procedures, protocols, and plans through collaborative plans for ITS
- Jointly measuring performance
- Sharing transportation information
- Developing tools for efficient communications in assisting stranded motorists, and exchanging information and assistance with partners
- Sharing resources
- Consolidating services
- Performing joint operations

In 2011, a practitioner's guide was released that summarized thirteen insights and lessons learned built upon applications and experiences from four RCTO demonstration sites (29). A practitioner's checklist was also provided in the report to help agencies identify actions and tasks for implementation. This report summarized experiences and lessons learned from four major areas: motivation, collaborative forum, making connections, and what and how, as presented below:

- **The Motivation leading to an RCTO**
 - Motivation to improve regional operations comes from high-level decision-makers.
 - Collaboration between the operators of each element
 - At strategic approach, developer motivated to provide continuity in the staff change, and raise visibility of operations
- **Collaborative forum for developing an RCTO**
 - Organizing a collaborative forum based on an existing collaborative group
 - Establishing champions and leaders

- Engaging participants through educate potential participants, ensure the individuals necessary for taking action, host workshop, and gain the participation of state DOT
- Maintaining participant involvement
- Gathering support from elected or appointed officials and agency leadership
- Establishing a process for gathering ideas and making decisions
- Linking the RCTO and the planning process
- Using an MPO to provide a neutral table and convene agencies from the region
- Revise operations objectives requiring regional funds to account for programming cycle
- Establish a regional funding program for an operation area
- **The “What” and the “How” of the RCTO**
 - Establishing clear operations objectives through identify desired objectives, performance measure and activity-oriented objectives to support outcome and solutions
 - Creating approach to gather expert practitioners, provide a menu of options, and maintain control over their operations
 - Defining the supporting elements of the approach

The latest study in this area focused on designing for transportation management and operations during transportation project design and development (35). This report identified six policy and procedure elements to support designing for operations, include:

- **Institutional policies** – it is important that these policies ensure that collaboration between designers and operations.
- **Agency structure** – A successful organizational approach to management and operations.
- **Linking planning and designing for operations** – An effective approach to mainstreaming the practice of designing for operations stems.
- **Scoping and financing stage** – Practitioners will define project limits, establish a budget.
- **Preliminary design stage** – This stage is for general project location and design concepts.
- **Final design stage** – this stage is denoted by the preparation of construction plans and detailed specifications.

E LINKAGE OPPORTUNITIES

The concept for linkage opportunities was first introduced in 2004, where nine linkage opportunities were identified (3). Later in 2008, a report with a statewide focus highlighted five major types of opportunities with case studies of successful experiences and a self-assessment questionnaire to help State DOT planning and operational staff understand how well they are currently linking planning and operations (8). These five major categories include, also shown in Figure 5:

- **Institutional arrangements**, such as organizational structures, divisional responsibilities, coordination and interactions among agencies, which provide the platform for linking planning and operations;
- **Regional considerations** enhance coordination across DOTs and between DOTs and other agencies, and promote seamless transitions between systems and jurisdictions;
- **Data, analysis tools, and performance measures** help agencies assess different types of transportation strategies, and are three of the most significant areas for linking planning and operations;
- **Include operational strategies** in transportation plans and corridor studies create linkages between planning and operations; and
- **Policy and regulations** defines the role of regional ITS architecture and set the foundation for linkage between planning and operations



Figure 5 Opportunities for linkage.

For the purpose of this study, we further aggregated the linkage opportunities into three major categories – Organization, Business Programs, and Technical Aspect, as demonstrated in Figure 6.

- **Organization opportunities** include institutional agreements, MOUs, organization structures and funding arrangement among multiple agencies.
- **Business programs** indicate various programs, procedures and policies that could benefit from and accommodate the linkage between planning and operations.
- **Technical aspects** refer to the data/information and analysis tools that facilitate the collaboration and coordination activities.

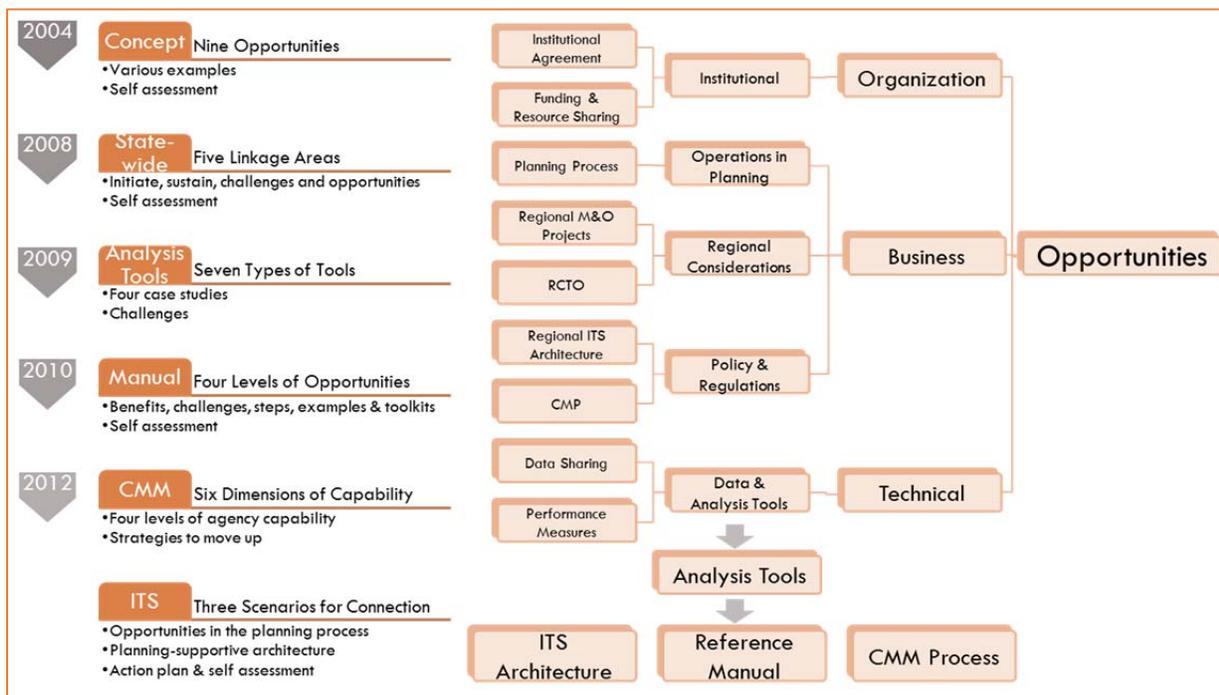


Figure 6 Linkage opportunities development evolution.

In 2009, a report was released focusing on the use of software and analytical tools as well as basic analysis methods to support planning for operations (15). Seven types of tools were examined, including traffic signal optimization tools, simulation tools, sketch planning tools, deterministic models, travel demand forecasting models, operations-oriented performance measures and archived operations data. The report also provided accompanying case studies to help planners and operations professionals to better use existing analysis tools and methods to analyze, evaluate, and report the benefits of investments in M&O strategies.

The next year, a reference manual was developed to provide the “how-to” guidance to assist State DOTs in integrating operations and planning to produce better investment decisions (24). The report identified opportunities at various levels of decision-making – statewide, regional, corridor, and project – and the benefits, challenges, stakeholders, and implementation actions for each opportunity. The manual also included toolkits, case study examples, and self-assessment checklists at each level of decision-making. The four levels of decision-making and the opportunities are presented in Figure 7:

- Statewide level – provides an opportunity to establish goals, objectives, and strategies that support the larger agency mission.
- Regional level – focuses on interaction between the DOT regional or district-level offices, in coordination with MPOs and other agencies. It provides key opportunities for advancing integration in data sharing and analysis tools.
- Corridor and sub-area level – considers integration within planning studies and corridor system management and operations activities. Key opportunities include use of operations/safety data and tools in planning studies and multidisciplinary teams to develop solutions.
- Project level – presents opportunities for integration within project development where representatives of each function (operations, safety, and multimodal planning) interact.

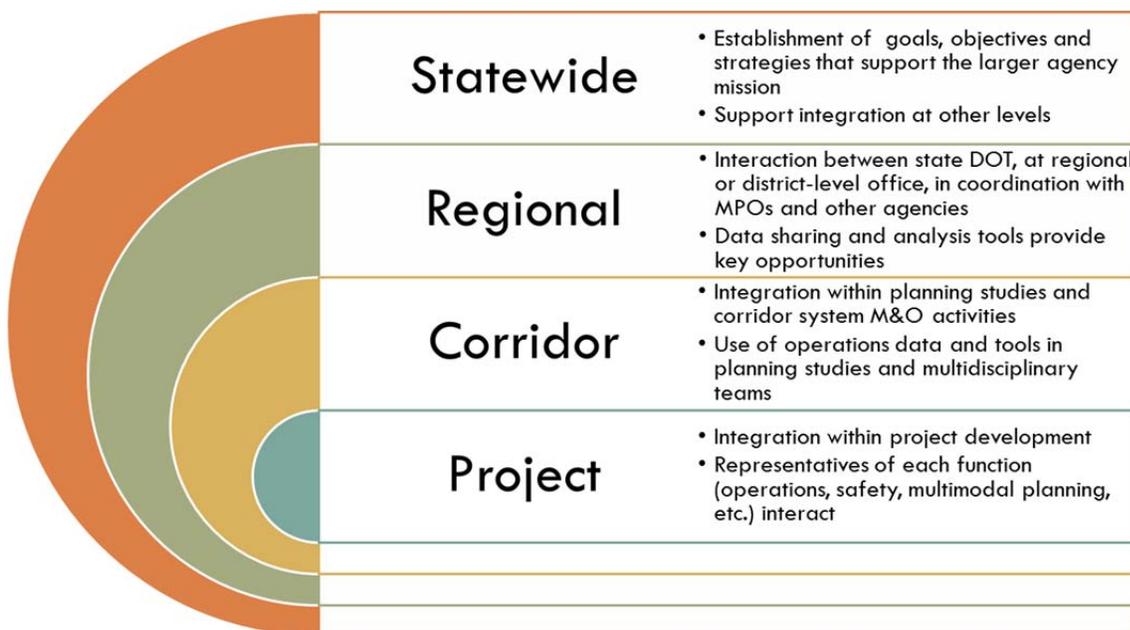


Figure 7 Linkage opportunities at multiple levels.

In 2012, the concept of Capability Maturity Model (CMM) was introduced to identify the key areas that impact program effectiveness (31). Figure 8 below presents the six critical dimensions of agency capability. Figure 9 presents the various levels of agency capability and the relationships among the levels. The report also provide matrix for capability maturity process as well as strategies in each level of maturity.



Figure 8 Six critical dimensions in capability maturity model.

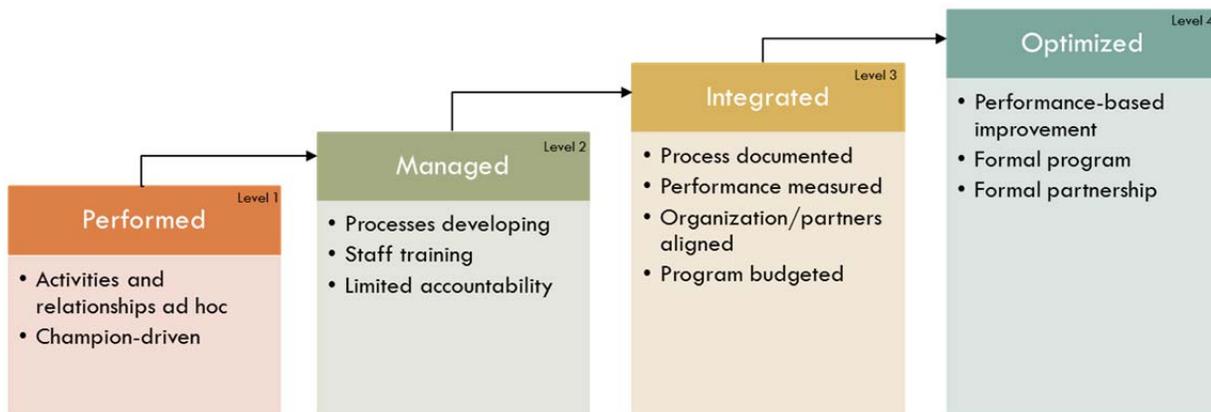


Figure 9 Four levels of agency capability. (31)

In terms of applying the regional ITS architecture to enhance planning for operations (32), the report provided a menu of opportunities that leverage the regional ITS architecture in integrating operations into the objectives-driven, performance-based

approach. Figure 10 below presented key connections between the regional ITS architecture and the planning process.

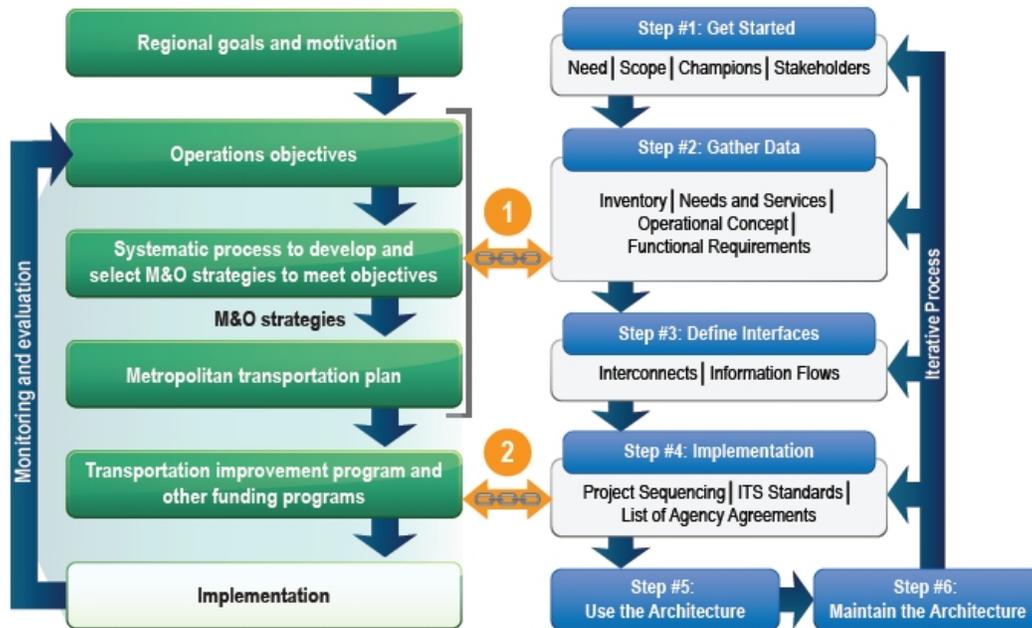


Figure 10 Key connections in the context of the planning and architecture processes. (32)

F M&O CONSIDERATIONS IN THE PLANNING PROCESS

M&O considerations focus on the inclusion of measurable, performance-based regional operations objectives into the metropolitan transportation planning process. Figure 11 below presents a timeline of development in this element. The concept of objective-driven performance based approach was first introduced in 2007 (7), and served as the major milestone for later studies in the efforts of linking planning and operations. Efforts in this area focus on the inclusion of measurable, performance-based regional operations objectives into the metropolitan transportation planning process.

Following this guidance, six case studies were conducted around the country where agencies are applying elements of an objectives-driven, performance-based approach to planning for operations.

In 2010, a series of reports were produced that further advanced practices in incorporating operations objectives in the planning process, including desk references, building blocks and case studies.

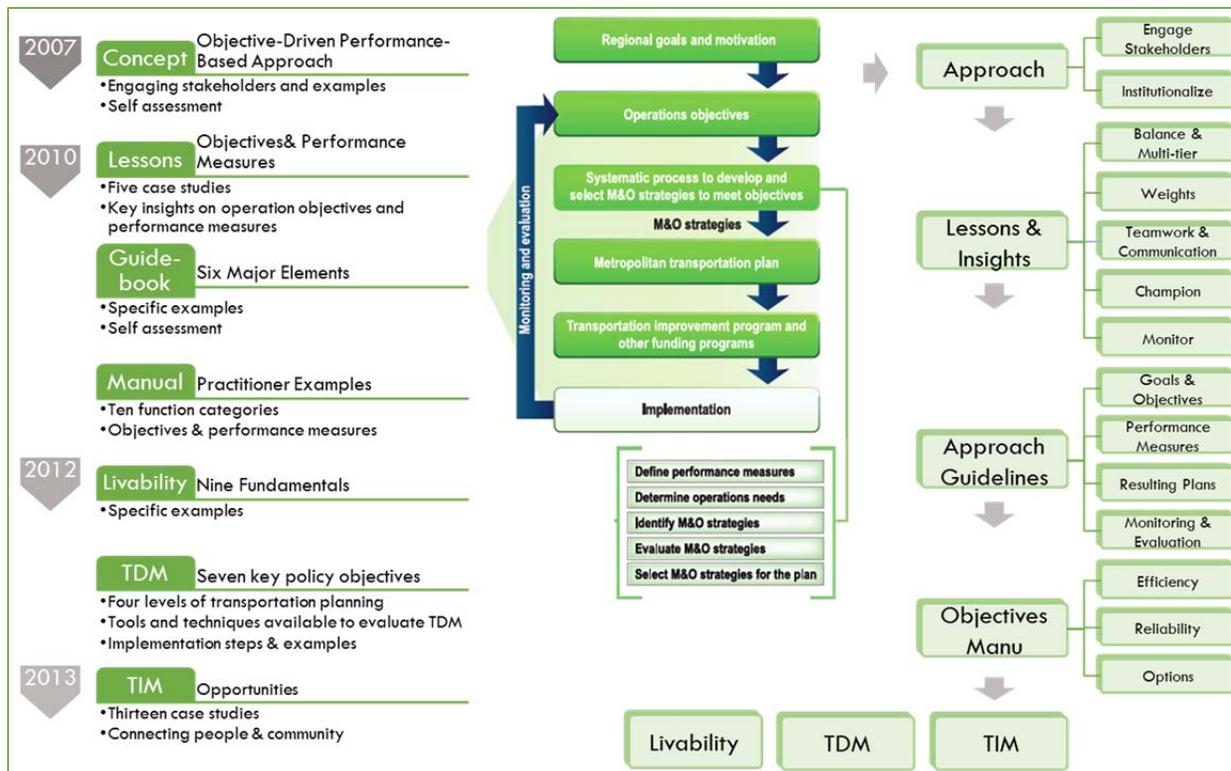


Figure 11 Operations considerations in the planning process development timeline.

“The Use of Operations Objectives and Performance Measures in Private and Public Organizations” provided key insights and lessons learned on the use of operation objectives and performance measures (20), including:

- Develop a balanced set of objectives and performance measures
- Develop objectives for different levels or tiers in the organization based on responsibility
- Assign weights to performance objectives according to their impact on customer satisfaction
- Set up a team for each objective or performance measure
- Communicate performance information regularly to staff
- Ensure objective have a senior level champion
- Maintain a high level of awareness of operational performance

“Advancing metropolitan planning for operations, an objectives-driven, performance-based approach” described six major elements in applying the objective-driven performance-based approach (21), including:

- Developing one or more goals within the MTP that focus on the efficient management and operations of the transportation system.
- Developing regional operations objectives for the MTP – specific, measurable statements of performance that will lead to accomplishing the goal or goals.
- Implementing a systematic approach to developing performance measures, analyzing transportation performance issues, and recommending M&O strategies.
- Selecting M&O strategies (within fiscal constraints and to meet operations objectives) for inclusion in the MTP and transportation improvement program (TIP)
- Implementing M&O strategies, which may include investment and collaborative activities.
- Monitoring and evaluating the effectiveness of implemented strategies and tracking progress toward meeting regional operations objectives.

Another report focusing on practitioners’ perspective provided more than 200 examples of customizable operations objectives that can be incorporated into transportation planning documents, divided by ten function categories (e.g. TIM, freeway management, etc.) (22, 23). The report described key characteristics of an operations objective as SMART – Specific, Measurable, Agreed, Realistic, and Time-bound. It also emphasized the connections of operations objectives, as illustrated in Figure 12 below (22).

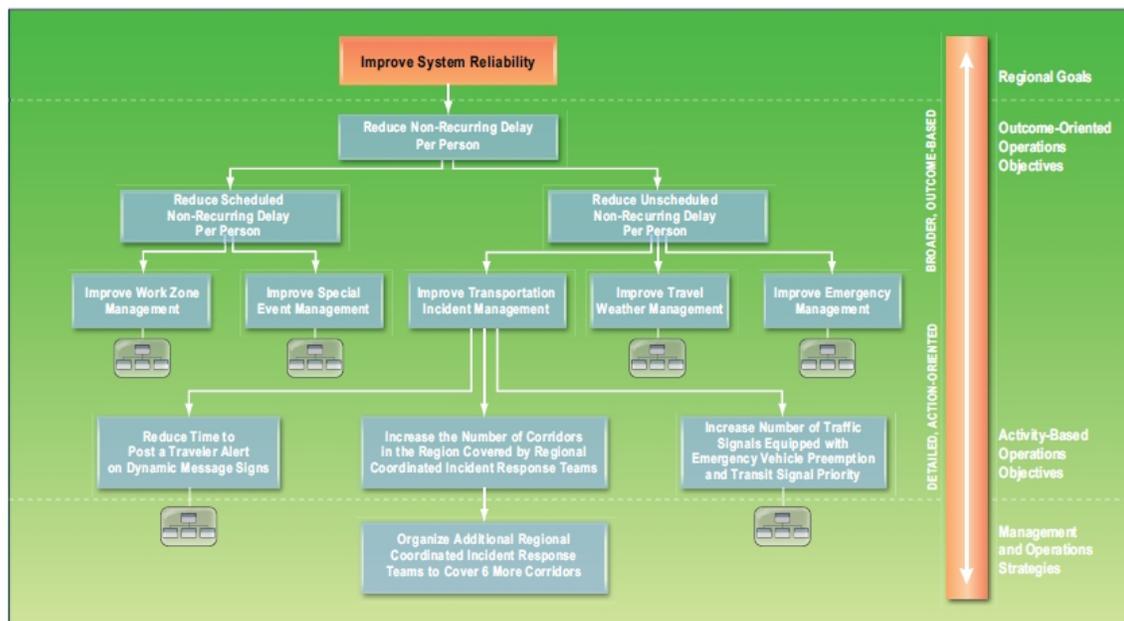


Figure 12 Example of an objectives tree. (22)

Later on in 2012 and 2013, the study efforts shifted to specific program elements that could incorporate M&O considerations, such as livability and sustainability, traffic incident management, prioritizing and funding issues (30, 34, 36, and 37).

Figure 13 below presents a list of potential M&O performance measures in supporting livability principles (30).

Livability Principles	M&O Performance Measures	
Provide more transportation choices	<ul style="list-style-type: none"> •Multimodal Level of Service •Transit Accessibility and Coverage 	<ul style="list-style-type: none"> •Mode Share •Person Delay (rather than vehicle delay)
Promote equitable, affordable housing	<ul style="list-style-type: none"> •Jobs/Housing Balance •Location Efficiency 	<ul style="list-style-type: none"> •Housing and Transportation Index (combined housing and transportation cost/affordability)
Enhance economic competitiveness	<ul style="list-style-type: none"> •Travel Time Reliability •Workforce Accessibility 	<ul style="list-style-type: none"> •Job Accessibility •Travel Time Index
Support existing communities	<ul style="list-style-type: none"> •Accessibility to Essential Destinations (e.g., stores, healthcare, schools) 	<ul style="list-style-type: none"> •Safety (crashes by mode) •Vehicle Speed Suitability
Coordinate policies and leverage investment	<ul style="list-style-type: none"> •Consistency with Local Land Use and Transportation Plans 	<ul style="list-style-type: none"> •Return on Investment •Cost-Benefit Ratio
Value communities and neighborhoods	<ul style="list-style-type: none"> •Connectivity Index •Community Character (e.g., resident satisfaction) 	

Figure 13 Potential M&O performance measures in supporting livability.

Integrating Demand Management into the Transportation Planning Process – A Desk Reference discussed how TDM relates to seven key policy objectives that are often included in transportation plans, at different decision levels, as illustrated in Figure 14 below (34).

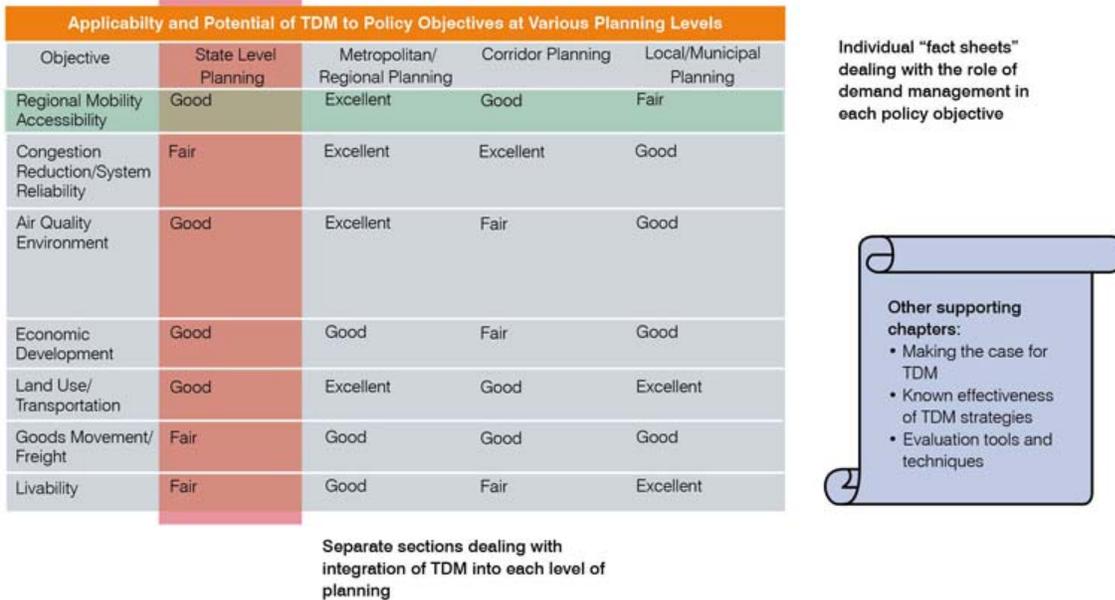


Figure 14 Applicability of TDM to policy objectives in the planning process. (34)

SECTION III CASE STUDIES

Various agencies around the country have implemented the ideas and strategies in linking planning and operations. Table 4 provides a quick overview of the applications in the past decade. The first column of the table reflects the report ID consistent with the report No. in Table 1 and Table 2, which also match with the reference numbers in Section V of this report.

Case studies as well as empirical applications from various reports are summarized in the table. The table presents basic information about the agency, location, and the focus area, and also summarizes the approaches and opportunities taken to link planning and operations, as well as the challenges encountered.

These case studies demonstrated various applications covering the three major focus areas, from RCTO to operations considerations in the planning process, to analysis tools. A few observations can be made from these applications:

- Most of the efforts involved the establishment of specific committees or task forces that 1) oversee and promote the program, 2) set guidance and directions for the efforts, and 3) provide the collaborative forum for the involved agencies.;
- Regular meetings and communications are commonly implemented to sustain and enhance integrated planning and operations;

- Funding sources for these effort vary by the nature of the focus of the program, some programs are supported by Federal funds for specific programs such as CMAQ, some are supported by sharing costs among the member agencies;
- Many committees developed MOUS, strategic plans, standards or other planning documents that govern the collaboration among partnering agencies and outline the requirements, needs and priorities;
- Various business areas have seen integrated planning and operation efforts, including, TIM, traveler information system, traffic management, CMP, TIP, signal coordination, and multimodal coordination, etc.

G APPROACHES

Across the literature, four general approaches can be identified to enhance the linkage between planning and operations. Figure 15 presents some of the examples of activities that can be undertaken in each of the four categories.

- Data Collection and Sharing
- Funding and Resources
- Institutional Arrangements
- Performance Measures

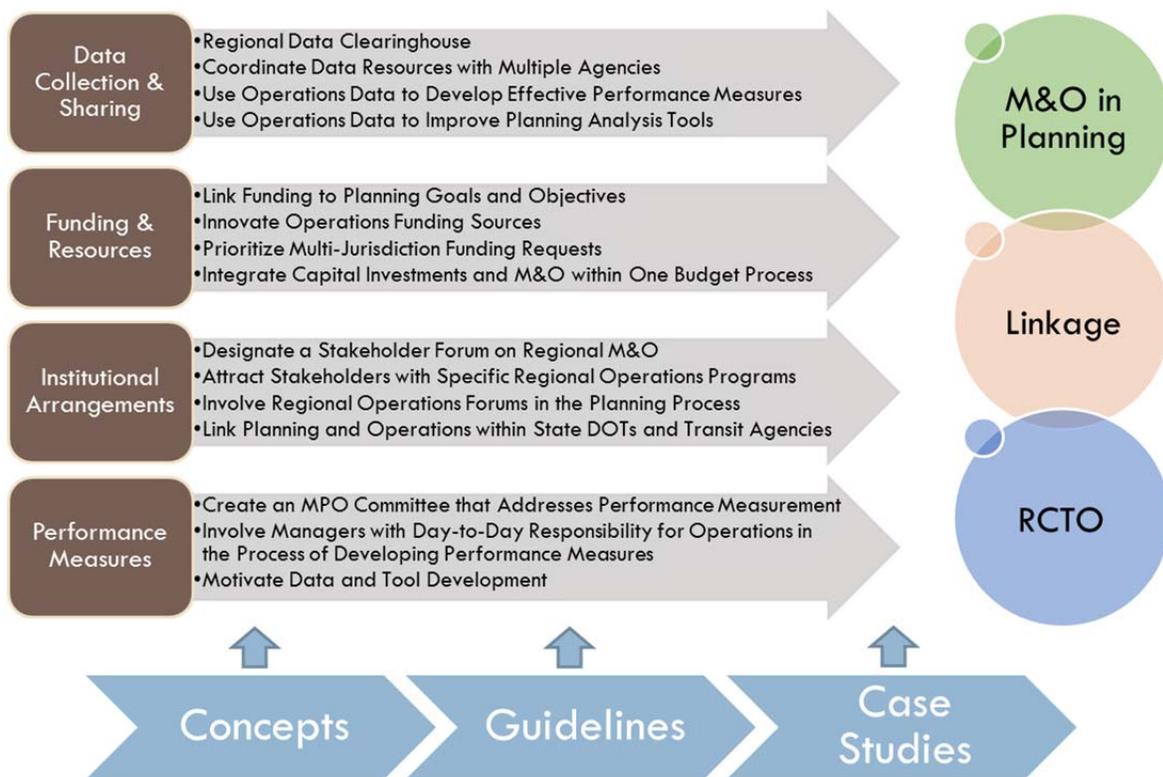


Figure 15 Approaches to linking planning and operations.

Table 4 Summary of Case Studies and Opportunities

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
1	Jan-03	RCTO	New York, New Jersey, and Connecticut	TRANSCOM	16 member agencies, including major State and city DOTs, toll authorities, transit authorities, and State police.	TRANSCOM was formed to provide a forum to collectively address traffic, incident management and construction issues, and to determine collaborative, multimodal approaches, creating a shared vision for the region's transportation system.	Both planner and operators participate in TRANSCOM's activities; collaborative resource and funding; its concept of operations governed how the involved agencies interact and share information.	It also maintains planning documents such as a multiyear strategic plan, an annual business plan and budget, information and communication systems plan, and a technology programs development plan.	Real-time and archived data shared among the agencies	
1	Jan-03	RCTO	Southern California	the Priority Corridor Steering Committee	Caltrans, the California Highway Patrol, six county transportation authorities/commissions, two MPOs, four air quality management district, and three regional ITS strategic planning subcommittees	The committee was formed to oversee the TIS Priority Corridor program, it receives Federal funds.	The Priority Corridor fostered new relationships among planners and operators, and promotes a common understanding of each other's missions that has resulted in the movement of the regional initiative from major planning to operations.	Integrated traveler information; Linkage between four Caltrans TMCs that enables contingency control during emergencies; Assesses ITS projects on a regional or corridor-wide basis.	Decentralized information sharing and an open system that supports technical information sharing and the integration of different systems	The Priority Corridor decision-making process was conducted outside the bounds of traditional funding processes, the participants have had to work hard to sustain political buy-in and acquire champions for their programs.
1	Jan-03	RCTO	Maryland	the Coordinated Highways Action Response Team (CHART)	Maryland State Highway Agency, Maryland State Police, and Maryland Transportation Authority	CHART is formed to improve real-time operations the highway system through teamwork and technology	Integrated local government communications	Traveler information, incident management, traffic monitoring, and traffic management. MdSHA cooperatively funds joint needs.	24/7 monitoring and control activities of its Statewide Operations Center (SOC) and Traffic Operations Centers	
1	Jan-03	RCTO	Maryland, Virginia, and Washington, DC.	law enforcement, fire and rescue, EMS, transportation agencies, motorist assistance services, information service providers, etc.	Developed an integrated transportation and criminal justice information wireless network, Capital Wireless Integrated Network (CapWIN), to improve coordination and information sharing among public safety and transportation agencies	Developed MOUs for the maintenance and long-term requirements of the network	Strategic plan that outlines the function needs, system requirements, priorities, strategies, etc.; TIM	Efficient communications and data sharing for real-time and historical information		
1	Jan-03	RCTO	Baltimore region	Baltimore Regional Operations Coordination (B-ROC)	More than 20 jurisdictions and agencies, including police, fire, and public works from cities and counties, as well as various Maryland transportation agencies and other Federal, State, and local organizations.	B-ROC was formed as a regional operations coordination committee, to promote interagency coordination across modes and jurisdictions.	The committee defines operations goals, objectives and needs, functional requirements for operations, an operations framework, and an implementation plan	Intermodal planning and incident response		
1	Jan-03	RCTO	Montgomery County	Montgomery County government	Local transportation agencies and departments	Created the Advanced Traffic Information System (ATIS) program to manage its transportation system using advanced integrated technologies	support and resource sharing among	Traffic surveillance, signal control, incident detection, transit fleet management, and traveler information.	Open architecture design for data sharing among agencies	

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
1	Jan-03	RCTO	East Valley of Phoenix	Arizona DOT	transportation specialists from the five jurisdictions in Phoenix	The East Valley Task Force was formed to identify areas for improvement and establish standards for interagency and inter-jurisdictional coordination.	Each of eight regions involved in the project share the development and operating costs.	Signal coordination; standards for interagency coordination and developed a regional traffic control and management plan.	Information sharing through linkages to the AZTech server	
1	Jan-03	RCTO	San Antonio	Texas DOT	Texas DOT, TransGuide Control Center, emergency service providers	San Antonio's advanced warning to avoid railroad delays (AWARD) project was developed to provide advance information on train crossings to operators and travelers.	Resources were pooled with other MMDI projects, thereby reducing some AWARD fixed costs. Using MMDI program funds, Texas DOT funded the operation and maintenance of AWARD.	TMC calculates train passing time and duration, while the traveler information system and variable message signs send alerts on potential delays and alternative routes	Acoustic and Doppler radar sensors on poles along a railroad track to detect the presence, speed, and length of trains prior to their arrival at grade crossings close to freeway exits.	Because railroads hesitated to participate in the project, San Antonio modified it to focus on traveler information and placed detectors on city or State rights-of-way.
1	Jan-03	RCTO	San Antonio	Texas DOT, City of San Antonio	Texas DOT, City of San Antonio, region's EMS provider, TransGuide Freeway Operations Center, and City of San Antonio's TMC	San Antonio Medical Center Corridor created a link between the region's freeway and incident management system.	Costs are shared among agencies; A peer-to-peer, permissive operating philosophy was adopted, in which management decisions are generated regionally but instituted locally.	TIM; predetermined signal response plans	INTEGRATION model is used to determine impact	Local agencies were challenged to think regionally and recognize travelers' concerns for quick, safe, and efficient movement through the entire transportation network.
1	Jan-03	RCTO	Phoenix	Arizona DOT	Local jurisdictions and agencies	Phoenix Roadway Closure and Restriction System (RCRS) was developed to provide integrated information about the status of maintenance activities, road construction, special events, traffic speeds, and incidents information in Phoenix.	By reaching out to AZTech municipal partners, Arizona DOT championed the inclusion of local traffic system information.	Focus groups were formed to analyze the positive and negative aspects of RCRS.	Web-site usage statistics were studied to determine the success of the system.	
1	Jan-03	RCTO	Ventura County, California	Ventura County Transportation Commission (VCTC)	transit agencies	Ventura County tested an automated integrated transit fare collection system to create a seamless fare payment system across transit agencies in the region, and to improve data collection and reporting processes.	VCTC and the participating agencies signed MOUs stating that VCTC would act as lead agency and would be solely responsible for contractual and financial issues.	Transit fare collection system and data collection and reporting process		Due to problems with the system, the project did not realize the expected benefits, but instead resulted in a list of lessons learned for future implementations of the system.
6	Aug-07	RCTO	Southeast Virginia	Hampton Roads ITS Committee	Virginia DOT, Virginia State Police, Virginia Port Authority, Department of the Navy, FHWA, and the Hampton Roads Planning District Commission	Hampton Roads ITS Committee was formed to coordinate and guide cross-jurisdictional ITS initiatives, and motivated by the development of a long-range ITS plan.	The champions brought together local operators and traffic engineers who saw the value in talking with each other about technical and institutional issues and working together to ensure compatibility across jurisdictional boundaries.	A working group to develop an RCTO for TIM; Regional data archiving and operations project assessment for CMAQ and regional STP		

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
6	Jun-07	RCTO	Nebraska, Colorado, and Kansas	The High Plains Corridor Coalition	State DOT/DOR directors, a steering committee of State ITS managers/coordinators, and a working group of State transportation maintenance superintendents and staff.	Developed a multi-state Traveler Information system to decrease traveler delay associated with road closures and restriction, major incidents and disasters.	Transportation Pooled Fund Study, monthly meetings and increased inter-agency contacts among the three states.	TIM, road weather management, traveler information,	Web-based traveler Information network.	
6	Aug-07	RCTO	Merced County, California	Merced County	Merced County, Los banos, Atwater, Dos Palos, Gustine, and Livingston	Merced County Transit (MCT) is formed under the joint powers agreement (JPA) , and operates the transit services in the county	In the JPA, each jurisdiction agreed to a minimum level of service and a cost-sharing arrangement such that each jurisdiction contributes its State Transportation Development Act (TDA) funds based on the number of service hours in its area.	Transit service management		
6	Aug-07	RCTO	Clark County, Washington	the Southwest Washington Regional Transportation Council	City of Vancouver, Washington State DOT, C-TRAN, Clark County, and Oregon DOT	The Vancouver Area Smart Trek (VAST) partnership was formed to collaboratively implement and use TIS applications in the county.	VAST members meet regularly through a steering committee that is in charge of coordinating and endorsing projects and a communications infrastructure committee that works at the technical level to facilitate a shared communications infrastructure.	Traveler information, transit management, incident management, freeway and arterial operations, and communications.	traveler information website hosted by Washington DOT	
6	Apr-09	RCTO	North-central Colorado	Denver Regional Council of Governments (DRCOG)	Denver Regional Council of Government, 28 local signal operating agencies, and 3 districts of the Colorado DOT	The Traffic Signal System Improvement Program (TSSIP) included a combination of management and operations strategies designed to time and coordinate traffic signals.	The TSSIP is updated every 3 to 4 years through a collaborative planning process involving representatives from the region's operating agencies. The program is funded through the TIP with CMAQ funding.	cost-effective traffic signal timing and coordination improvements	GIS is used in the inventory assessment stage	TSSIP identified time-of-day schedule-based timing as its future plans and funding will be needed to develop this
6	Aug-07	RCTO	Niagara Frontier region of New York and Niagara region of Ontario, Canada	New York State DOT, Ministry of Transportation Ontario	New York State DOT, New York State Thruway Authority, Ministry of Transportation Ontario, City of Buffalo, Niagara Falls Bridge Commission, Niagara Parks Commission	The Niagara International Transportation Technology Coalition (NITEC) coordinate transportation operations through the contributions of member executives and staff that serve on four subcommittees	Partnership under MOUs and funded through Federal CMAQ and STP funds.	Traveler information, incident management, special event planning and management, emergency management, environmental and road weather monitoring, construction coordination.	Created a source of information to provide the traveler with a comprehensive view of the region	
6	Aug-07	RCTO	Phoenix, Arizona, metropolitan area	Maricopa County DOT and Arizona DOT	Over 75 public and private agencies. FHWA, Arizona DOT, Arizona Department of Public Safety, Maricopa County, City of Phoenix, local police and fire departments	AZTech is a partnership of Federal, state, local and private entities to address regional operations issues.	The AZTech Executive committee provides guidance on the direction and the implementation of its programs, which meets every other month.	Center-to-center communications, traffic signal optimization, arterial incident management, joint ITS procurements, and improved traveler information and system performance measurement.		

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
6	Aug-07	RCTO	Maryland National Capital Region	Maryland State Highway Administration, the Montgomery County DOT, and Prince George's County DOT	Maryland State Police, Montgomery County Police Department, Fire and Rescue Service, and Department of Public Works and Transportation, FHWA and Maryland Emergency Management Association	Maryland National Capital Region -- Regional Operations Coordination Committee (ROC) responds to major incidents and identify any areas where inter-agency coordination should be improved.	Partnering agencies attend monthly ROCC meetings and review recent activates. Mutual aid between state and county police departments	Transportation incident management and emergency management.		
6	Aug-07	RCTO	Arrowhead Region of northeastern Minnesota	Transportation Operations Communication Center	Minnesota DOT and Minnesota State Patrol(MSP)	The Transportation Operations Communications Center (TOCC) is covering Minnesota's rural and small areas that bring together resources from transportation and public safety to provide better service to the public and save money for ongoing operations.	The TOCC facilitated communications between Minnesota DOT and MSP, enabling quicker responses to requests for assistance.	TIM, planned special events, road weather management	Upgraded communication equipment and a new dispatch center	
9	Apr-09	Planning process	Albany-Schenectady-Troy metropolitan area	Capital District Transportation Committee (CDTC)		<i>New Visions 2030 Regional Transportation Plan</i> focused on transportation investments to encourage urban reinvestment, mixed use, transit-oriented development, and context sensitive design.	Involved operators and other stakeholders in the CMP; Maintained a formal TIP	CMP and TIP	Management Information System for Transportation	data is not collected in the frequency and consistency; Improvements in the transfer of transit data to the formal CMP are needed
11	Apr-09	Planning process	Philadelphia metropolitan region of southeastern Pennsylvania and southern New Jersey	Delaware Valley Regional Planning Commission (DVRPC)		Tracking Progress toward 2030: Regional Indicators for the DVPRC Long Range Plan was used to develop regional indicators to measure the region's progress toward the goals in its metropolitan transportation plan.	Maintain, optimize, and modernize existing transportation system and ROW	L RTP, TIP, CMP	GIS improved the data availability	Communication of the CMP to those who need to cooperate for the process is difficult; DVRPC did not find a robust sketch-level program available to better select strategies.
12	Apr-09	Planning process	San Francisco Bay Area	Metropolitan Transportation Commission (MTC)		The MTC used performance measures to evaluate project. It can be useful to conduct project-level performance assessments and to establish regional performance objectives.		The initial analysis suggested that management and operations strategies	Large reliance on data generated through the regional travel demand model	Participation and commitment of the appropriate participants was a struggle.
13	Apr-09	RCTO	Tucson metropolitan region	Pima Association of Governments (PAG)		The PAG RCTO working group fully developed an RCTO for specific aspects of their three target areas of operations: arterial management operations, traveler information, and work zone management.	Established a RCTO working group. The stakeholders planned to implement regular training and certification for the Work Zone Safety and Mobility Rule	Arterial management operations, traveler information, and work zone management.	Computer aided dispatch information, Transview into Arizona 511, GIS	The PAG RCTO working group struggled to commit to performance measures that were outcome-oriented; insufficient funding.
14	Apr-09	Planning process	Maryland, between the greater Philadelphia region and Baltimore	Wilmington Area Planning Council (WILMAPCO); Delaware Transit Corporation		The WILMAPCO integrated CMP into transportation planning process, applied a four -step Congestion management System approach which focus on the core function of a CMP.	Measures involving all modes of transportation, and encourages efficient land use and development patterns	TIP, CMP	GIS data, incorporated crash data into the identification of congested corridors.	Engaging the operations community; limited transit funding, growing public demands, and meeting the needs of a changing population.

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge	
							Organization	Business	Technical		
16	Sep-09	Linkage	Cincinnati region	Ohio-Kentucky-Indiana (OKI); Regional Council of Governments;						ITS Deployment Analysis System (IDAS) Software	
17	Sep-09	Linkage	the Salt Lake City-Ogden region	Wasatch Front Regional Council (WFRC)		1) transfer demand volumes from a regional model for HCM Urban Streets procedure, 2) combine the volumes with known traffic signal timings to calculate a link-specific capacity, and 3) transfer that capacity back to the regional model for the next iteration.		regional model and operation analysis		ARTPLAN software, integration of regional model and operation analysis	
18	Sep-09	Linkage	the San Francisco Bay Area	Metropolitan Transportation Commission (MTC)		This particular case study focused on the application of archived data as a tool for operations planning.		Caltrans Highway Congestion Monitoring Program (HICOMP)		Archived data for Freeway Performance Monitoring System (PeMS), Traffic Accident Surveillance and Analysis System	
19	Sep-09	Linkage	Alameda County, California	the Alameda County Congestion Management Agency (ACCMA)		Integrated travel demand forecasting models with micro simulation tools for freeway operational studies.		freeway operation studies		integration of travel demand forecasting model and microsimulation	The physical limits on the ability of the analysis to manually adjust large OD trip tables.
25	Nov-10	Planning Process	the tri-county Orlando Urban Area in the I-4 Corridor	MetroPlan		Institutionalize of M&O in the MetroPlan through the formation of an M&O subcommittee and a Systems Management & Operations Department with dedicated staff	Separate programs were set in place to fund ITS and M&O project	TIP, TRIP		MetroPlan collected data about traffic signal	Data is constantly needed and used to monetize the benefits of completed projects.
26	Nov-10	Planning Process	The Portland, Oregon metropolitan region	Metro		<i>Regional Transportation Plan</i> prompted a new approach for metropolitan planning which focuses on desired outcomes and measurable performance.	Metro initiated a monitoring program to assess the state transportation system; Using information to inform incremental land use and transportation project implementation decisions.	TIP, CMAQ, Surface Transportation Program, and TSMO		the travel demand forecast model, MetroScope	Insufficient data
27	Nov-10	Planning Process	Home to University of Illinois at Champaign-Urbana	Champaign County Regional Planning Commission (CCRPC), Champaign Urbana Urbanized Area Transportation Study (CUUATS)		The Champaign Urbana Urbanized Area Transportation Study defined 12 regional goals, which directly improve transportation systems management and operations (M&O).	Funding for the strategies falls into the responsibility of the partner agencies	CUUATS coordinated with the Illinois DOT, public and private stakeholders to develop MTP		GIS -based data management and update	Resource availability, Difficulties in demonstration of effects of proposed bicycle and pedestrian improvements
42	Jul-06	Planning Process	greater Kansas City area	Mid-America Regional Council (MARC)		MARC developed an enhanced CMS designed to integrate with the RTP, TIP, and corridor evaluations, including the Major Investment Study (MIS) planning processes.	MoDOT staff, especially at the district level, reference MARC's CMS Toolbox on a regular basis but also define project and strategy alternatives using other methods designed to meet the needs and deficiencies of a given corridor	CMS, RTP, TIP, corridor evaluation study.		Coordinating planning and NEPA through the CMP, duplication or redoing the planning work in the NEPA process is avoided.	The process works if MARC is the lead agency, but MARC is not always in the lead.

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
43	Jul-06	Linkage	southeast Virginia	Hampton Roads Planning District Commission (HRPDC)		HRPDC's approach for improving congestion management was to strengthen the relationship between CMP and operations	A key component of HRPDC's operations planning has been its partnership with VDOT's Hampton Roads Smart Traffic Center (STC). The RCTO has been instrumental in improving the dialogue between State police, fire and rescue, and traffic engineers.	The STC operations data is archived at the Smart Travel Lab1 at the University of Virginia.	The ADMS allows stakeholders throughout the State to access operations data via a password-protected web site. Data is also collected from four localities that maintain their own traffic monitoring programs.	Maintenance of the technology is difficult because the transportation system receives heavy use nearly round the clock. Data quality challenges due to loop failure and limited quality control. completeness of the data; lack of real-time data on arterials
44	Jul-06	Linkage	central Puget Sound region in Washington State	Puget Sound Regional Council (PSRC)		The CMP process was linked with The LRTP by developing recommended ways to improve efficiency that are then incorporated into strategies, projects, and programs in The LRTP.	PSRC's relationships with the Washington State Transportation Center (TRAC) at the University of Washington and the Washington State Department of Transportation (WSDOT) have helped develop some of the newer presentation methods.	The agency has also worked with consultants, other state agencies, and learned from peers at conferences to best refine both the methods for presentation and communication.	"Boomerang chart" displayed speed and hourly volume. PSRC also used the "brain scan" contour map created by the University of Washington's TRAC; it is created from traffic volumes and lane occupancy percentage	The data PSRC receives is primarily developed by WSDOT for transportation operations purposes. PSRC often has to fit this available data into its analysis framework. PSRC lacks data on its arterial system. Lacking OD data
		Planning Process	greater Detroit area	Southeast Michigan Council of Governments (SEMCOG)		SEMCOG developed an effective process for using congestion management as a method for prioritizing projects through its long-range planning process and ensuring that congestion management projects are implemented	SEMCOG developed an RTP Priority Corridor process for the 2030 RTP to ensure that project investments occur in the corridors and areas that meet the highest needs regionally	SEMCOG reviews the projects submitted for the RTP with those identified through the CMP process; if a submitted project is not in the CMP, the submitting agency makes a case for including the project	SEMCOG is developing a land use model (UrbanSim) that will assist in determining if changes in land use will mitigate congestion.	The region lacks some data. Some current analyses could be improved. Improve of stakeholder and public outreach efforts
		Planning Process	greater Dallas/Fort Worth area	North Central Texas Council of Governments (NCTCOG)		Involved a large group of stakeholders early in the process is the most effective way to gain understanding of the location of the most pressing congestion problems and to gain consensus on the best solutions for the region.	Committees are responsible for adopting and approving the LRTP, TIP, CMP, and UPWP. NCTCOG's current CMP is part of the RTP, but the CMP will become a standalone entity so that its short-term strategies can be addressed	Strategies for congestion mitigation are developed at the system level (Metropolitan Transportation Plan), on the corridor level (in Major Investment Studies), and on the project level (in the TIP). For some programs with funding initiatives NCTCOG requires a 50/50 split to make the funds go further than an 80/20 match	The RTP section on system performance includes very simplified maps of current and forecasted congestion based on results from the NCTCOG regional travel demand model	Working with a large number of stakeholders leads to lengthy period to reach approval. A large effort is needed to inform all. Some data is lacking
46	Dec-10	Planning Process	Greater Atlanta area (Georgia)	Atlanta Regional Commission (ARC)		CMP is comprised of five elements: monitor and evaluate performance, identify causes, identify and evaluate alternative strategies, provide information supporting implementation, and evaluate the effectiveness of implementation.	ARC unified the CMP network with the Regional Strategic Transportation System (RSTS). The system includes rail, premium transit routes, and freight corridors.	ARC used consultant services to measure and evaluate congestion in the region every 1-3 years depending on needs and available resources. ARC obtains high-quality traffic count data along all State routes from GDOT's Office of Transportation Data; GDOT hires a private company.	The regional travel demand model is the primary tool for assessing congestion on the CMP network, but the region is moving towards greater reliance on observed system performance data.	There was difficulty in evaluation of congestion management strategies due to regional conditions. Funds were limited for data collection. There was a struggle to convince people that M&O strategies are effective at managing congestion.

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
47	Dec-10	Planning Process	Austin, Texas	Capital Area Metropolitan Planning Organization (CAMPO)		The CAMPO CMP is organized into four basic steps that occur within a 2-year cycle: (1) CMP network validation/update, (2) data collection and analysis, (3) congestion management strategy selection, and (4) monitoring implemented strategies	CAMPO staff established a relationship with TxDOT's National Environmental Policy Act (NEPA) practitioners from efforts to integrate planning and NEPA. The Regional ITS Architecture and Deployment Plan provides a framework for implementing projects and sharing resources among agencies.	The identification of congestion management strategies to support individual projects is a requirement for project programming and represents the primary link between the CMP and the TIP	There was a large emphasis of data collection. The collected data were from private companies, TxDOT, and other local counties and agencies. CAMPO recently launched a new GIS Viewer intended to provide easy access to data of interest to the public.	There was a lack of funding; this led to a tradeoff between the need for increased data collection and the ability to support individual improvements
48	Dec-10	Linkage	Albany-Schenectady-Troy metropolitan area of New York State	Capital District Transportation Committee (CDTC)		The CMP was closely linked to the vision and principles in the MTP.	Placing the Transportation Management Center (TMC) with the State police has helped both to work together.	The CDTC asks municipalities to put up a 25 percent match and agree to the New Vision's principles, and it hires a consultant to help address local transportation and land use planning issues. The TIP involves an open solicitation for any municipality.	The CDTC used its travel demand forecasting model, Systematic Travel Evaluation and Planning (STEP), to estimate excess delay and to identify Critical Congestion Corridors (CCCs).	Funding and resources are limited. Data collection could be more systematic. Additional efforts could be taken to evaluate the effectiveness of implemented strategies. Project designers and consultants might need further education on the regional vision and CMP measures.
49	Dec-10	Linkage	New Jersey, Pennsylvania area	Delaware Valley Regional Planning Commission (DVRPC)		The CMP was integrated with the MTP and TIP processes, and plays a significant role in project selection. DVRPC also uses the CMP as an educational tool for localities in their transportation planning.	The DVRPC decided to work with the North Jersey Transportation Planning Authority in its efforts to conduct before-and-after studies in northern New Jersey. DVRPC reviews all TIP projects to determine which add major SOV capacity.	DVRPC plans to purchase equipment next year that will enable detection of Bluetooth devices on the road allowing continuous collection of travel-time data.	GIS was used for inventory and data representation. The DVRPC travel demand model is source of data used in the CMP only in the absence of real data.	There is a steep learning curve involved in working on the development of the CMP. Scaling down examples from state to local, or even smaller, is difficult
50	Dec-10	Linkage	central Puget Sound area of Washington State	Puget Sound Regional Council (PSRC)		Congestion Management process (CMP) is fully integrated into its overall transportation planning process	Five performance measures were created through working with a group of six transit agencies and the city of Seattle.	PSRC is working closely with six transit operators in the region to get data on their physical infrastructure, on-time performance, and boarding. Implementing the management strategies occurs when the projects/programs are entered into the TIP	For each corridor, the maximum throughput travel-time index (TTI) was used by the Washington State Department of Transportation (WSDOT) to identify "Commonly Congested Commutes."	The challenge is finding data that are consistently collected by member agencies for each corridor. It is difficult to dictate actions to local jurisdictions from the regional level
51	Dec-10	Linkage	southwestern corner of Pennsylvania area	Southwestern Pennsylvania Commission (SPC)		The CMP is organized around five key elements: (1) planning and system definition, (2) data collection and analysis, (3) strategy evaluation, (4) strategy implementation and project programming, and (5) monitoring strategy effectiveness.	CMP is integrated with MTP, TIP, Project Planning, NEPA, Regional Operations Plan (via ITS)	The CMP also plays a role in the project development process; PennDOT places strong emphasis on connecting the planning and NEPA processes	SPC uses its Web site to provide information about the data collected and analysis performed as part of the CMP. Static maps created using GIS	One difficulty was the collection of transit operations data. It was difficult to make outside partners understand the value of the CMP

ID	Year	Focus	Location	Leading Organization	Member Agency	Approach	Opportunities			Challenge
							Organization	Business	Technical	
52	Dec-10	Linkage	Cecil County, MD and New Castle County, DE (aka Wilmington metropolitan region)	Wilmington Area Planning Council (WILMAPCO)		WILMAPCO follows a seven-step CMP consisting of (1) system analysis and definition, (2) congestion performance measures, (3) strategy evaluation, (4) Regional Transportation Plan project pipeline and needs inventory, (5) project and problem prioritization, (6) project implementation and programming, and (7) system monitoring and project effectiveness.	The CMP process is closely tied to the project selection process of the TIP, MTP, freight planning, operations planning, and local planning efforts.	The CMP relies heavily on outside agencies, including the Delaware and Maryland DOTs, Delaware Transit Corporation, and University of Delaware, for data resources	WILMAPCO has a mathematical process for assigning scores to proposed projects, which is used to develop a prioritized list of projects for funding. The WILMAPCO Web site provides links to interactive maps.	Good data are needed. A good subcommittee to guide the CMP is needed
56	Jun-02		Europe	N/A			Most ITS deployments were successful in spite of traditional transportation planning and programming processes and organizational structures. Some cases established special organizational arrangement.	Most projects used outside contractors for technical support.		Gaps in both technical support and technology system O&M. The complexity of ITS systems is confusing for both public and public officials in respect to value/need
58	2001	Planning Process	Austin, Texas metropolitan area	Austin District of the TxDOT		A planning process for developing a system of HOV facilities incorporated multiple regional agencies	A multi-agency inter-local agreement for HOV system planning	A regional HOV Task Force comprised of technical staff from participating agencies to support and compliment Major Investment Studies (MIS) on specific corridors. An inter-agency review teams for each MIS	Used research results from other communities as a basis for technical decisions and for the development of public education/awareness tools	The need to establish goals and objectives for HOV facilities under development in Austin

H CHALLENGES AND LIMITATIONS

Built upon the summary of the case studies and current practices, the challenges encountered in the efforts of linking planning and operations can be generally categorized into four aspects.

- **Institutional Issues** – establishing a shared vision and securing commitment in the program among involved stakeholders and agencies require hard work to sustain political buy-ins and acquire champions. Working with a large number of stakeholders could be lengthy and significant effort is needed to maintain communications. It can be difficult to dictate actions to local jurisdictions from the regional level.
- **Financial Issues** – due to the multi-agency/jurisdiction nature of the efforts, non-traditional funding process may be necessary, and it could be challenging to secure and sustain sufficient funds for the programs.
- **Technical Issues** – the projects may not realize expected benefits due to problems with the system, lack of robust procedures for strategy selection, limitations with the tools used, difficulties in demonstrating and convincing people of the benefits/value of proposed projects, need additional efforts in evaluating the effectiveness of implemented strategies, project designers and consultants might need further education on the regional vision and performance measures.
- **Data Issues** – many lack of data, such as data are not collected with the desired frequency and consistency, which could cause problems with the application of the programs, poor data quality, lack of real-time arterial data, lack of transit operations data, and limited funding for data collection.

SECTION IV FINDINGS AND RECOMMENDATIONS

Linking Planning and Operations is vital to improving transportation decision-making and overall efficiency of transportation systems management. Integrated planning and operations efforts ensure that transportation investment decisions reflect full consideration of all available strategies and approaches. It fosters greater consideration and understanding of the role and value of day-to-day operations in meeting the transportation vision and goals.

The key to Linking Planning and Operations is to provide the necessary environment, including institutional platform, funding sources and technical capabilities, to support the analysis of safety, mobility, reliability, and security of transportation systems that

are otherwise difficult to address in a traditional setting. An integrated approach to building transportation systems calls for the regional thinking and corresponding business processes to support all transportation-related decisions on what the future transportation system will be, its characteristics, and how it will operate. In the integrated framework, an alternative strategy should be a combined set of actions incorporating elements from infrastructure, ITS, system management, operations and policy, which best meet the region's goals and objectives in a cost effective manner.

To integrate system management and operations into transportation planning, programming and project development activities, there are three key components:

- Institutional - establishing shared vision, developing regional goals and joint resource arrangement;
- Functional - mainstreaming operations thinking into the business programs, establish relationships and procedures, and consolidating services;
- Information - promoting data and information sharing among agencies, monitoring performance measures, and developing analysis tools.

When establishing the integrated framework, different approaches may be identified at different levels of efforts, such as

- Long Range Transportation Plan (LRTP) - identify goals & objectives that address various aspects in operations (data sharing opportunities, operational needs/strategies, funding sources, etc.)
- Transportation Improvement Plan (TIP) - identify specific ITS and operations projects, strategies, and programs
- Corridor/Regional Studies - address ITS and operational solutions for a corridor or mode through ITS strategic plans or system management plans
- Congestion Management Program - incorporate ITS data and operation solutions within the congestion management program
- Performance Monitoring - provide operations data and expertise that help characterize system performance and travel conditions

Florida, as a fast growing State and national leader in implementing advanced technologies and operation strategies in promoting efficient, reliable and safe transportation system, possesses unique opportunities (as well as challenges) to further advance and broaden the knowledge and practices in integrating planning and operations. The key activities for next steps may include:

- Identify Agency key functions, program areas, and related processes and procedures that have a direct impact on the planning-operations integration,

- Capture opportunities and challenges for the integration, through the understanding of the interdependencies among the various functions, entities and program areas,
- Develop an integration framework incorporating Active Traffic & Demand Management (ATDM) and SHRP2 products and methodologies, and
- Implement the integration framework using the CMM (Capability Maturity Model) approach to integrate transportation demand and supply.

Based on the CMM approach, a phased implementation strategy should be considered, which may include three stages of implementation:

- Level I - Baseline assessment with solutions targeting low hanging fruit using planning/operations analysis tools available that require little or no efforts for applications
- Level II - Near term improvements adopting state-of-the-practice solutions using more advanced tools with enhanced analysis capabilities that require a fair amount of efforts in applications
- Level III - Application of new concepts and technologies using fully integrated models and decision support systems that address longer term impacts of system improvements but require high level of modeling/simulation efforts as well as institutional partnership and inter-agency coordination.

In summary, the following recommendations are proposed as the key elements to facilitate the linking planning and operations effort.

1. Establish special committees and task forces
2. Develop shared visions and specific objectives
3. Dedicate funding sources for sustainable program
4. Promote frequent communications among involved stakeholders
5. Develop MOUs and plans to set priorities and needs
6. Develop standards and procedures to facilitate data integration and sharing
7. Target specific programs and business areas

As for specific programs and business areas, this study identified the following areas that represent good starting point to implement the integrated approach.

- Integrated Data Exchange Architecture (IDEA) - which consists of various strategies to facilitate data integration throughout various stages: data acquisition, data processing, data sharing, and data integration as shown in Figure 16.

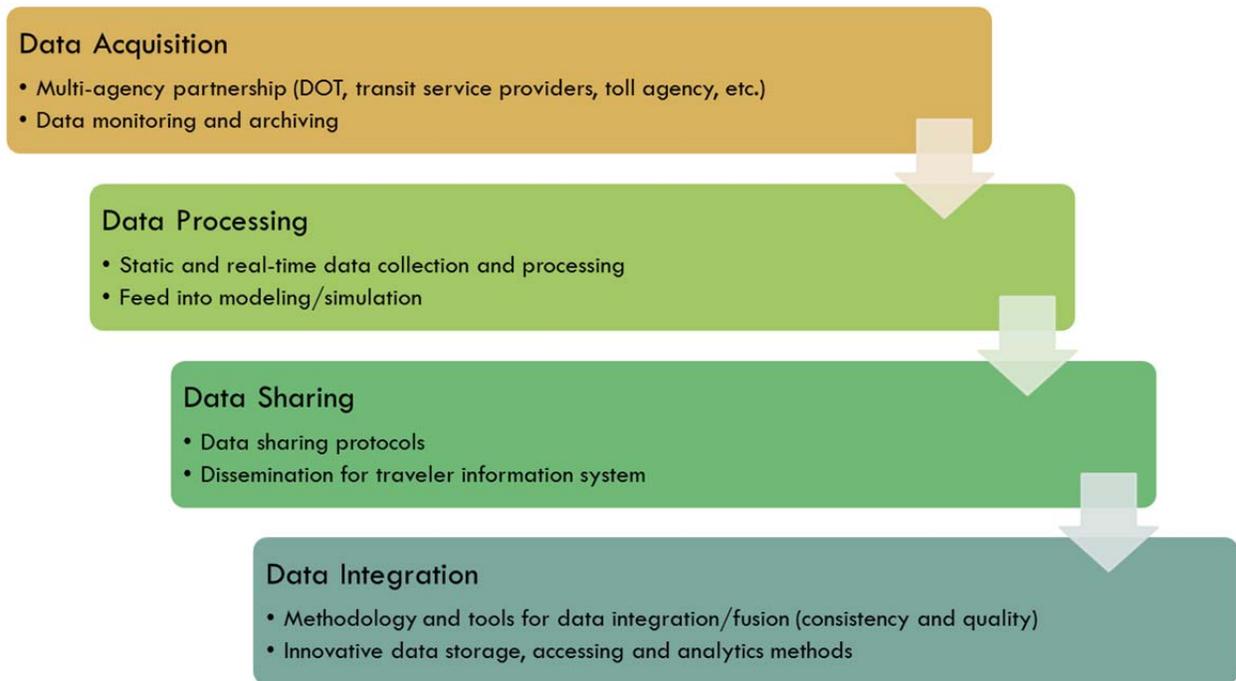


Figure 16 Integrated Data Exchange Architecture (IDEA).

- Integrated Modeling Approach - which integrates demand supply through various linkages among the model components as shown in Figure 17.

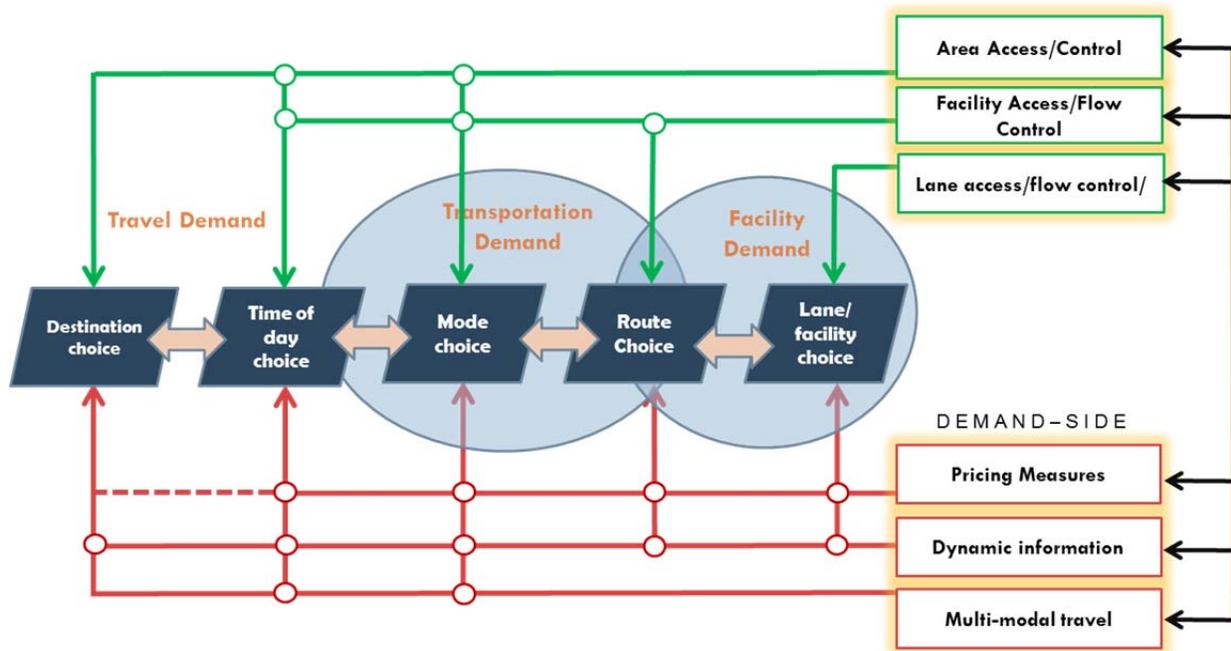


Figure 17 Integrated modeling approach.

- Multi-Modal and Multi-Resolution Integration – which integrates operation strategies into the modeling process taking advantages of the multi-resolution approach as shown in Figure 18.

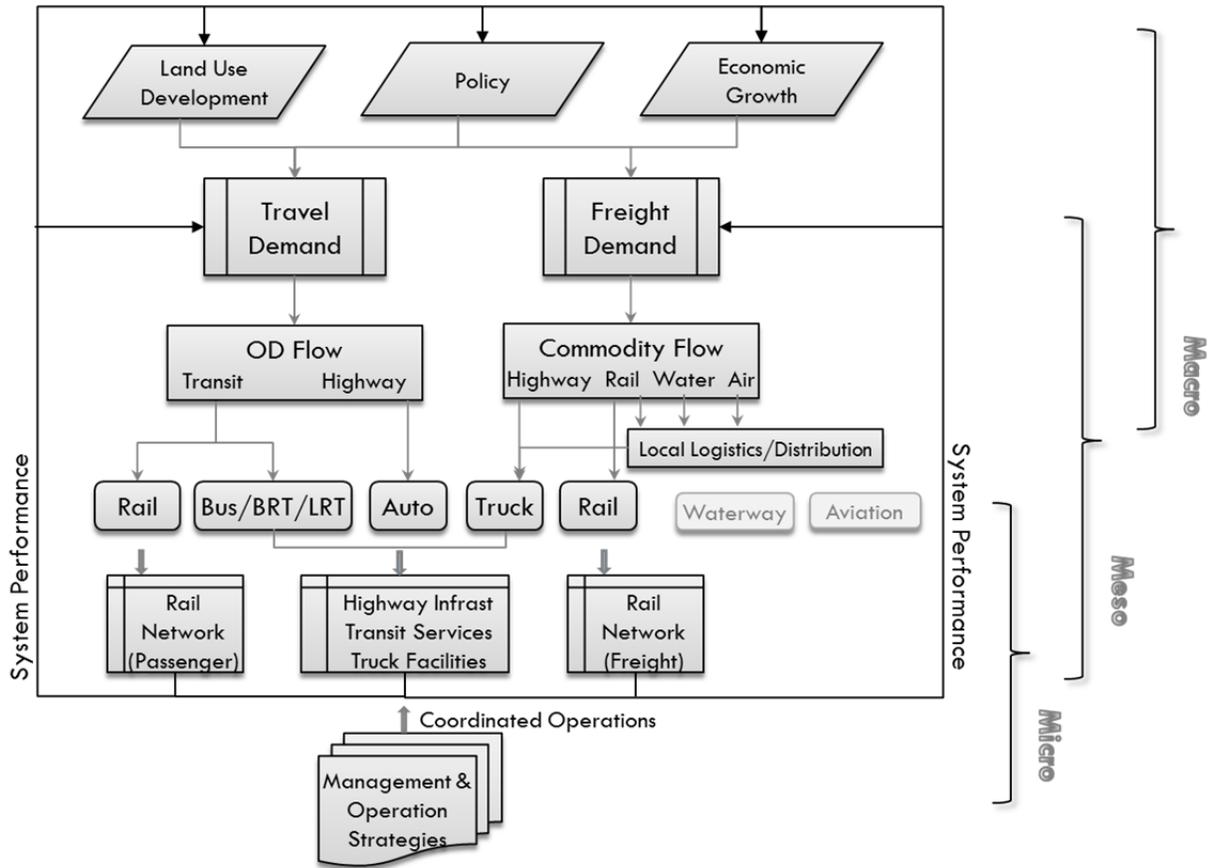


Figure 18 Multi-modal multi-resolution modeling approach.

In summary, this study provides a comprehensive synthesis of current state of knowledge and practices in Planning and Operations Integration, and identifies key elements in facilitating the integrated approach. Recommendations on near term actions and potential program areas are also identified for consideration, which may serve as inputs for the next phases in the Linking Planning and Operations Initiative. This integrated approach will help the Department build stronger connections between transportation planners, programmers, and operations managers, and promote inter-jurisdictional coordination among transportation agencies, which would lead to efficient use of resources, improved program management, and enhanced overall system efficiency.

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SECTION VI APPENDIXES

Appendix A Guidelines and Reports

1. Regional Transportation Operations Collaboration and Coordination – A Primer for Working Together to Improve Transportation Safety, Reliability, and Security

The report discussed the five major elements in RTCO, which are structure, process, products, resources, and performance.

Structure

- Structure consists of the relationships that enable regional collaboration, coordination, and related communications. These relationships include personal relationships among leaders and staff members of key operating agencies and neighboring jurisdictions who recognize common problems and opportunities and agree to work together to improve regional transportation systems performance.

Process

- The process aspect relates to the ways options are created and decisions are made to improve system performance. Regional collaboration and coordination relies on information about current transportation system operations and their projected performance under various potential scenarios. Information/data sharing is critical to effective regional operations collaboration and coordination.

Products

- In the regional collaboration framework, products encompass the use of data, information, plans, and outputs that result from structure and processes. This aspect also includes intermediate products such as studies, evaluations, and pilot test that support regional collaboration activities.

Resources

- Regional operations collaboration and coordination relies on activities and relationships that can occur only if individuals and organizations commit appropriate funding, staff, and possibly equipment. This may involve agreements to share key resources (equipment and personnel); agreement on acquisition and procurement that ensure interoperability and standard protocols

for communications and data exchange; or potentially, the identification of capital investments in operations-related infrastructure to be deployed on a regional basis or in conjunction with other capital improvement projects.

Performance

- Performance improvement addresses regional performance objectives and how they will be measures, including public safety, mobility, security, economic development, and environment. Performance measures are a key to assessing the success of a region's effort to collaborate and coordinate and to identifying areas where improvement is needed or possible.

2. Regional Concept for Transportation Operations – A Tool for Strengthening and Guiding Regional Transportation Operations Collaboration and Coordination

The report described three major purposes of an RCTO:

- Presents a mutual operations vision and direction for the future of transportation systems management and operations based on a holistic view of the region.
- Garners commitment from agencies and jurisdictions for a common regional approach to transportation management and operations.
- Provides an opportunity to strengthen the linkage between regional planners and managers responsible for transportation operations by providing a coherent operations strategy for consideration in planning process.

Transportation-related participants that could be involved in developing an RCTO may include: Traffic operations engineers and managers, Transit operations managers, Police officials, Fire officials, Emergency medical service officials, Emergency managers, Port authority managers Transportation planners, Bridge and toll facility operators.

Services that tend to be of regional significance and could benefit from an RCTO include: Congestion management, Traffic incident management, Traveler information, Electronic payment services, Emergency response and homeland security, Traffic signal coordination, Road weather management, Freight management, Work zone traffic management, Freeway management.

The four important elements of a RCTO:

- Operations objective
 - The desired operations outcome for more or more activities or services established through regional transportation operations collaboration and consistent with to regional goal expressed in regional planning documents.
- Physical improvements
 - The set of equipment, technology, facilities, people, and/or systems needed to achieve the operations objective.
- Relationships and procedures
 - The working agreements, institutional arrangements, memorandums of understanding, and procedures needed to achieve the operations objective.
- Resource arrangement needed to achieve the objective
 - The funding and other resource requirements and how those resources are to be obtained and applied to achieve the operations objective.

3. Getting More by Working Together - Opportunities for Linking Planning and Operations

This report provided a roadmap to linking planning and operations by focusing on specific linkage opportunities.

Nine specific linkage opportunities:

Transportation planning process

- Identify and engage stakeholders - Engage operating agencies, operating committees, and operations stakeholders
- Develop goals and objectives - Engage operations managers in developing goals and objectives for M&O
- Define performance criteria and data need - Include measure for network reliability and flexibility based on archived data
- Evaluate regional deficiencies - Evaluate deficiencies for systems management and interagency coordination
- Develop alternative plan scenarios - Involve operations experts in developing systems management alternatives
- Evaluate alternatives and select best option - involve operations experts in evaluating management and operations strategies

Data sharing

- Develop a regional data clearinghouse - help facilitate access to a region's full range of transportation data for both planning and operating agencies
- Coordinate data resources with transit agencies - become more valuable data sharing partners enabling them to participate in regional planning activities in new ways
- Use special events to initiate new data partnerships
- Use universities to help develop integrated databases
- Use operations data to develop more effective performance measures
- Use operations data to improve planning analysis tools
- Use archived data to inform management and operations planning

Performance measures

- Involve operations managers in the process of developing performance measures
- Incorporate operational performance measures into strategic and long-range transportation plan (LRTP)

- Use operations data for tracking performance in annual or quarterly reports
- Use performance measures to motivate data and tool development

Congestion management systems

- Involve operations managers in CMS development
- Integrate the CMS into the planning process
- Use the CMS to build a system for rapid response to congestion issues

Funding and resources sharing

- Link funding to planning goals and objectives
- Develop innovative operations funding sources
- Build on emergency response needs to create regional momentum for collaboration
- Integrate capital investments and M&O within a single budget process
- Share office facilities
- Use the unified planning work program to define commitments to M&O planning
- Use funding as a tool to attract participation in M&O discussions
- Funding constraints can elevate M&O solutions

Institutional Arrangements

- Designate an MPO stakeholder forum on regional management and operations
- Attract stakeholders with specific regional operations programs
- Involve regional operations forums in the planning process
- Define an organizational structure for the MPO that reflects the importance of regional operations
- Link planning and operations within state DOTs and transit agencies
- Reinforce institutional links by integrating operations into project design and delivery

Regional ITS architecture

- Designate the MPO to lead the development of the regional ITS architecture
- Make the regional ITS architecture part of an integrated regional plan
- Link the architecture to the TIP
- Build from the architecture's operational concept
- Build a sustained forum around maintenance of the architecture

Regional management and operations projects

- Work zone management programs – the goal of work zone management programs is to reduce the impact of roadway construction and maintenance on the mobility and safety.
- Regional incident response programs – incident management is the process of managing multi-agency, multi-jurisdictional responses to highway traffic disruptions.
- Special events management – serve as a catalyst for the development of a new model for planning and operations coordination
- Regional signal coordination – Interconnecting traffic signals and optimizing signal timing has been shown to reduce travel time by 8% to 25% along an arterial or corridor.
- HOV lane development
- Transportation emergency preparedness and security planning
- Regional traffic management centers – typically involved with M&O projects and programs such as those discussed in this section
- Cross-cutting regional implementation actions

5. Regional Concept for Transportation Operations – The Blueprint for Action

The primer described an RCTO and its essential components, explained its potential role in the transportation planning process, and illustrated its development through examples. Additionally, the primer highlighted the benefits gained from partnerships that develop an RCTO and the keys for success as partners work towards an RCTO.

The RCTO may relate to three of those processes or structure: the transportation planning process, the regional intelligent transportation systems (ITS) architecture, and a concept of operations.

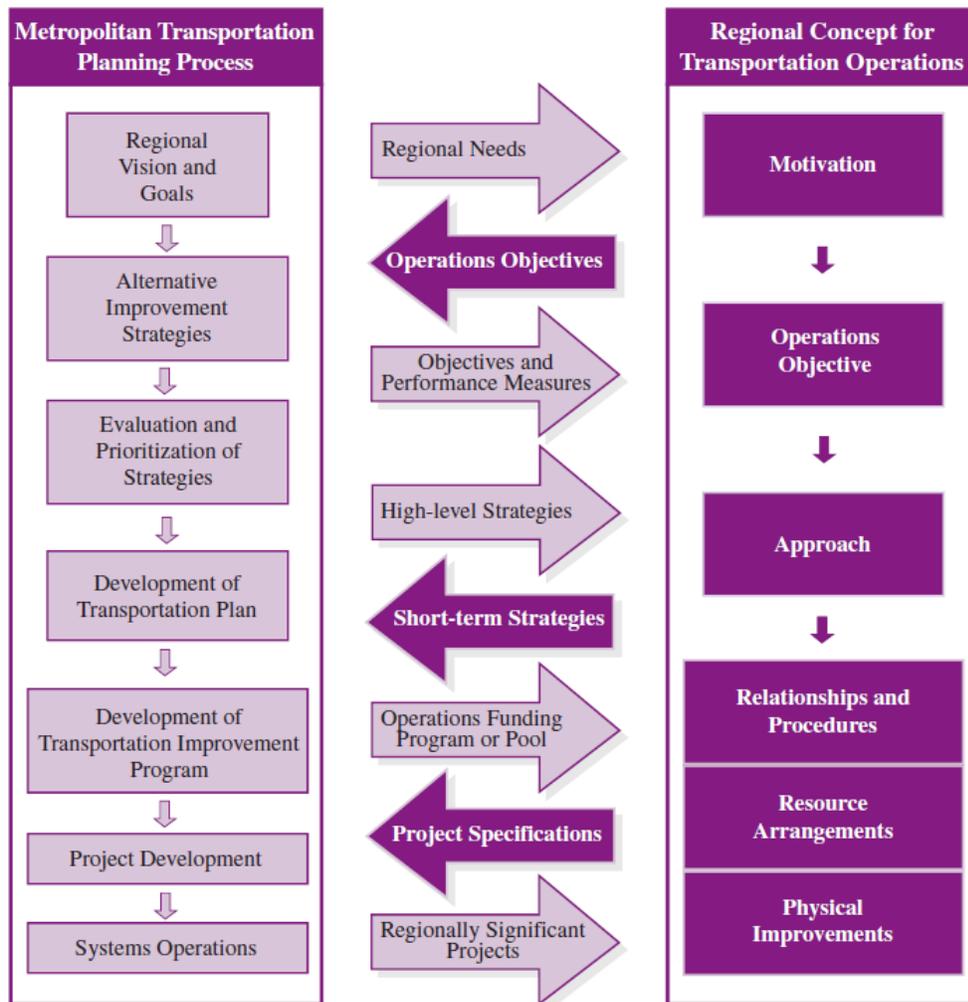


Figure: The RCTO can be used to translate outputs of the planning process into specific operations objectives short-term strategies, and project specifications to be included in the MTP and TIP.

A RCTO contains six key elements:

- Motivation – Reasons for developing an RCTO based on regional needs, goals, or operational concerns.
- Operations Objective – Desired near-term outcomes in terms of transportation system performance.
- Approach – Overall description of how the operations objective will be achieved.
- Relationships and procedures – Institutional arrangements, MOUs, protocols, information sharing, etc.
- Physical Improvements – Facilities, equipment, systems, etc.
- Resource arrangements – Sources and use of funding, staff, equipment, etc.

6. The Collaborative Advantage – Realizing the Tangible Benefits of Regional Transportation Operations Collaboration

This manual is designed to help decision-makers within local, regional, and state agencies who participate in transportation operations and planning to understand the range of benefits that can be gained from participating in multi-agency collaborative efforts.

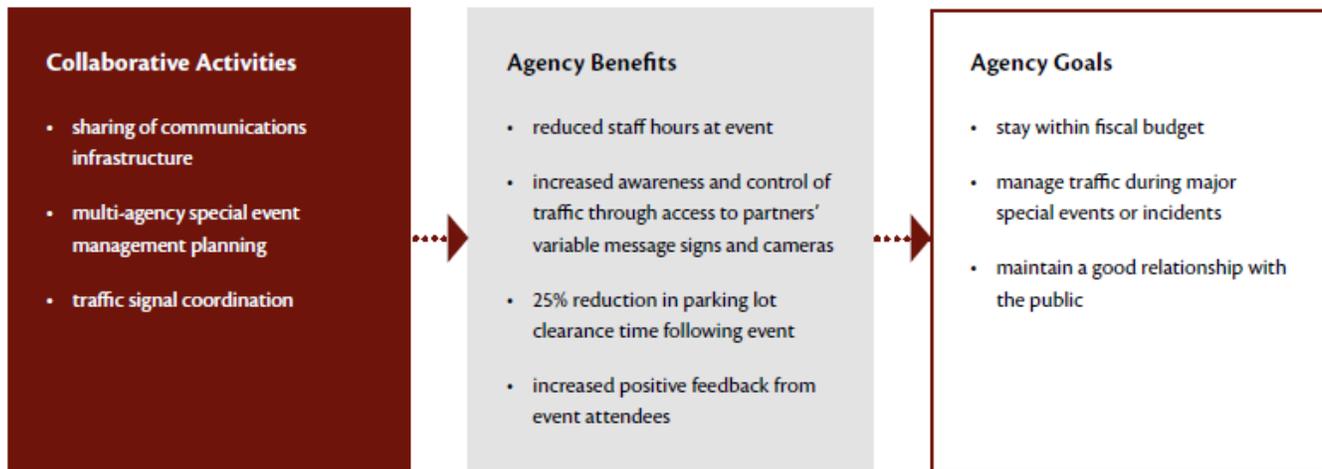


Figure 1. Benefits to a public safety agency participating in a collaborative effort to manage traffic during a special event.

This report highlights 10 collaborative strategies and actions agencies commonly used to improve transportation systems performance.

- Collaborative pursuit of funding – Follow the money
- Sharing expertise and joint learning – Get smart
- Coordinating communications and giving a consistent message – With one voice
- Developing common procedures, protocols, and plans – On the same page
- Jointly measuring performance – Measuring up
- Sharing transportation information – You ought to know
- Developing tools for efficient communications – Can you hear me now
- Sharing resources – Sharing the wealth
- Consolidating services – Building economies of scale
- Performing joint operations – All together now

7. Management & Operations in the Metropolitan Transportation Plan - A Guidebook for Creating an Objectives-Driven, Performance-Based Approach

This guidebook is designed to help metropolitan planning organizations and other stakeholders in the metropolitan transportation planning process to integrate management and operations considerations into planning.

Engaging stakeholders in developing regional operations objectives

- Key regional transportation system operators in the metropolitan transportation planning process which include State DOTs, Local jurisdictions, Transit agencies, Bridge and toll facilities, Port authorities, Police and fire officials, Emergency medical service officials, Emergency managers, Public works officials, The tourism industry, Freight shippers, and Business organizations.
- Engage existing operations agencies in thinking about M&O
- Engage new stakeholders in the planning process – one way to achieve greater stakeholder participation is to focus discussions on specific operations concerns

Developing MPO committees focused on operations issues

- An increasing number of MPOs support interagency committees that deal directly and regularly with regional systems management and operations. In hosting such committees, the MPO facilitates a vital forum where inter-jurisdictional coordination, funding strategies, and data sharing can be addressed.

Building on the ITS architecture

- Developing a regional ITS architecture and forming ITS committees can be starting point for collaborative efforts among operators, and for interface between the MPO and operating agencies.

Developing a regional concept for transportation operations (RCTO)

- An RCTO typically focuses on one or more management and operations functions of regional significance such as traveler information, road weather management, or traffic incident management. An RCTO can be developed and implemented by a group of transportation operators, planners, public safety agencies, or other stakeholders who want to improve regional transportation system performance by working together.

8. Statewide Opportunities for Linking Planning and Operations - A Primer

This primer is designed to raise awareness of the benefits and opportunities for coordinating planning and operations activities within State DOTs, targeted at mid-level DOT planning and operations staff.

Opportunities:

- Organization level policies and strategies
- Business process, programs and procedures
- Technical aspects in data and analysis tools
 - Data
 - Analysis Tools
 - Performance measures

Challenges:

- Organization level policies and strategies
 - Time constraints
 - Lack of data and tools
 - Established organizational culture
 - Study continuity
- Business process, programs and procedures
 - External stakeholders
 - Staff changes
- Technical aspects in data and analysis tools
 - Traditional focus on level of service
 - Analysis gap between operations and traditional investments
 - Data limitations - coverage and quality, purpose, and repurposing data

15. Applying Analysis Tools in Planning for Operations

This document summarized tools not only include physical software and devoted analytical applications, but also more basic analysis methods and procedures as well.

Sketch Planning Tools

- Sketch planning methodologies and tools produce general order-of-magnitude estimates of travel demand and traffic operations in response to transportation improvements.

Deterministic Models

- Most analytical/deterministic tools implement the procedures of the HCM. These tools quickly predict capacity, density, speed, delay, and queuing on a variety of transportation facilities and are validated with field data, laboratory test beds, or small-scale experiments.

Travel Demand Forecasting Models

- Travel demand models have specific analytical capabilities, such as the prediction of travel demand and the consideration of destination choice, mode choice, time-of-day travel choice, and route choice, and representation of traffic flow in the highway network.

Simulation Tools

- Agencies use simulation tools to analyze operations of both transit and traffic to conduct needs assessments, alternatives analysis, environmental impact studies, and operations planning. These tools include microscopic simulation, mesoscopic simulation, or macroscopic simulation.

Archived Operations Data

- Traffic surveillance data on freeways, typically volumes, speeds, and lane occupancies.
- Traffic Signal Optimization Tools
- Traffic optimization tool methodologies are mostly based on the HCM procedures and are primarily designed to develop optimal signal phasing and timing plans for isolated signal intersections, Arterial Street, or signal networks.

Operations-oriented Performance Measures/Metrics

20. The Use of Operations Objectives and Performance Measures in Private and Public Organizations

This paper examined lessons and insights from private companies and public organizations that may apply to agencies in the U.S. working to advance transportation planning for operations using a strategic approach.

The following list of activities was developed for consideration in the use of objectives and performance measures in planning and managing transportation operations among public transportation agencies.

- Develop a balanced set of objectives and performance measures
- Develop objectives for different levels or tiers in the organization based on responsibility
- Assign weights to performance objectives according to their impact on customer satisfaction
- Set up a team for each objective or performance measure
- Communicate performance information regularly to staff
- Ensure objective have a senior level champion
- Maintain a high level of awareness of operational performance

21. Advancing Metropolitan Planning for Operation --- An Objectives-Driven, Performance-Based Approach (Business)

The report described six elements in applying the approach

- Developing one or more goals within the MTP that focus on the efficient management and operations of the transportation system.
- Developing regional operations objectives for the MTP – specific, measurable statements of performance that will lead to accomplishing the goal or goals.
- Implementing a systematic approach to developing performance measures, analyzing transportation performance issues, and recommending M&O strategies.
- Selecting M&O strategies (within fiscal constraints and to meet operations objectives) for inclusion in the MTP and transportation improvement program (TIP)
- Implementing M&O strategies, which may include investment and collaborative activities.
- Monitoring and evaluating the effectiveness of implemented strategies and tracking progress toward meeting regional operations objectives.

The benefits of this objectives-driven, performance based approach to planning for operations include:

- A metropolitan transportation plan that illustrates the inclusion of specific, measurable, and agreed-upon operations objectives and shows the ties of these objectives to resource allocation in the document.
- A closer tie between specific, desired outcomes and resource allocation.
- Increased accountability and communication with the public and stakeholders through performance measurement.
- Engagement of the operations community, as well as law enforcement, freight, and the private sector, in setting objectives and measuring performance.
- A focus on both short-range and long-range needs related to the operation of the transportation system in the MTP.

22. Advancing Metropolitan Planning for Operations – the Building Blocks of a Model Transportation Plan Incorporating Operations

This document provided an overview of the objectives-driven, performance-based approach and a set of sample operations objectives and associated performance measures and data needs.

Developing Operations Objectives

- An operations objective should have the SMART characteristics which are specific, measurable, agreed, realistic, and time-bound.
- The four dimensions in considering the objectives are: area, time, mode and facility type, and user type.
- Using the structure of a tree to develop operations objectives and ensure that the supporting connections exist is a common technique in strategic planning and systems analysis.

Menu of Operations Objectives

- System Outcomes: System Efficiency, System Reliability, and System Options.
- TSM&O: Arterial Management, Emergency/Incident Management, Freeway Management, Freight Management, Special Event Management, Transit Operations and Management, Travel Demand Management, Travel Weather Management, Traveler Information, and Work Zone Management.

24. Statewide Opportunities for Integrating Operations, safety and Multimodal Planning

This reference manual is designed to assist transportation professionals in taking action to integrate these activities. It identified and described opportunities at various levels of decision-making -- statewide, regional, corridor, and project level - and the benefits of these approaches.

Challenges:

- Organization level policies and strategies
 - Strategies, projects, and policies included in plans might not get funded or implemented.
 - Effectively linking these specialized plans with the overall SLRTP and statewide investment strategy may be a challenge; making tradeoffs can be difficult in these plans.
- Business process, programs and procedures
 - A commitment to the process from top agency officials is required since it may require staff to go outside their standard job responsibilities.
 - The wide range of transportation system operators, jurisdictions, and stakeholders involved can make it difficult to develop consensus on appropriate system-level performance objectives.
 - Requires top-level management support to initiate, and plan needs to be tied to internal performance tracking.
 - Public transportation divisions have traditionally been primarily grants-related divisions, with limited long-range planning.
 - Update schedules for the SHSP and SLRTP may not be aligned.
 - Operations staff tends to focus on near-term issues, and changing technologies and other factors makes it difficult to plan over a long-range time period.
- Technical aspects in data and analysis tools
 - Data and analysis capability limitations may limit the use of performance measure.
 - Data in a format that is useful to planners can be difficult.
 - There may be limited availability of statewide data and analysis to support performance measurement.

28. Congestion Management Process – A Guidebook (Business – CMP)

This publication is a guidebook designed to provide information on how to create an objectives-driven, performance-based congestion management process (CMP). This guidebook described a flexible framework of 8 actions that should be included in the development of a CMP.

- Develop regional objectives for congestion management – The objectives should draw from the regional vision and goals that are articulated in the MPO’s MTP. Congestion management objectives also may be developed for the CMP as part of the long-range transportation planning process and incorporated directly into the MTP.
- Define CMP network
- Develop multimodal performance measures
- Collect data/ monitor system performance
- Analyze congestion problems and needs – There are several issues that MPOs should take into account when analyzing data for the purpose of defining or location congestion problems
- Identify and assess CMP strategies
- Program and implement CMP strategies
- Evaluate strategy effectiveness – Evaluation of strategy effectiveness can be seen as either a sequential step within the CMP process or as an on-going process. This is an essential, required element of the CMP that is often overlooked. The primary goal of this action is to ensure that implemented strategies are effective at addressing congestion as intended, and to make change based on the findings as necessary.

This guidebook also provided practitioners with an understanding of the individual elements of a CMP and included practical examples of how to implement a successful process based on lessons learned from MPOs across the country.

29. The Regional Concept for Transportation Operations – A Practitioner’s Guide

The purpose of this document is to provide information on how to develop and implement an RCTO effectively and efficiently by highlighting practices that have been used successfully to overcome challenges by the four implementing regions that forged ahead into this new territory. This guide offers lessons from these pioneering sites that can help other implementing regions to select the methods that are most effective in improving regional transportation system performance.

The motivation leading to an RCTO:

- Need for improved regional operations at the core of
- Need to work collaboratively – A necessary element of RCTO motivation – the interconnected nature of the regional transportation system requires collaboration between the operators of each element in order get the best performance from the system.
- Need for a strategic approach – A necessary element of RCTO motivation – another crucial component in the motivation to use an RCTO is the need for a strategic, formal approach to improving operations through collaboration.

Collaborative forum for developing an RCTO:

- Organizing a collaborative forum
- Establishing champions and leaders – ensure at least one committed champion
- Engaging participants – The progress that can be made on improving regional operations through an RCTO is limited by the participants that can be brought into the collaboration.
- Maintaining participant involvement
- Gathering support from elected or appointed officials and agency leadership
- Establishing a process for gathering ideas and making decisions

Linking the RCTO and the planning process

- Use an MPO to provide a neutral table and convene agencies from the region – One of the keys to successful collaborative effort like the development and implementation of an RCTO is finding an appropriate host or convener for the collaborative forum.
- Revise operations objectives requiring regional funds to account for programming cycle

- Establish a regional funding program for an operation area – Opening funding avenues for operations from sources such as the Congestion Mitigation and Air Quality Improvement Program, Surface Transportation Program, and state, regional, or local tax programs is another compelling reason to link regional operations activities to the planning process.

The “What” and the “How” of the RCTO

- Establishing clear operations objectives
 - Identify desired objectives before moving on to solutions
 - Try identify an operations objective in term of risk management
 - Identify activity-oriented objectives to support outcome-oriented objectives
 - Divide the operations area of focus into smaller elements and identify any needed improvements in each element
 - Keep scope of operations objective manageable
 - Create performance targets for objectives using baseline data
 - Identify performance measure to track progress toward operations objectives
- Creating an approach
 - Gather expert practitioners in the operations area to discuss and recommend actions
 - Provide a menu of options for senior decision-makers to select from
 - Develop an approach sensitive to participating agencies’ needs to maintain control over their operations
- Defining the supporting elements of the approach –relationships and procedures, resource arrangement, and physical improvements
 - Build a structure of champions
 - Gain commitment from participants for actions and specify roles and responsibilities
 - Estimate resource needs and identify realistic options for meeting those needs

30. The role of Transportation Systems - Management & Operations in Supporting Livability and Sustainability

The document highlighted the connections between M&O and livability and sustainability objectives and importance of a balanced, comprehensive approach to M&O in order to support those objectives. The document described nine key elements for managing and operating transportation systems in ways that support livability and sustainability.

- Operate to serve community priorities
- Increase opportunities for safe, comfortable walking and bicycling
- Improve the transit experience
- Support reliable, efficient movement of people and goods
- Manage travel demand
- Provide information support choices
- Support place making
- Use balanced performance measures
- Collaborate and coordinate broadly

31. Creating an Effective Program to Advance Transportation System Management and Operations

The purpose of this primer is to raise awareness of the opportunities for improving the effectiveness of State and Local Transportation System Management and Operations (TSM&O) activities. The primer provides high-level guidance focused on key program, process, and organizational capabilities that are essential to the development of more effective TSM&O strategy applications.

Key dimensions of capability:

- Business processes - including formal scoping planning, programming, and budgeting
- System and technology - including systems architecture, standards, interoperability, and standardization and documentation
- Performance measurement - including measures definition, data acquisition, analysis, and utilization
- Culture - including technical understanding, leadership, policy commitment, outreach, and program authority
- Organization and workforce - including organizational structure, staff capacity, development, and retention
- Collaboration - including relationships with public safety agencies, local governments, MPOs, and the private sector

Levels of agency capability:

- Performed - activities and relationships largely ad hoc, informal, and champion-driven-substantially outside the mainstream of other transportation activities.
- Managed - Basic strategy applications in place with key process and needed staff capacities under development.
- Integrated - Standardized strategy applications implemented in priority contexts and managed for performance; the TSMO technical and processes developed, documented, and integrated into the regional transportation agencies, partnerships aligned.
- Optimized - The TSM&O as full, sustainable, region-wide program, established on the basis of continuous improvement with all partners.

32. Applying a Regional ITS Architecture to Support Planning for Operations (Business -- ITS)

This primer offers transportation planners and operations managers a menu of opportunities for applying the regional ITS architecture to enhance planning for operations. This primer focuses on the use of an objective-driven, performance-based approach to planning for operations; an approach that increases the potential supports from the regional ITS architecture given the approach's emphasis on data and performance measures.

Opportunities for architecture use:

- Establishing collaboration and coordination
 - Sustain and build on the collaborative relationships from the regional ITS architecture
- Developing goals, operations objectives, and performance measures
 - Incorporate operations objective from the transportation planning process into the regional ITS architecture
 - Leverage the operations expertise of the regional ITS architecture stakeholders in developing objectives
 - Consult the architecture to identify available sources of operations data to track measurable objectives
- Determining operations needs
 - Gather information on needs from ITS stakeholders
 - Look for available sources of data in the architecture to measure system deficiencies
 - Identify gaps in coverage of ITS-supported services in the region
- Identifying , evaluating, and selecting M&O strategies
 - Examine service packages selected in current architectures for ITS-based M&O strategies
 - Select service packages in support of the overall metropolitan/statewide transportation planning process
- Defining programs and projects
 - Define programs and major initiatives in a regional context
 - Define project scope and identify integration opportunities
- Selecting and prioritizing projects
 - Define an efficient timeline for project implementation
 - Include the architecture as part the TIP or STIP project application process
- Implementation and system operations

- Use the architecture to kick-start project development
- Leverage agency roles and responsibilities and interagency agreements needed to operate the implemented system
- Monitoring and evaluation
 - Support planning for transportation system performance monitoring
 - Consolidate system performance measures across agencies within a region
 - Support planning for improved measurement of operating agencies' performance

34. Integrating Demand Management into the Transportation Planning Process - A Desk Reference

The purpose of this desk reference is to provide the reader with a better understanding of where, how, and when to integrate Travel Demand Management (TDM) into the evolving performance-based transportation planning process. The desk reference is organized around two fundamental aspects of transportation planning: policy objectives and scope of the planning effort.

Application of TDM policy issues:

- Improvement in regional mobility and accessibility
- Congestion reduction, system reliability, and safety
- Air quality and environment
- Economic development
- Land use/transportation integration
- Goods movement and freight
- Quality of Life, livability, and health

Integration of TDM into the activities in the transportation planning process:

- Regional vision and goals
- Setting objectives for TDM
- Definition of performance measures
- Assessment and selection of strategies and programs to support objectives
- Integration of strategies into plan and funding programs
- Monitoring and evaluation of progress toward objectives

35. Designing for Transportation Management and Operations

Approach:

This primer is focused on designing for operations, the collaborative and systematic consideration of management and operations during transportation project design and development. Effectively designing for operations involves the development and application of design policies, procedures, and strategies that support transportation management and operations.

Opportunity:

- Organization level policies and strategies
 - Institutional policies – It is important that these policies ensure the collaboration between designers and operations, both the users of the implemented systems as well as those responsible for maintaining the systems’ intended functionality, begins before the design process actually starts.
 - Agency structure – A successful organizational approach to management and operations requires that operational strategies are formally considered during project development and infrastructure design.
 - Linking planning and designing for operations – An effective approach to mainstreaming the practice of designing for operations stems from a strong connection to planning at the State and metropolitan levels.
- Business process, programs and procedures
 - Scoping and financing stage – Practitioners will define project limits, establish a budget, and determine the project’s schedule for subsequent design and construction phases.
 - Preliminary design stage – This stage is for general project location and design concepts are determined and design element alternatives are considered.
 - Final design stage – this stage is denoted by the preparation of construction plans and detailed specifications for construction work to be performed.
- Technical aspects in data and analysis tools
 - Systems engineering – system engineering is an organized approach to developing and implementing a system. The approach can be applied to any system development, including an operations strategy on a roadway network.

Challenges: Limitations in current design practices

- Institutional challenges – Successful systematic consideration of operations in the design process typically takes place within an organizational setting in which operations is considered just as crucial as design, construction, and maintenance.
- Fiscal impacts designing for operations – one barrier to operations consideration in design is that when M&O strategies are proposed for inclusion into a roadway infrastructure design, the additional costs to do so may be construed as an unwarranted accessory.
- Understanding management and operation needs – Without experience in the practical application of M&O strategies, designers have no fundamental understanding of how their design may impact roadway operations.

36. Making the Connection - Advancing Traffic Incident Management in Transportation Planning

The intent of this primer is to inform and guide TIM professionals and transportation planners to initiate and develop collaborative relationships and advance TIM programs through the metropolitan planning process. The primer aims to inspire planners and TIM professionals to create transportation plans and programs that support regional TIM programs through TIM-focused objective, performance measures, and TIM strategies and projects.

Opportunities to engage the TIM community:

- Early engagement of the entire TIM community can be accomplished through a meeting hosted by MPO or co-hosted with the TIM Team champion.
- A desired outcome of this initial TIM community engagement is the identification of individuals who would commit further time to investigating effective ways to achieve sustained involvement of TIM professionals in the transportation planning process.

Involving the TIM community in planning:

- Standing committees - it provides technical or policy guidance in the development, implementation, and monitoring of the long-range transportation plan.
- Special committees - it focuses on improving transportation system safety and efficiency through more effective management and operation.
- Task forces - it involves safety, reliability, emissions, delay, and system management and operations.

Integrating TIM in the development of the metropolitan transportation plans:

- Guidance - Setting meaningful goals and objectives that tie directly to the vision and lead to desirable plan solutions is always a challenge.
- Current and future issues - Identifying existing needs
- Potential and preferred solutions - Solving short-term and long term transportation issues
- Cost feasible plan
- Implementation and monitoring

Appendix B Case Studies

9. Capital District Transportation Committee Albany, New York

Geographic Scope: Albany-Schenectady-Troy metropolitan area (the Capital District)

Leading Organization: Capital District Transportation Committee (CDTC)

Approach

- Capital District Transportation Committee (CDTC) released New Visions 2030 Regional Transportation Plan, in which they developed and incorporated a new Congestion Management Process (CMP). New Visions focuses transportation investments to encourage urban reinvestment, mixed use, transit-oriented development, and context sensitive design. Performance measures were an important part of the New Visions plan and were selected to meet community goals. The CMP updates the Congestion Management System (CMS).

Opportunities

- Organization Level Policies and Strategies
 - The New Visions plan focuses transportation investments to encourage urban reinvestment, mixed use, transit-oriented development, and context sensitive design.
- Business Process, Programs, and Procedures
 - The CDTC maintained a formal Transportation Improvement Program (TIP) process to analyze projects, but involved operators and other stakeholders in the CMP to collect information earlier in the process in order to generate the scope of projects for further development.
- Technical Aspects in Data and Analysis Tools
 - The CDTC supplemented its modeled data in the CMP with a new data set called MIST (Management Information System for Transportation) to mitigate the effect of unpredictable incidents. This data is collected by the New York State Department of Transportation (NYSDOT).
 - Using the MIST data, planning time indices were calculated on Capital District expressway segments for AM and PM peak periods.

Challenges

- Much of the data provided is not collected in the frequency and consistency needed to fully support the CDTC's CMP.
- The identified performance measures require collection of some data that is not currently available.
- Improvements in the transfer of transit data to the formal CMP are needed.
- Funding for the Transportation Management Center (TMC) is a major commitment in CDTC's TIP. The TMC is a source of extensive data necessary for the CMP.
- In addition, emerging technologies hold promise for even more extensive data collection through the TMC (such as the TRANSMIT system).

10. The Denver Region Traffic Signal System Improvement Program

Geographic Scope: North-central Colorado

Leading Organization: Denver Regional Council of Governments (DRCOG)

Approach

- The Denver Regional Council of Governments (DRCOG), and local jurisdictions, worked on the Traffic Signal System Improvement Program (TSSIP). This program is a combination of management and operations strategies designed to time and coordinate traffic signals in the region.
- The traffic signal program is identified as one of six action strategies in DRCOG's 2035 Metro Vision Regional Transportation Plan to support the region's policy of effective management and operations. It serves as a key component of DRCOG's congestion mitigation program.

Opportunities

- Organization Level Policies and Strategies
 - TSSIP is a set of management and operations strategies that are a significant component to DRCOG's congestion mitigation program that also include travel demand management and intelligent transportation systems (ITS).
- Business Process, Programs, and Procedures
 - Congestion Mitigation/ Air Quality (CMAQ) funding was provided for the combined traffic signal and ITS program in the TIP.
- Technical Aspects in Data and Analysis Tools
 - GIS was used in the inventory assessment stage in order to assess the existing system at the beginning of the TSSIP process.

Challenges

- The TSSIP identified time-of-day (TOD) schedule-based timing as its future plans and funding will be needed to develop this.

11. Delaware Valley Regional Planning Commission Philadelphia Metropolitan Region

Geographic Scope: Philadelphia metropolitan region

Leading Organization: Delaware Valley Regional Planning Commission (DVRPC)

Approach

- The Delaware Valley Regional Planning Commission (DVRPC) employed the CMP to strengthen the connection among the long-range plan (LRP), transportation improvement program (TIP), corridor studies and other projects and to enhance sharing of data, analysis, and completed studies. The CMP helped with Federal requirements for supplemental projects when road capacity is needed and tracks completion.
- Tracking Progress toward 2030: Regional Indicators for the DVPRC Long Range Plan was used to develop regional indicators to measure the region's progress toward the goals in its metropolitan transportation plan. This was done in response to the difficulty of evaluation of effectiveness of completed projects. Tracking Progress was also used to provide feedback about to the LRP, Destinations 2030.

Opportunities

- Organization Level Policies and Strategies
 - Maintain, optimize, and modernize existing transportation system and ROW.
 - Manage demand for transportation by fostering land use patterns and other strategies that reduce the need for and length of trips.
 - Increase capacity of the existing multimodal transportation system, limiting the addition of through travel lanes.
 - Add new capacity where necessary, limiting the addition of new roads.
- Technical Aspects in Data and Analysis Tools
 - GIS improved the understanding of available data, allowed data to be analyzed in new ways, eased the process of updating information in the future, and helped create understandable and interesting graphics.

Challenges

- Communication of importance of the CMP to those who need to cooperate for the process is to work is difficult.
- Difficulties stemmed from large databases of varying quality with differing data definitions.
- DVRPC did not find a robust sketch-level program available to better select strategies and develop complimentary packages of solutions for congested corridors.

12. Metropolitan Transportation Commission San Francisco Bay Area

Geographic Scope: San Francisco Bay Area

Leading Organization: Metropolitan Transportation Commission (MTC)

Approach

- The Metropolitan Transportation Commission (MTC) used performance measures to evaluate projects in the past as part of the development of the regional transportation plan (RTP). The MTC decided that to inform investment trade-off discussions in the updated plan, it would be useful not only to conduct project-level performance assessments, but also to establish regional performance objectives with quantitative targets early in the process to help guide investment analysis.
- The 2035 RTP sought to achieve three overarching principles referred to as the Three E's: Economy, Environment, and Equity.
- The RTP 2030 takes an objectives-driven, performance-based approach in its metropolitan transportation planning.

Opportunities

- Organization Level Policies and Strategies
 - Several of the specific performance targets reflected guidance from existing State regulations and plans.
 - The initial analysis suggested that management and operations (M&O) strategies, including freeway management, high occupancy toll (HOT) lanes, and transit efficiency measures such as bus rapid transit and transit priority projects, were among the most cost-effective strategies.
 - One of the most notable of MTC's investment programs was the Freeway Performance Initiative. The initiative is much like a strategic plan for the freeways.
- Technical Aspects in Data and Analysis Tools
 - There was a large reliance on data generated through the regional travel demand model in order to achieve a quantitative analysis of project costs and benefits.

Challenges

- Participation and commitment of the appropriate participants was a struggle.
- There is a need for good detection infrastructure in order to attain more accurate data.

13. Regional Concept for Transportation Operations Fosters Planning For Operations in the Tucson Metropolitan Area

Geographic Scope: Tucson metropolitan region

Leading Organization: Pima Association of Governments (PAG); The Pima Association of Governments RCTO

Approach

- The Pima Association of Governments RCTO working group fully developed an RCTO for specific aspects of their three target areas of operations: arterial management operations, traveler information, and work zone management.

Opportunities

- Organization Level Policies and Strategies
 - A regional traffic signal operations program and multi-jurisdictional sharing of traffic management resources was implemented.
 - The stakeholder planned to implement regular training and certification for the Work Zone Safety and Mobility Rule.
- Business Process, Programs, and Procedures
 - The stakeholders recognized the need to coordinate traveler information systems in the region, reduce duplicative efforts, and make better use of the existing systems in disseminating information.
 - The action plan for work zone management included regular regional construction coordination meetings between representatives of each jurisdiction to provide updates on construction project status.
- Technical Aspects in Data and Analysis Tools
 - They improved area maps in the statewide system and increased the quantity and quality of the work zone information that is input into that system.
 - They integrated filtered computer aided dispatch (CAD) information from public safety agencies, import information from Transview into Arizona 511 using a regional archived data server, and improve the availability of transit information.
 - Stakeholders identified the need for a full-time staff person to help coordinate projects and maintain a geographic information system (GIS) database of all projects.

Challenges

- The PAG RCTO working group struggled to commit to performance measures that were outcome-oriented because of the effort required to obtain and analyze the necessary data.
- The development and implementation of the project stemming from the RCTO needed funding.
- There was a shortage, in terms of commitment of staff, funding and equipment from upper-levels of the participating agencies.

14. Wilmington Area Planning Council New Castle County, Delaware and Cecil County, Maryland

Geographic Scope: Maryland, between the greater Philadelphia region and Baltimore

Leading Organization: Wilmington Area Planning Council (WILMAPCO); Delaware Transit Corporation (the region's primary public transportation provider)

Approach

- The Wilmington Area Planning Council (WILMAPCO) paid special attention when to integrating its Congestion Management Process (CMP) into its transportation planning process. The RTP 2030 takes an objectives-driven, performance-based approach in its metropolitan transportation planning.
- The agency applied a four-step Congestion Management System (CMS) approach that focused on the core functions of a CMP. While WILMAPCO retained the name CMS, its approach embodied current CMP elements.
- The promotion of transportation alternatives was clearly stated as an objective in the RTP 2030.

Opportunities

- Organization Level Policies and Strategies
 - Measures involving all modes of transportation, as well as encouraging efficient patterns of land use and development are considered as a way to mitigate congestion.
- Business Process, Programs, and Procedures
 - Projects that were identified as viable were short-listed and then evaluated during the project prioritization process for inclusion in the Transportation Improvement Program (TIP) along with other agency capital improvement programs.
 - County zoning staff use a CMS summary when reviewing land use plans, especially in assessing the adequacy of developer contributions for transportation improvements
- Technical Aspects in Data and Analysis Tools

- Data for the performance measures were provided by Delaware DOT, University of Delaware Center for Transportation, and Delaware Transit Corporation (DTC).
- GIS and current data were used, in place of modeled data, to review congestions measures.
- WILMAPCO recently incorporated crash data into its identification of congested corridors.

Challenges

- Engaging the operations community was the biggest challenge.
- Limited transit funding, growing public demands, and meeting the needs of a changing population was also a struggle.

16. Applying Analysis Tools in Planning for Operations: Case Study #1 - Operations Strategy Impact Reference and Deployment Guidance

Geographic Scope: Cincinnati region; Florida

Leading Organization: Ohio-Kentucky-Indiana (OKI) Regional Council of Governments; Florida DOT

Approach

- This report considered the following tools: Sketch planning tools, Travel demand forecasting models, Deterministic models, Traffic signal optimization tools, Simulation tools, Archived operations data, Operations-oriented performance measures/metrics, and Combinations of these tools and methods.
- These were selected for further inquiry not because they are the only existing practices, but rather because they are currently being applied in new and innovative manners.
- The goal of this piece was to develop two spreadsheets in order to help practitioners. The two spreadsheets were: Impact Summary and Deployment Guidelines

Specific Cases

- The Ohio-Kentucky-Indiana Regional Council of Governments undertook a major study to estimate the benefits of the current and future planned ITS deployments in the Cincinnati region. The region decided to conduct the analysis using the FHWA ITS Deployment Analysis System (IDAS) software.
- The Florida DOT recently conducted the development of a ITS Benefits Repository. The Florida DOT effort utilized the ITS benefits library in the FHWA's IDAS Tool.

17. Applying Analysis Tools in Planning for Operations: Case Study #2 - Incorporating Highway Capacity Manual Procedures into Long-Range Transportation Planning

Geographic Scope: the Salt Lake City–Ogden region

Leading Organization: Wasatch Front Regional Council (WFRC)

Approach

- This case study developed an automated methodology to 1) transfer demand volumes from a regional model to software implementing the Highway Capacity Manual's (HCM) Urban Streets procedure, 2) combine the volumes with known traffic signal timings to calculate a link-specific capacity, and 3) transfer that capacity back to the regional model for the next iteration. Operational treatments that can influence capacity can be accounted for in the HCM implementing software, thus allowing the effects of these treatments to be reflected in the regional model output.

Specific Case

- The participating agency for this case study was the Wasatch Front Regional Council (WFRC), the MPO for Salt Lake City–Ogden region.
- WFRC staff had developed a prototype spreadsheet implementing the HCM's Urban Streets methodology, decided at the start of the case study to use the ARTPLAN software developed by the Florida DOT (FDOT) for capacity analysis.

18. Applying Analysis Tools in Planning for Operations: Case Study #3 - Using Archived Data as a Tool for Operations Planning

Geographic Scope: the San Francisco Bay Area.

Leading Organization: Metropolitan Transportation Commission (MTC)

Approach

- This particular case study focused on the application of archived data as a tool for operations planning.

Specific Case:

- This case study summarizes an effort involving the use of archived data for operations planning conducted by the Metropolitan Transportation Commission (MTC) in the San Francisco Bay Area.
 - Archived Data: Freeway Performance Monitoring System (PeMS), MTC 511 system, Caltrans Highway Congestion Monitoring Program (HICOMP), Caltrans Traffic Accident Surveillance and Analysis System (TASAS), and Historical probe vehicle runs and traffic counts.
 - Performance Measures: travel time, speed, delay, travel time reliability, safety, and productivity.
 - Pros: cost effectiveness, time savings, capture of seasonal and daily variations, analysis of traffic trends, and ability to identify both recurrent and non-recurrent congestion
 - Cons: Ability to fully mine the archived data, low detector health rate, existence of detection gaps, weakness in capturing non-recurrent congestion, especially in areas without adequate detector coverage, and conflicts between different data sets

19. Applying Analysis Tools in Planning for Operations: Case Study #4 - Application of Micro-simulation in Combination with Travel Demand Models

Geographic Scope: Alameda County, California; east of the San Francisco Bay Area in California

Leading Organization: the Alameda County Congestion Management Agency (ACCMA)

Approach

- This case study documents the benefits as well as the pros and cons of integrating travel demand forecasting models with microsimulation tools for freeway operational studies.

Specific Cases

- The goal of the Alameda County (California) Central Freeway Study was to prioritize a funding sequence among various combinations of all potential freeway improvement projects in the jurisdiction.
 - The ACCMA official travel demand model (developed in Cube) was used to forecast future travel demand in the corridor, including ramp and mainline volumes on the freeways. Paramics microsimulation software was selected for producing measures of effectiveness (MOE) results of freeway operations for each alternative.
 - Pros: At the end of this project, the benefits of applying microsimulation in combination with travel demand models were shown and helped the agency to prioritize the funding sequence of all project scenarios.
 - Cons: Besides the physical limits on the ability of the analyst to manually adjust large OD trip tables. Theoretical concern that the demand adjustments are being made on an “ad-hoc” basis, without taking advantage of the behavioral models already incorporated at great expense in the demand model.
- The goal of this more innovative approach to combining travel demand models with microsimulation was to reflect the effects of downstream weaving and queuing on upstream locations (the output of the microsimulation model) within the travel demand model itself.
 - The ACCMA initiated the Triangle Study to evaluate and develop a near-term and long-range plan for sequencing improvements for practical traffic relief on the Tri-Valley freeways (I-580, I-680 and SR 84) in a cost effective manner consistent with the transportation needs in the area.

- The regional travel demand model used for this case study was the Contra Costa Transportation Authority's (CCTA) Decennial model.
- Pros: The approach applied took into account known information about supply constraints and travel demand patterns as well as the effects of queuing and bottlenecks on route diversion.
- Cons: Iterative feedback between the travel demand model and the microsimulation model needed. The microsimulation models are difficult to calibrate and validate to existing conditions. Calibration and validation is time-consuming and expensive for large-scale studies. There are many options in matrix estimating, engineering knowledge and judgment is integral to making correct input adjustments and constraints.

25. Developing Decision-maker Support for Management and Operations at MetroPlan Orlando

Geographic Scope: the tri-county Orlando Urban Area in the I-4 Corridor

Leading Organization: MetroPlan

Approach

- MetroPlan is the MPO for the tri-county Orlando Urban Area in the I-4 Corridor. Initially the MPO focused on addressing congestion through capacity expansion but through its work with intelligent transportation systems (ITS), however, it began to look more closely at addressing non-recurring congestion with M&O strategies.
- The County Commissioner was introduced to traffic incident management (TIM) and a multi-agency form was held. The initial projects stemming from this were successful which led to the institutionalization of M&O in the MetroPlan through the formation of an M&O subcommittee and a Systems Management & Operations Department with dedicated staff

Opportunities

- Organization Level Policies and Strategies
 - Separate programs were set in place to fund ITS and M&O projects.
- Business Process, Programs, and Procedures
 - The region's committee of mayors to approve an action that made traffic signal retiming the top priority of the transportation improvement program (TIP).
 - The committee of mayors helped to obtain half of the funding for the traffic signal program through a Florida Department of Transportation Incentive Program (TRIP).
- Technical Aspects in Data and Analysis Tools
 - MetroPlan collected data about all traffic signal retiming projects in order to monetize the value of the improvements.

Challenges

- Data is constantly needed and used to monetize the benefits of completed projects.

26. Outcomes-Based, Performance-Driven Planning at Metro Portland

Geographic Scope: the Portland, Oregon metropolitan region

Leading Organization: Metro

Approach

- The release of the 2035 Regional Transportation Plan prompted a new approach for metropolitan planning in this region that is focused on desired outcomes and measurable performance. The region's elected leaders chose an outcomes-based framework with policy-level performance targets to guide investments and demonstrate measurable results. Metro, and others, created a Regional Transportation System Management and Operations (TSMO) Plan that lays out how M&O can be used to support the desired performance outcomes.

Opportunities

- Organization Level Policies and Strategies
 - The ability of the region to meet its performance targets depends not just on the RTP but also on land use and other regional policy decisions.
 - Metro also initiated a monitoring program to periodically assess the state of the performance of the transportation system and use that information to inform incremental land use and transportation project implementation decisions.
- Business Process, Programs, and Procedures
 - The performance targets provided an investment strategy and guide for selection of a mix of investments in the transportation improvement program (TIP).
 - Metro has developed a "Mobility Corridor Atlas" that includes performance data and information about the land uses.
 - TSMO is funded through the Congestion Mitigation & Air Quality (CMAQ) program and the Surface Transportation Program (STP)
 - The MPO worked with three advisory committees to develop the TSMO Plan. These committees were comprised of public and private sector stakeholders.
- Technical Aspects in Data and Analysis Tools
 - Metro planners and partner agencies used the regional travel demand forecast model and MetroScope, a regional land use model, to estimate effectiveness of each investment package at improving the region's performance
 - Metro developed a strong partnership with Portland State University, which worked on new methods for collecting, analyzing, and archiving transportation system performance data.

Challenges

- Metro found that obtaining buy-in from the local jurisdictional planning partners required overcoming misperceptions
- Performance measurement limitations occurred due to insufficient data.
- The MPO needed to manage expectations of the elected leaders regarding the region's performance measurement capabilities.

27. The Use of an Objectives-Driven, Performance-Based Approach at the Champaign County Regional Planning Commission

Geographic Scope: Champaign-Urbana

Leading Organization: Champaign County Regional Planning Commission (CCRPC), Champaign Urbana Urbanized Area Transportation Study (CUUATS)

Approach

- The Champaign Urbana Urbanized Area Transportation Study (CUUATS) adopted an objectives-driven, performance-based approach to metropolitan transportation planning for its recent plan, Choices 2035. Through the development of Choices 2035, CUUATS and its planning partners defined 12 regional goals, several of which tie directly to improving transportation systems management and operations (M&O).

Opportunities

- Organization Level Policies and Strategies
 - Funding the strategies falls into the responsibility of the partner agencies.
 - Objectives used in the MTP and followed the SMART principles: objectives were specific, measurable, agreed upon, realistically achievable within the budget, and time constrained.
- Business Process, Programs, and Procedures
 - CUUATS coordinated with the Illinois DOT, public and private stakeholders as well as the general public to develop the region's metropolitan transportation plan (MTP).
 - That strategies used to achieve goals is usually delegated to partner agencies.
- Technical Aspects in Data and Analysis Tools
 - The MTP goals and objectives were developed based on a combination of the SAFETEA-LU factors, local planning efforts, and stakeholder input as well as updates to the list of goals presented in the last MTP.
 - CUUATS evaluated system performance against regional achievement of MTP objectives by developing specific performance measures designed to help local agencies track the progress of each objective during the 5-year period between MTP updates.
 - The MPO developed a database that is updated annually with the most current data on performance measures.

- Data was collected by local agencies and reported to local agencies along with recommendations for transportation system improvements.
- The MPO's geographic information system (GIS) inventory was also updated with the new data in order to produce a map of the region's progress in meeting performance objectives for distribution community-wide.

Challenges

- Resource availability, including data, personnel, and funding, was scarce.
- CUUATS experienced difficulties in demonstration of effects of proposed bicycle and pedestrian improvements because its current demand model only accounts for automobile travel.