SHRP 2 Reliability Project L17

Gap Filling Project 2: Deployment Guidance for TSM&O Strategies

SHRP 2
STRATEGIC HIGHWAY RESEARCH PROGRAM
Accelerating solutions for highway safety, renewal, reliability, and capacity

TRANSPORTATION RESEARCH BOARD
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Deployment Guidance for TSM&O Strategies

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SHRP 2 Project L17 – A Framework for Improving Travel Time Reliability

Gap Filling Project 2: Deployment Guidance for TSM&O Strategies

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EXECUTIVE SUMMARY

Need for Guidance

Transportation Systems Management and Operations (TSM&O) strategies offer cost-effective, quick turnaround, and less invasive solutions for congestion and safety problems than large-scale capital expansion projects. However, the process for deciding where, when, and what to deploy in terms of TSM&O strategies has largely been informal, and agencies have taken a variety of approaches to it. Therefore, the purpose of Gap Filling Project 2: *Deployment Guidance for Transportation Systems Management and Operations Strategies* is to provide guidance to practitioners in short-term deployment planning.

The project team interviewed agencies to identify the methods that they had developed to perform short-term deployment planning. This compilation is useful to other agencies, as they can see how others have dealt with the issues. The project team then classified the agency approaches into general categories or approaches that agencies have used. Finally, a set of recommendations for developing a formalized and structured approach to short-term deployment planning is specified. Both technical and institutional issues are addressed by the syntheses.

TSM&O Strategies

The strategies identified for operations planning vary significantly but fall into several identifiable categories. In most cases, planning activities are undertaken on a case-by-case basis, with examples including ramp metering, advanced traffic management systems, arterial signal corridor management, freeway managed lanes, variable speed limits, and intelligent transportation systems (ITS) system expansion.

The case studies illustrate that techniques used for operations planning vary with the scope and nature of the strategies being considered, as well as resources available. Agencies have different philosophies about the level of effort needed at the front end. The case studies also included a range of desired outcomes, all of which ultimately address the goals of improved safety and mobility. Outcomes fall into two general categories: implementation of individual projects or programs and development of a general umbrella plan or strategy. Ideally, the individual strategies should be reflected in an overall plan, but in the operational area, that is often not the case. The experience of Michigan and Wisconsin demonstrates that an umbrella plan can be developed either from top down or bottom up, as long as the interests of various stakeholders are effectively represented. Case studies showed that those agencies with specific proposed projects wanted to find the most effective implementation scenario and strategy.

Conditions and context of the case studies also fell into two distinct categories. Several were a response to rapidly increasing congestion in specific locations or in a general area. In other cases, the conditions and context were political in nature, generally involving funding and/or decision maker support of the overall program.

Strategies ranged from those covering individual facilities, to corridors, to statewide programs. In several of the case studies, deficient corridors were already defined by other planning efforts. Time frames for implementation are generally short term. Long-term plans for TSM&O strategies need to account for ongoing changes in technologies and services and thus may be less specific about the nature of deployments.

The case studies indicated the use of a number of existing planning operational planning tools such as the Federal Highway Administration (FHWA) benefit-cost database, the ITS Deployment Analysis System (IDAS), and simulation models, as well as increasing usage of real-time archived operational data for analysis of new or expanded projects. Agencies indicated a need for overall guidance on how to approach the operations planning process on a high level and how to select the proper tools for specific analyses. Depending on the specific context and conditions, agencies may wish to develop their own methodology and use datasets unique to their agency.

Organizational and Institutional Challenges

One of the major challenges in operations planning for many agencies is to align their process with organizational structures that are oriented toward the planning of capital projects. Since many capital projects require a long time horizon to implement, the planning, project development, and design functions are generally well aligned with each other. The steps between these stages are well-defined, and there are strong linkages that enable projects to be passed efficiently from one group to another.

Institutional issues were viewed as major obstacles. Operations departments have generally been isolated from capital projects, focusing originally on traffic signal operations and expanding in more recent years to freeway management, ITS deployment, and emergency operations. Deployment of ITS through the 1990s and early 2000s was accomplished largely with dedicated funds from the federal ITS program. The planning, design, and deployment generally took place within operations, with some required coordination with design and construction. While the projects may have been incorporated into the Transportation Improvement Program (TIP) or Statewide Transportation Improvement Program (STIP), little interaction with traditional planning departments took place. Some recommendations for addressing institutional issues include

- Cross-training planning department personnel so that they are familiar with issues and technical tools particular to operations planning;
- Developing a multiyear TSM&O plan that is compatible with STIP and/or TIP and uses similar data for prioritization methodology;
- Developing a "toolbox" document that relates TSM&O solutions to specific transportation system problems;
- Ensuring that operations personnel participate in project selection and prioritization processes;
- Transferring technical knowledge on design and implementation of TSM&O projects to design and construction departments through training and seminars or assignment of operations personnel to these departments; and
- Taking a more holistic approach to project planning.

While planning is the focus of this discussion, a guidance document that includes information on promoting institutional coordination would be helpful to agencies. A high-level document on how to conduct operations planning would not necessarily prescribe a single methodology but would provide checklists for the items that need to be covered, steps required to reach the intended outcome, and a comprehensive guide to operational planning tools.

The existence of a formal guidance document would greatly facilitate implementation, but even without it, the results of this gap-filling project should be woven into the SHRP 2 implementation program. Because the topic of this project (short-term deployment planning) is closely related to the topic of gap-filling project #3 (*Best Practices for TSM&O Program and Budget Development*), it is recommended that the two projects be bundled together for implementation purposes. Both projects are based on examining current practices, so the best medium for implementation would be to establish a peer-to-peer program.

This area is expected to evolve as agencies begin to incorporate deployment planning and budgeting into existing planning and programming practices. A periodic review of these practices should be undertaken to ensure that best practices are up to date. This report provides the framework for efficiently conducting these reviews.

1.0 INTRODUCTION

Purpose and Need

Transportation Systems Management and Operations (TSM&O) strategies offer cost-effective, quick turnaround, and less invasive solutions for congestion and safety problems than large-scale capital expansion projects. However, the process for deciding where, when, and what to deploy in terms of TSM&O strategies has been largely informal, and agencies have taken a variety of approaches to it. Therefore, the purpose of Gap-Filling Project 2: *Deployment Guidance for Transportation Systems Management and Operations Strategies* is to provide guidance to practitioners in short-term deployment planning.

Scope

Originally, the scope of the project was purely technical: to identify the factors and conditions that led agencies to deploy certain types of strategies. The team was interested to see if certain triggers existed that indicated the choice of one strategy over another. However, the team quickly discovered that no specific thresholds for congestion, safety, environmental impacts, or budget constraints were in use by agencies. Rather, the decision to deploy was based on a more generalized understanding of congestion and safety problems. What was deployed was determined mostly subjectively, based on engineering judgment of what types of strategies might work, could fit into the roadway environment, and could be funded.

This realization led to the team taking a different tack. It was clear that institutional issues were at least as important as technical considerations, so a synthesis approach was taken for this effort. The project team interviewed agencies to identify the methods that they had developed to perform short-term deployment planning. This compilation is useful to other agencies on its own as they can see how others have dealt with the issues. The project team then classified the agency approaches into general categories. Finally, a set of recommendations for developing a formalized and structured approach to short-term deployment planning is specified. Both technical and institutional issues are addressed by the syntheses.

2.0 BACKGROUND

Deployment Guidance

Technical and scholarly studies on the topic of short-term operations deployment guidance were not found. However, much information exists on the nature of operations deployment. The main source is the ITS Deployment Tracking System maintained by the Research and Innovative Technologies Administration (RITA):

Arterial Management

- Surveillance: traffic, infrastructure
- Traffic control: Adaptive signal systems, advanced signal systems, variable speed limits. Bicycle and pedestrian, special events
- Lane management: High-occupancy vehicle (HOV) facilities, reversible flow lanes, pricing, lane controls, variable speed limits, emergency evacuation
- Parking management: data collection, information dissemination
- Information dissemination: dynamic message signs, in-vehicle systems, highway advisory radio (HAR)
- Enforcement: speed enforcement, traffic signal enforcement

Freeway Management

- Surveillance: traffic, infrastructure
- Ramp control: ramp metering, ramp closures, priority access
- Lane management: HOV facilities, reversible lanes, pricing, lane control, variable speed limits, emergency evacuation
- Special event transportation management: occasional events, frequent events, other events, temporary traffic management center
- Information dissemination: dynamic message signs, in-vehicle systems, HAR
- Enforcement: speed enforcement, HOV facilities, ramp meter enforcement

Crash Prevention and Safety

- Road geometry warning: ramp rollover, curve speed, downhill speed, overheight/overwidth
- Highway-rail crossing warning

- Pedestrian safety
- Bicycle
- Animal

Road Weather Management

- Surveillance, monitoring and prediction: pavement conditions, atmospheric conditions, water level
- Information dissemination: dynamic message signs, HAR, Internet/wireless/phone
- Traffic control: variable speed limits, traffic signal control, lane use/road closures, vehicle restrictions
- Response and treatment: fixed winter maintenance, mobile winter maintenance

Roadway Operations and Maintenance

- Information dissemination: portable dynamic message signs, HAR, Internet/wireless/phone
- Asset management: fleet management, infrastructure management
- Work zone management: temporary traffic management, temporary incident management, lane control, variable speed limit, speed enforcement, intrusion detection, road closure management

Transit Management

- Operations and fleet management: automatic vehicle location and computer-aided dispatch, transit signal priority, maintenance, planning, service coordination
- Information dissemination: in-vehicle systems, in-terminal/wayside
- Transportation demand management: ride-sharing/matching
- Dynamic routing/scheduling
- Safety and security: in-vehicle surveillance, facility surveillance, employee credentialing, remote disabling systems

Transportation Management Centers (TMC)

- Temporary TMC: seasonal, special events, work zones
- Permanent TMC: freeway, arterial, transit, rural, multiagency/colocated

Traffic Incident Management

- Surveillance and detection: detectors, imaging/video, wireless enhanced 9-1-1, mayday/automated collision notification, call boxes, traveler reported
- Mobilization and response: automatic vehicle location/computer-aided dispatch, response routing, service patrols
- Information dissemination: dynamic message signs, HAR

Emergency Management

- Hazardous materials management: tracking, detection, driver authentication, route planning
- Emergency medical services: advanced automated collision notification, telemedicine

Electronic Payment and Pricing

- Toll collection
- Transit fare payment
- Parking fee payment
- Multiuse payment
- Pricing

Traveler Information

- Pre-trip information: Internet/wireless, 511, other telephone, TV/radio, kiosks
- En route information: wireless, 511, other telephone, TV/radio, in-vehicle systems
- Tourism and events: travel services, advanced parking

Information Management

- Data archiving

Commercial Vehicle Operations

- Credentials administration: electronic funds, electronic registration/permitting
- Safety assurance: safety information, exchange, automatic inspection
- Electronic screening: safety screening, border clearance, weight screening, credential checking

- Carrier operation and fleet management: automatic vehicle location/computer-aided dispatch, on-board monitoring, traveler information
- Security operations, asset tracking, remote disabling systems

Intermodal Freight

- Freight tracking
- Asset tracking
- Freight terminal processes
- Drayage operations
- Freight-highway connector system
- International border crossing processes

Collision Avoidance

- Intersection collision warning
- Obstacle detection
- Lane change assistance
- Rollover warning
- Road departure warning
- Forward collision warning
- Rear impact warning

Driver Assistance

- Navigation/route guidance
- Driver communication: with other drivers, with carrier/dispatch
- Vision enhancement
- Object detection
- Adaptive cruise control
- Intelligent speed control
- Lane keeping assistance
- Roll stability control
- Drowsy driver warning systems
- Precision docking
- Coupling/decoupling

- On-board monitoring: cargo condition, safety and security, vehicle diagnostics, event data recorders

Collision Notification

- Mayday/automated collision notification

The RITA website on deployment statistics can be found at http://www.itsdeployment.its.dot.gov/.

Lessons Learned

In addition to tracking the amount of ITS/operations deployment, RITA also asks agencies to submit lessons learned on general deployment issues. A summary of these issues is listed below.

- Recognize opportunities and challenges posed by political timetables, deadlines, pricing equity;
- Work together with all agencies—be proactive;
- Ensure proper sequencing;
- Anticipate delays—allot sufficient time and funds;
- Recognize that deployment delay leads to ripple effect of challenges to deployment;
- Recognize champions;
- Divide large-scale projects into smaller, individual tasks;
- Issues, strategies, and trade-offs that motivate agencies to join;
- Consider the consensus organization model to help assure support and participation;
- Examine contextual factors and carefully manage the associates' issues that will determine success or failure;
- Conduct systems engineering process improvement reviews in order to identify, prioritize, and refine systems engineering procedures;
- Plan staffing and communication needs;
- Develop concept of operations (ConOps) to help project partners stay focused on true needs;
- Determine training needs;
- Anticipate, understand, and manage risks;

- Understand institutional issues;
- Understand that ITS contracting is complex and subject to changes in technology and market forces;
- Consider risks that ITS standards may be subject to change;
- Facilitate private sector companies in deployment considering intellectual property rights;
- Address intellectual property rights early;
- Address procurement procedures for public-private partnership projects;
- Balance project goals against the constraints and capabilities of project partners; and
- Address enforcement issues early.

3.0 STATE OF THE PRACTICE

Introduction

The state of the practice in planning for TSM&O projects includes a variety of methods and techniques, which are a function of several factors, including:

- How operations fits within the structure of the agency; including whether it is subsumed within a larger unit or stands on its own, level of access to top management.
- Relationships between operations and other agency functions; particularly planning and project development.
- Funding sources and allocation formulas/strategies.
- Whether the project(s) is statewide or confined to a region, corridor, or location.
- Type, size, and geographic scope of proposed project.
- Level of centralization and decentralization within the agency.

In order to better gauge the state of the practice, a number of agencies were identified and specific planning activities reviewed through interviews and review of relevant materials. A wide range of activities were covered, ranging from localized operational deployments to development of statewide plans. Techniques applied to conduct these planning activities included established tools, customized methodologies, and combinations of both. In general, the planning of TSM&O projects is still an independent process from the capital planning process, although improved linkages are reflected in some of the case studies presented. Brief summaries of individual projects are summarized in Table 3.1 below, which is followed by brief descriptions of each project. Findings and conclusions are summarized at the end.

Table 3.1 Summary of Agency Interviews on Short-Term Deployment Planning

		Transportation Agency						
Deployment Planning Component	**Caltrans D4**	**FDOT D6**	**FDOT D4**	**KC Scout Ramp Meter**	**KC SCOUT B/C**	**WisDOT Plan**	**MDOT Plan**	**GDOT Operations (Atlanta Metro)**
General Technical Strategies, Deployment Planning	Corridor System Management Plans (CSMP)	Develop Regional Concept of Transportation Operations	Active arterial management similar to that practiced on freeways	Benefit-cost analysis	Benefit-cost analysis	Statewide ITS plan	Series of regional ITS pre-deployment plans	Cursory data review with extensive post-deployment evaluations
Desired outcome driving strategy	Get more capacity out of existing highway system, get capacity improvements to last longer.	Expansion of regional express lane network	Create advanced arterial network in Broward County	Ramp meter implementation	Expansion of regional ITS system	Mainstream ITS into transportation capital program	Provide basis for allocation of scarce ITS funds across the state.	Near universal coverage of Atlanta freeways; congested arterials
Conditions and context	California Transportation Commission (CTC) concerned by repeated requests by Caltrans for more and more capacity improvements. CTC wanted Caltrans to work more with local agencies to develop joint operations solutions to improve effectiveness of state highway systems	• Increased congestion and need to improve reliability • Lack of revenue for system expansion • Ongoing development of TSM&O business plan with central office	• Update of software platform in process from UTMS to ATMS • Increasing arterial traffic and congestion • Increased collaboration with transit on arterial operation	• Interest in using ramp metering to address congestion and reliability issues on I-70 corridor • With no experience with ramp metering in KC, Scout wanted analysis to gauge effectiveness	• To build support for funding system expansion, KC Scout wanted analysis to justify both existing system investment and future investment in expanded system	• State legislation removed opportunity to implement stand-alone ITS projects. • A statewide ITS plan was required so that projects could be integrated into roadway/bridge capital projects.	• A need for ITS deployment was identified for areas outside the two major legacy systems in Detroit and Grand Rapids. • Since investments were needed in the legacy system as well, regional plans were developed to help allocate funds across the state.	• Opportunities for lane additions on existing freeways very limited • Public "has gotten used to" aggressive deployments • Strong upper management support for operations funding (can be traced back to 1996 Olympics and 1990s EPA bans on new capacity)
Decision to implement	Desire to take advantage of recent advances in real-time management of facility operations.	• Desire to build upon success of management lanes.	• Updated signal software project • Growing awareness of need to address arterial congestion	• Ramp metering appeared to be realistic and cost-effective solution to congestion and reliability problems in corridor • Study also provided information for any future deployments	• Need to fill gaps in ITS system which had limited coverage in northern, fast-growing part of the region.	• Need for plan to continue ITS implementation across the state. Plan was needed to take advantage of deployment opportunities offered by major capital projects.	• Before implementing statewide program, MDOT needed to conduct a series of regional pre-deployment studies to determine needs, which varied across the state.	• In the past, has either come from upper DOT management or governor directives [e.g., FastForward, Regional Traffic Operations Program (RTOP)]; these are major program-level initiatives

What to implement?	Ramp metering, traveler information, express lanes, freeway service patrol, improved incident detection, speed harmonization, advanced system monitoring, integration with other active traffic management strategies	Used an Urban Partnership Agreement (UPA) as part of value pricing agreement	Signal systems master plan, decision based on knowledge and experience	Ramp metering system.	ITS Expansion plan to be integrated with existing KC Scout system.	Statewide ITS plan along major corridors of significance that had already been selected.	Statewide ITS plan to be implemented over several years, with both new deployments and replacement of legacy systems.	GDOT historically focused on expanding "standard" strategies to as many highways as possible [ramp meter, Traffic Incident Management (TIM), dynamic message signs (DMS), signal coordination]; now considering active transportation and demand management (ATDM)
Where to implement?	Congested urban freeway corridors in San Francisco Bay area	Worked in partnership with transportation agencies. ML implemented along I-95 and planned for several other freeway facilities as well as one arterial.	Worked with Broward County to identify	I-70. Corridor selected based on knowledge of congestion there. Analysis used to refine proposal.	Northern part of Kansas City region.	Statewide on corridors of significance.	Statewide with deployment locations based on findings of study.	Congested sections of highways and/or highways with gaps in coverage
Tools or guidance	FREQ, TOPL, VISSIM, Paramics (for operations analysis), Smart Mobility Framework (multimodal planning/ operations with Complete Streets)	Local expertise and national expertise	Used existing data to measure density and transit usage for corridor selection	Used real-time freeway data and data on diversions to parallel arterials to estimate the impact of ramp metering.	Used ITS Deployment Analysis System (IDAS) for benefit-cost analysis	Developed and applied customized tool using available WisDOT planning data	Used ITS Deployment Analysis System (IDAS) for benefit-cost analysis. This was used in part to prioritize projects	Preexisting data coverage used to identify congested locations; analysis kept simple
Tools or guidance needed	Updated macroscopic analysis model for other ATDM strategies besides metering and HOV lanes, examples of Caltrans Smart Mobility Framework implementation best practices	• Menu of ITS strategies, benefits and costs • Guide for using ITS techniques • - Evaluating benefits of active traffic management	• Better defined methodology for corridor selection • Methodology for evaluating active traffic management strategies	• Tools for evaluating benefit-cost analysis for arterial corridors	• Tools for evaluating benefit-cost analysis for arterial corridors	• Methods for feeding real-time data back into operational decision making as well as for use as a sales tool	Method for evaluating cost of work zone mitigation requirements versus travel time benefits and delay	As funding gets tighter, prioritization methods for deployment decisions

Strategies not implemented	Dynamic shoulder [California Highway Patrol (CHP) opposes]	Active traffic management on arterials is not as advanced	Adaptive signal control				Consolidated a proposed series of regional TMCs into a statewide TMC to cover all areas except Detroit and Grand Rapids	Now looking beyond the traditional strategies of ramp metering, TIM, and HOV/HOT. Now are deploying variable speed limits (VSL).
Stability of funding over multiple years	Generally good	Relatively stable		Funding has been stable. Missouri Department of Transportation (MoDOT) and Kansas Department of Transportation (KDOT) have been able to work out simple formula to allocate costs. Major cuts in MoDOT budget may have longer-term impact.	Funding has been stable. MoDOT and KDOT have been able to work out simple formula to allocate costs. Major cuts in MoDOT budget may have longer-term impact.	Operations funding is a significant issue. ITS deployments need to be incorporated into capital projects.	MDOT currently has strong commitment to ITS/Operations funding.	They are pretty well-funded for operations in the coming year. We have federal projects programmed all the way through 2020, with placeholder projects all the way to 2030. These are 80/20 federal/state splits. The sources are: HN: (ISTEA CD 315), National Highway System, and Congestion Mitigation. GDOT is really focusing on operations, now that the transportation referendum failed (no new construction). They are going to maintain what we've got and try to make it operate as efficiently as possible.
Other partners involved in deployment decisions	Local metropolitan planning organizations (MPO) and local cities and counties, transit agencies	MPOs, transit agencies, toll authorities	MPOs, transit agencies, county/signal engineers	MPO technical support for modeling and technical analysis.	MPO runs regional signal coordination from operations center.	University of Wisconsin maintains and updates operations plan.	Planning in partnership with MPOs in some regions. County road commissions.	Most of the decisions to deploy Navigator FREEWAY devices are made internally, as GDOT is the sole operator of the freeway system. Ramp metering decisions would also involve the local agency, especially if the crossing road is not a state route. As far as arterial deployments, there is much more local involvement.

Use of performance measures in either project planning or program direction	Vehicle hours of delay, travel time, Traffic Accident Surveillance and Analysis System (TASAS) data, equivalent lost lane miles, Smart Mobility Framework performance measures	Just beginning for project planning- Southeast Florida Transportation Council just adopted a performance measurement system that will be used to guide decision making at the long range transportation plan (LRTP) level. DOT Central Office is undergoing a similar effort that is anticipated to go to the district level. Managed lanes system is monitored for success and has been adjusted to optimize the investment	Just beginning for project planning: Southeast Florida Transportation Council just adopted a performance measurement system that will be used to guide decision making at the LRTP level. DOT central office is undergoing a similar effort that is anticipated to go to the district level. Active Traffic Management projects are assessed for performance and adjusted as needed over time given many of the strategies are first-timers	Conducted an evaluation of the ramp metering pilot that measured freeway travel time, ramp delay, crash reduction, meter compliance and public acceptance (survey).[1]	Scout produces an annual congestion report that includes freeway Travel Time Index, Planning Time Index, Buffer Index and speed data.[2] MoDOT's statewide tracker program includes travel time on selected freeway segments, mobility ratings for major signalized routes and incident clearance times for the KC area.[3]	Measures freeway level of service and incident clearance times as part of statewide performance measure report.[4]	MDOT operational performance measures are currently focused on incident response and work zones. New ATMS software and a statewide probe data contract will allow more mobility measures to be incorporated.	Evaluations of deployed projects are routinely done. Incident management trends have been tracked for a long time, and have led to changes in service patrol schedules and on-scene policies. Georgia Regional Transportation Agency produces an annual area-wide performance report that is used to discuss program needs within GDOT.
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[1] http://www.kcscout.net/downloads/RampMetering/2011RampMeteringEvaluationReport.pdf

[2] http://www.kcscout.net/downloads/Announcements/CongestionReport.pdf

[3] http://www.modot.org/about/tracker_archive/documents/Tracker_PDF_Oct12/Chapter_1.pdf

[4] http://www.dot.state.wi.us/about/performance/docs/report-jan12.pdf

CALIFORNIA DISTRICT 4

Corridor System Management Plans

Problem The California Transportation Commission (CTC) was concerned by repeated requests by the California Department of Transportation (Caltrans) for more capacity improvements. CTC wanted Caltrans to work more with local agencies to develop joint operations solutions to improve effectiveness of state highway systems.

Solution Implement a series of Corridor System Management Plans (CSMP) to get more capacity out of the existing system and develop improvements that last longer. An important project goal was to take advantage of recent advances in real-time management of facility operations.

Project Description A number of improvements are being implemented in congested urban freeway corridors in the San Francisco Bay area, including

- Ramp metering;
- Traveler information;
- Express lanes;
- Freeway Service Patrol/improved incident detection;
- Speed harmonization;
- Advanced system monitoring; and
- Integration with other Active Traffic Management strategies.

Dynamic shoulder running strategies were considered but rejected due to opposition from the California Highway Patrol.

A number of technical tools were used to evaluate and prioritize corridors, including FREQ, TOPL, VISSIM (for operations analysis) and Smart Mobility Framework for multimodal planning and operations with Complete Streets.

Results Improved mobility and safety with benefits measured through changes in vehicle hours of delay, travel time, TASAS (accident) database, equivalent lost lane miles, and Smart Mobility Framework Performance.

Cost N/A

Public Benefits Improved mobility and safety through a variety of operational improvements that help to limit the need for high-cost capital improvements.

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FLORIDA DISTRICT 6

TSM&O Business Plan and Regional Express Lane Network

Problem Increased congestion and the need to improve trip reliability in the region with no revenue to expand the current network.

Solution Development of a TSM&O Business Plan with support of the Florida Department of Transportation (FDOT) central office. Implementation of a Regional Express Lane Network.

Project Description

- Under the FDOT D6 TSM&O core group, a Regional Express Lane Network is being implemented. The concept started with the I-95 Express managed lanes that connect Miami-Dade County to Broward County. Now, FDOT wants to expand the network. The program is to be implemented along congested corridors throughout the South Florida Region (I-75, I-525, SR-826) with stakeholder input and involvement.

- A Regional Concept for Transportation Operations is being put together to develop a framework plan for the expansion throughout the state.

- A legal mechanism and infrastructure (toll collection, incident management program, etc.) scheme is already in place to implement and expand managed lanes.

Results Used the Urban Partnership Agreement with FHWA and the U.S. Department of Transportation (DOT) as part of the Value Pricing Pilot (VPP) program developed in the 1990s to continue implementation of managed lanes. Continued program through analysis of strategies via the Project Development and Environment Study (PD&E) process.

Cost N/A

Public Benefits Managed lanes are providing an opportunity to improve mobility while optimizing capacity and existing funding.

Contact Omar Meitin, Florida District 6

FLORIDA DISTRICT 4

Active Arterial Management

Problem Increased traffic and congestion on arterial roads in Broward County. A need was recognized to better manage arterial traffic and to work with public transit to improve service along the arterial system.

Solution Broward County was in the process of updating the software platform from a Universal Traffic Management System (UTMS) to an Advanced Traffic Management System (ATMS), providing an opportunity to implement an actively managed arterial management system. The system uses ITS detection and surveillance technology for incident management as well as tools for improved signal timing.

Project Description

The program consists of the following elements:

- Active Arterial Management: what is currently done on freeways but applied to arterials
  - Dynamic signs
  - Signal management
  - Cameras
  - Incident response
  - Data collection
- Plan to create a full network in Broward
  - Aim for locations with high-density, high use of transit (U.S.-1, Sunrise, SR-7, etc.)
  - Network to grow over time
- Increased collaboration with Broward County transit agencies and higher need for better transit and traffic management
- Time frame
  - Initial completion Fall 2013
  - More to be completed in next five years

Results Began implementation of the arterial management framework previously developed for Broward County. FDOT and Broward County worked collaboratively to prioritize locations with higher levels of congestion and transit usage. Adaptive signal control has not been implemented because it has been hard to convince management of the cost-effectiveness of the investment. In addition, there are limited experience and resources to manage such a system. This points out the need for technical tools to estimate the benefits and costs of active traffic management. Technical tools are also needed as an aid for prioritizing corridors for improvements.

Cost N/A

Public Benefits Improved mobility and safety through increased ability to monitor and manage arterial roadways. Measurement tools are needed to estimate the benefits and document them for decision makers.

Contact Mark Plass, Florida District 4

CASE STUDIES

Kansas City Scout

Using Archived Data to Evaluate Ramp Meter Operations, Part 1

Problem Kansas City Scout had deployed an extensive bi-state ITS system in the Kansas City region. The system did not cover the entire region, however, and it particularly did not cover a growing area in the northern part of the region that includes the airport. A plan was developed to expand the ITS system in this area but Scout wanted assurance that the investment would be cost-effective.

Solution Kansas City Scout authorized a benefit-cost analysis of both the existing system and the proposed expansion. The results were documented in a report and a brochure oriented toward funding agencies and decision makers. The effort had two purposes: to make decision makers and the public aware of the benefits of the Scout system using quantitative measurements to the extent possible and to make sure the proposed expansion was cost-effective, thus justifying funding for it.

Project Description

- The ITS Deployment Analysis System (IDAS) and the Mid-America Regional Council's (MARC) travel demand model were used to estimate benefits for both existing and proposed deployments. Existing and proposed deployments were modeled separately so the benefits could be compared. Costs were based on KC Scout's current system.

Results

- The benefit-cost analysis showed that the existing system provided $46 million in annual benefits versus $4.9 million in annual operating and annualized capital costs. The majority of benefits ($36 million) were in travel time savings to the public. The benefit-cost ratio for the system was 9.4:1.

- The most cost-effective portion of the system was the Motorists Assist patrols, which had a benefit-cost ratio of 12:1.

- The proposed additions added $6.5 million in annual benefits against an annual cost of $1.6 million for a benefit-cost ratio of 4:1. While this is a lower cost-benefit ratio than that of the existing system, this analysis still showed that the investment was justified.

- The results of both the existing and proposed system analyses were combined showing the entire system providing $54 million in benefits and $6.5 million in cost for a benefit-cost ratio of 8.3:1. The results were presented in a brochure that explained the system and its benefits to decision makers and the public.

Cost The cost of the benefit-cost analysis was approximately $90,000.

Public Benefits The benefit-cost analysis provided data to support ongoing funding for the existing Scout system and to obtain funds for the expansion.

Contact Jason Sims, KC Scout Program Manager, ervin.sims@modot.mo.gov, (816) 622-0528

KANSAS CITY SCOUT

Using Archived Data to Evaluate Ramp Meter Operations, Part 2

Problem Determining the effectiveness of ramp meters in a demonstration project and planning for additional ramp meters if the demonstration was deemed successful. Providing justification for implementing ramp meters.

Solution The Kansas City Scout program, a joint operation of Missouri Department of Transportation (DOT) and Kansas Department of Transportation (DOT), developed a data archive to collect freeway detector data and used that data to evaluate the ramp meter demonstration program on a section of I-435 in the Overland Park area of the Kansas City region.

Project Description

- The Kansas City (KC) Scout operations staff, which manages the freeway system in the Kansas City region, collects all freeway detector data for portions of the regional freeway network. Travel speed, travel time reliability, level of congestion, and incident data are the basic operations data that are collected and used.

- The KC Scout operations staff conducted an evaluation of ramp meters implemented along a section of I-435 for a 12-month period in 2010–2011.

Results

- The evaluation results found that the number of accidents in the study was significantly reduced (64%) and changes in freeways travel speeds ranged from a decrease of 8% to an increase of 33%, with most segments experiencing a slight increase in speed. Travel times remained reliable overall, and reliability increased in some segments by 5%.

- Motorists have generally accepted the meters, choosing to comply with them rather than ignore them, thereby helping to improve the safety of their commutes.

- Motorists agreed that ramp meters should be installed on other freeway segments in the Kansas City region.

- The KC Scout Board provided the budget needed to implement the ramp meter program.

- The evaluation provided KC Scout with measures and targets that will be used in identifying locations and evaluating the implementation of future ramp meter projects.

Cost The cost of the ramp meter evaluation was approximately $100,000.

Public Benefits The implementation of ramp meters was found to be beneficial to the traveling public. KC Scout is planning to implement ramp meters along other freeway segments in the region. The evaluation provided the justification needed for decision makers to approve the ramp-metering program.

Contact Jason Sims, KC Scout Program Manager, ervin.sims@modot.mo.gov, (816) 622-0528

http://www.kcscout.net/Default.aspx

http://www.kcscout.net/downloads/RampMetering/2011RampMeteringEvaluationReport.pdf

http://www.kcscout.net/Default.aspx

http://www.kcscout.net/downloads/RampMetering/2011RampMeteringEvaluationReport.pdf

WISCONSIN DEPARTMENT OF TRANSPORTATION (DOT)

Using Data and Analysis to Plan for Operations

Problem The ability to deploy stand-alone ITS and operations projects in Wisconsin was severely limited by legislation, requiring ITS projects to be incorporated into capital pavement and bridge projects. It became a significant challenge to incorporate ITS into these projects, since most are carried out at the regional level and the ITS program is operated on a statewide basis. Without a plan, many projects would be scoped and budgeted before ITS and operations could be incorporated.

Solution The Wisconsin Department of Transportation (WisDOT) developed a statewide operations plan, called the Transportation Operations Improvement Program (TOIP) that documented proposed ITS and operations deployments for all major corridors in Wisconsin. These corridors were those defined within the state's long-range transportation plan. Four levels of deployment were proposed, depending on a variety of highway characteristics. When capital projects are proposed, the plan is reviewed, a benefit-cost analysis is developed for the TOIP deployment plan, and refinements are made as needed. Operations staff then works with regional engineers to incorporate the ITS components into the design. This plan was necessary to make sure that ITS could be incorporated into the capital projects without delaying the project or requiring an additional budget. The plan also helped stretch budgetary resources, since, in most cases, it is less expensive to install ITS during a roadway capital project than as a stand-alone project. Another justification for the plan was that it defined the appropriate level of deployment in different parts of the state based on need.

Project Description

- The TOIP was developed using data from WisDOT's MetaManager database, which includes demographic, traffic, and safety data. A series of measures were developed through an internal stakeholder process; they were weighted and applied to all segments of major corridors to determine the need for ITS and operations. Among the MetaManager data included were existing and future volumes, growth projections, volume-to-capacity (V/C) ratios, and crash rates. Weather and special event data were drawn from other sources. The initial proposed deployments were refined as needed based on a high-level planning and engineering review. The plan is currently updated on an annual basis.

- Benefit-cost analysis of proposed TOIP deployments has been conducted using the ITS Deployment Analysis System (IDAS) as part of the design process on several major corridor projects. Refinements have been made to the plans based on the benefit-cost (B/C) analysis and also due to engineering feasibility considerations.

Results

- ITS has been successfully deployed as part of several major capital corridor projects, including U.S.-41 in northeastern Wisconsin and I-94 in southeastern Wisconsin, and it is planned in others.

- The TOIP process has provided an opportunity for the operations staff to work with the regional engineering staff in developing ITS.

Cost The initial cost of the TOIP was approximately $350,000.

Public Benefits Faster and more extensive deployment of ITS to benefit the safety and mobility of the public.

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MICHIGAN DEPARTMENT OF TRANSPORTATION (DOT)

Using Data and Analysis to Plan for Operations

Problem The Michigan DOT ITS program faced the challenge of replacing and/or upgrading large portions of its legacy system, while also addressing needs to expand the system statewide.

Solution The Michigan Department of Transportation (MDOT) took a standardized approach to developing either new or updated ITS architecture and pre-deployment plans in each of its seven regions. Proposed projects from this process were used to develop a statewide ITS program. Staff meets annually to develop a financially constrained five-year plan and reprioritize projects as necessary. This has enabled MDOT to expand its ITS program throughout the state while still maintaining and upgrading its large legacy system in the Detroit area. The major justification for this effort was to define ITS needs across the entire state, helping to justify continued funding and to ensure that resources are used in an efficient manner to meet the specific needs of each region. Another objective of the planning process was to educate MDOT personnel and other stakeholders in regions that did not understand the benefits of ITS and operations.

Project Description

- New or updated pre-deployment plans and ITS architectures were developed for all seven MDOT regions over approximately a three-year period. ITS needs were developed based on stakeholder input and review of traffic, safety, and travel demand model data. Projects were then identified, evaluated for their benefit-cost, and prioritized as short, medium, or long range. All potential projects were incorporated into the architecture. A process was defined for updating regional architectures as necessary and assuring that a consistent approach was taken statewide.

- MDOT ITS and regional staff responsible for ITS began meeting on an annual basis to allocate available funds between different projects.

Results

- While there were legacy systems in Detroit and Grand Rapids, many areas of the state had no ITS deployments. The planning effort helped familiarize MDOT personnel throughout the state with ITS projects and technologies, enabling them to manage the required design and construction work.

- Projects were selected and implemented that were tailored to the specific needs of each region. For example, the North and Superior regions, which experience severe winter weather, have focused on Road Weather Information Systems. Systems oriented toward summer tourist traffic have also been deployed.

- While an ITS funding program was already in place, the process and plans helped to solidify support for ongoing funding of new ITS deployments and for replacement of older legacy equipment in the Detroit area.

Cost Regional architecture and pre-deployment studies cost roughly $150,000 for each of the seven regions. These were consultant costs only and do not include internal costs for MDOT.

Public Benefits MDOT has been able to deploy a statewide program with specific projects tailored to the needs of each region.

Contact Matt Smith, MDOT, Smithm81@michigan.gov

GEORGIA DEPARTMENT OF TRANSPORTATION (DOT) ATLANTA METRO OPERATIONS

Advanced Operational Projects

Problem Opportunities for lane additions on existing freeways are very limited; beginning in the 1990s, there have been environmentally based bans on new capacity.

Solution The goal of the Georgia Department of Transportation (GDOT) is near-universal coverage of Atlanta freeways with operational strategies, which has been largely achieved, and coverage of congested arterials. The public has gotten used to aggressive deployments, and there is strong upper-management support for operations funding that can be traced back to the 1996 Olympics and limits on new capacity.

Project Description GDOT historically focused on expanding standard strategies to as many highways as possible [ramp meter, Traffic Incident Management (TIM), Dynamic Message Signs (DMS), signal coordination]; and is now considering ATDM. Focus is on congested sections of highways and/or highways with gaps in coverage. Preexisting data coverage is used to identify congested locations, and analysis is kept relatively simple. There is a need for improved prioritization methods as funding gets tighter.

Results GDOT is currently deploying variable speed limit systems and is looking for other strategies beyond ramp metering, TIM, and high-occupancy vehicle (HOV) lanes and high-occupancy toll (HOT) lanes. While GDOT is the sole operator for the freeway system, increased arterial deployments have led to more local involvement and cooperation. Most signals are operated and maintained by local jurisdictions. GDOT is supporting deployment of additional cameras and detection, such as BlueToad, on these routes.

Cost N/A

Public Benefits Ongoing evaluation of existing projects has helped improve service and has specifically led to changes in service patrol schedules and on-scene policies. An annual performance-measure report is used to help improve operational performance and identify program needs. The program generally has helped to address congestion needs, in light of a recent referendum failure that will severely limit capital improvements.

Contact Mark Demidovich, Georgia DOT

LAS VEGAS FREEWAY AND ARTERIAL SYSTEM OF TRANSPORTATION (FAST)

Using Archived Data to Plan for Operations

Problem Determining locations to implement specific operations applications on the freeway system. Providing justification (for operations activities) that is used in contract negotiations with Nevada Department of Transportation (DOT).

Solution The Freeway and Arterial Systems of Transportation (FAST) Division of the Regional Transportation Commission (RTC) of Southern Nevada collects and uses real-time traffic data to identify locations of bottlenecks and conducts analysis using that data to evaluate and select projects that address the problems.

Project Description

- The FAST operations staff, which manages the freeway system in the Las Vegas region under contract with Nevada DOT, collects all freeway detector data for major portions of the regional freeway network. Travel speed, travel time reliability, and level of congestion, along with incident data, are basic operations data collected and used.

- The FAST operations staff has created analysis tools and visualization techniques that enable traffic engineers to identify bottlenecks and problem areas and to evaluate proposed solutions.

Results

- The FAST operations staff has implemented several mainline and ramp lane drop striping configurations to reduce location-specific congestion.

- The FAST operations staff has implemented ramp metering on sections of I-15, I-515, and U.S.-95. The staff has continuously tweaked the ramp meter signal timing to improve both mainline and ramp traffic flow.

- The FAST staff plans to use the data and tools to evaluate future operations activities such as variable speed limits, hard shoulder running, and other active traffic management techniques.

- The FAST staff has been able to show the Nevada DOT that their activities have improved traffic congestion and that FAST has been able to maintain its operating budget.

Cost The cost of the operations planning efforts is conducted within the existing budget and did not cause a need for additional staff or program funds.

Public Benefits The implementation of operations projects has provided low-cost benefits to traffic congestion in the Las Vegas region.

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http://bugatti.nvfast.org/Default.aspx

Summary of Findings

STRATEGIES

The strategies identified for operations planning vary significantly but fall into several identifiable categories. In most cases, planning activities are undertaken on a case-by-case basis, including ramp metering, advanced traffic management systems, arterial signal corridor management, freeway managed lanes, variable speed limits, and ITS system expansion. The case studies presented from Florida, Kansas City, and Georgia involved use of a methodology that was either developed specifically for the proposed strategy or one-time use of an existing tool (IDAS) for planning and analysis.

Michigan and Wisconsin, on the other hand, are examples of a statewide planning approach. Wisconsin's is corridor-based and followed the development of a Corridors of Significance program that was originally developed as a framework for capital projects. This program was developed on a statewide basis using a customized methodology while Michigan's is regionally based and was developed from a series of regional architecture and pre-deployment planning projects. Under Wisconsin's plan there is a follow-up analysis conducted when corridor deployments go into design. Benefit-cost analysis is conducted in order to refine the proposed deployments in the statewide plan.

The case studies illustrate that techniques used for operations planning vary with the scope and nature of the strategies being considered, as well as resources available. Agencies have different philosophies about the level of effort needed at the front end. Kansas City, for example, was cautious in deployment of ramp meters and conducted extensive analysis before deployment, while Georgia deployed quickly and used actual experience to evaluate the effectiveness. The Georgia strategy is faster and higher risk and may be appropriate for that region, due to the higher level of congestion and more rapid growth.

DESIRED OUTCOMES

The case studies also included a range of desired outcomes, all of which ultimately address the goals of improved safety and mobility. Outcomes fall into two general categories: implementation of individual projects or programs and development of a general umbrella plan or strategy. Ideally, the individual strategies should be reflected in an overall plan, but in the operational area, that is often not the case. The experience of Michigan and Wisconsin demonstrates that an umbrella plan can be developed either from top down or bottom up, as long as the interests of various stakeholders are effectively represented. Case studies showed that those agencies that had identified specific proposed projects wanted to find the most effective implementation scenario and strategy. Wisconsin DOT faced more immediate problems with funding restrictions that had the potential to inhibit deployment of new systems and threaten the viability of existing systems. Michigan DOT's concern was the equitable allocation of scarce resources across a number of different needs and geographic regions. Georgia DOT and the two Florida DOT districts included in the study needed to deploy solutions quickly due to rapidly increasing congestion and, in the case of Georgia, a severe limitation on capital improvements due to a referendum defeat. Georgia DOT had a well-established and rigorous evaluation system in place that can be used to tweak improvements once they are implemented. Caltrans District 4, on the other hand, went through an elaborate planning process prior to implementation. The process involved extensive data collection and the use of a variety of technical tools.

CONDITIONS AND CONTEXT

Conditions and context of the case studies also fell into two distinct categories. Several were a response to rapidly increasing congestion in specific locations or in a general area. In other cases, the conditions and context were political in nature, generally involving funding and/or decision-maker support of the overall program. Examples of this context are Kansas City Scout's benefit-cost analysis of system expansion and WisDOT's statewide plan; they were effective responses that addressed the problem.

WHAT AND WHERE TO IMPLEMENT?

Strategies ranged from those covering individual facilities to corridors to statewide programs. In several of the case studies, corridors were already defined by other planning efforts. Examples are the Regional Express Lane Network in Florida District 6, the arterial network in Florida District 4, the CSMP corridors in California, and the Corridors of Significance in Wisconsin. In some cases, the operations analysis recommended changes in the location of deployments, while in others, such as Wisconsin, the locations are fixed, based on other efforts. Time frames for implementation are generally short term, although projects such as the Regional Express Lane Network, the CSMP program, and the full Wisconsin ITS plan are longer term. In all cases, however, there are specific pieces of the implementation plan that will be put into place over the next few years. Long-term plans for operations and ITS strategies need to account for ongoing changes in technologies and services and thus may be less specific about the nature of deployments.

4.0 Critical Guidance Needs and Recommended Actions

TOOLS AND GUIDANCE

The case studies indicated the use of a number of existing planning operational planning tools such as the FHWA benefit-cost database, IDAS, and simulation models, as well as increasing use of real-time archived operational data for analysis of new or expanded projects. Development of regional architectures is a requirement for federal funding that allows agencies to obtain stakeholder input and establish linkages between various projects. It is not, however, an analytical tool that can be used to evaluate, refine, or prioritize projects, and there is no federal requirement in this area. Agencies indicated a need for overall guidance on how to approach the operations planning process on a high level and how to select the proper tools for specific analyses. FHWA has done extensive training in the latter area, but the overall planning guide is a need that has not been addressed. Depending on the specific context and conditions, agencies may wish to develop their own methodology and use datasets unique to their agency, as Wisconsin did. Georgia DOT's experience with ramp metering shows that real-time operational data can be used effectively to evaluate deployments and refine operational strategies. Extensive deployment prior to a feasibility assessment, however, carries a high level of risk that may not be acceptable to most agencies.

Recently, tools have become available that should help agencies in deployment planning. SHRP 2 Project L05 (the *Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes* report is in publication at the date of this document) summarized the available tools for doing deployment planning, and also developed its own sketch-planning method for doing benefit-cost analyses, including reliability costs. SHRP 2 Project L08 (Incorporating Travel Time Reliability into the *Highway Capacity Manual*) developed an analytic procedure for predicting reliability at the project level. SHRP 2 Project C11 (Development of Improved Economic Analysis Tools) extended the L05 benefit-cost methodology and developed a tool based on it; this tool is currently being tested by agencies under SHRP 2 Project L38. Finally, the recent FHWA publication, *Operations Benefit/Cost Analysis Desk Reference,* provides a detailed methodology for conducting benefit-cost analysis, as well as the TOPS-BC software. All of these tools are spreadsheet based, so user requirements are held to a minimum. The publication can be found at http://ops.fhwa.dot.gov/publications/fhwahop12028/index.htm

INSTITUTIONAL ISSUES

One of the major challenges in operations planning for many agencies is the alignment of their process with organizational structures that are oriented toward planning of capital projects. Since many capital projects require a long time horizon to implement, the planning, project development, and design functions are generally well aligned with each other. The steps between these stages are well defined, and there are strong linkages that enable projects to be passed efficiently from one group to another.

Operations departments have generally been more isolated from capital projects, focusing originally on traffic signal operations and expanding in more recent years to freeway management, ITS deployment, and emergency operations. Deployment of ITS through the 1990s and early 2000s was accomplished largely with dedicated funds from the federal ITS program. The planning, design, and deployment generally took place within TSM&O, with some required coordination with design and construction. While the projects may have been incorporated into the TIP or STIP, little interaction with traditional planning departments took place. More recently, federal, state, and local agencies have focused on mainstreaming operations and ITS into agency planning and project development. This comes at a time when many of the originally deployed systems are at or beyond their useful life and in need of replacement. The interactions between TSM&O and other departments have increased due to these factors and others, including

- With greater flexibility in the use of federal funds, agencies are using a wider range of sources to fund operations and TSM&O projects.
- In order to access a wider range of funding sources, operations departments need to justify the benefits of larger operational projects such as transportation management centers and extensive TSM&O deployments. FHWA and some state agencies have been developing tools to do this.
- Many agencies are incorporating TSM&O projects in roadway capital projects. Replacing or installing ITS infrastructure can be accomplished more efficiently and at lower cost if done during a capital construction project. The downside of this approach is that replacement

may occur in piecemeal fashion, leading to incompatible technologies and communication difficulties.

- With fewer large roadway expansion projects being funded, there has been a shift within DOTs to lower-cost operational strategies. Personnel in many states are shifting from capital project design and construction to operations, picking up new skill sets in the process.

- Increasing congestion has led to greater restriction on work zone activity, resulting in increased costs, lengthened schedules, and further delays to the traveling public. This has spawned greater interest in ITS technologies and operational strategies that can improve work zone management.

Training has been offered by FHWA, TRB, and other organizations on the technical aspects of operations, including regional ITS architectures, technical tools for operations planning, standards, and technology. While technical transfer of knowledge is critical to success, greater impediments are often institutional. Capital projects have the advantage of “ribbon-cutting,” in which the public and decision makers can see a physical product. The impacts of operational improvements are more subtle and are often more difficult to measure. The ability to advance these projects depends on the ability to forecast and measure impacts and coordinate these efforts with other departments within the organization. Some recommendations for addressing institutional issues include

- Cross-train planning department personnel so they are familiar with issues and technical tools particular to operations planning.

- Develop a multiyear TSM&O/ITS plan that is compatible with STIP and/or TIPS and uses similar data for prioritization methodology.

- Develop a “toolbox” document that relates TSM&O/ITS solutions to specific transportation system problems.

- Make sure that operations personnel participate in project selection and prioritization processes.

- Transfer technical knowledge on design and implementation of TSM&O projects to design and construction departments through training/seminars or assignment of operations personnel to these departments.

- Take a more holistic approach to project planning. One of the easiest ways of ensuring that operations is more tightly integrated with existing planning and programming processes is to ensure that operations strategies are included in the toolbox when projects are undertaken, especially at the planning and preliminary engineering levels. This consideration does not mean that TSM&O should be considered separately from other types of improvements (e.g., capacity expansion, demand management, transit service) but rather in concert with them. Likewise, when operations personnel are considering system expansion (e.g., extending ramp meter coverage or incident management services), they should also consider other strategies. In particular, the correction of small capacity/bottleneck deficiencies at the same time that operations strategies are implemented can yield big benefits.

While planning is the focus of this discussion, a guidance document that includes information on promoting institutional coordination would be helpful to agencies for several reasons:

- There is no established methodology for operational planning. Some agencies use existing tools while others develop their own. Methodologies vary greatly, depending on the scope of the deployment and the reasons why the planning effort is being conducted. The current set of tools available from FHWA and other sources is helpful to agencies in addressing specific problems and deployments. There is a need, however, for higher-level guidance, particularly on how to develop a high-level plan that addresses a set of goals and objectives.

- Reasons for conducting operations planning vary and include a need to assess the feasibility of specific projects or programs, a need to advocate for funding, and a need to allocate scarce resources to different projects or geographic regions. The purpose of the planning effort and the intended audience should help define the level and type of analysis, as well as the format of the outputs.

A high-level document would not necessarily prescribe a single methodology but would provide checklists on the items that need to be covered, steps required to reach the intended outcome, and a comprehensive guide to operational planning tools. A sample outline of such a document is provided below.

OUTLINE FOR THE MORE DETAILED GUIDANCE DOCUMENT

The proposed guidance document identified at the end of Section 4.0 is designed to help agency personnel implement and carry out a planning process for operational and ITS projects. As noted above, a number of other guidebooks are available that focus on technical analysis techniques and tools. This document will cover those areas but focus more heavily on strategy selection and definition, incorporating TSM&O into the planning process and addressing institutional issues that inhibit TSM&O.

1. Introduction
    - 1.1. Why TSM&O planning?
    - 1.2. Purpose and summary of document
2. TSM&O Resources
    - 2.1. Description of Operations/ITS Assets
        - 2.1.1. Freeway management systems
        - 2.1.2. Arterial signal control systems
        - 2.1.3. Work zone/temporary monitoring surveillance systems
        - 2.1.4. Road Weather Information Systems (RWIS)
        - 2.1.5. Transportation Management Centers (TMC)
    - 2.2. Description of TSM&O Activities and Strategies (see Section 2 for more detailed breakdown)
        - 2.2.1. Incident management
        - 2.2.2. Ramp metering
        - 2.2.3. Coordinated signal systems
        - 2.2.4. Monitoring and surveillance
        - 2.2.5. Emergency management
        - 2.2.6. Road weather management
        - 2.2.7. Active traffic management/lane management
    - 2.3. Matrix matching problems to TSM&O solutions (see Table 3.1 for sample matrix)
        - 2.3.1. Criteria for selecting potential solutions
        - 2.3.2. Measurement of impacts and effectiveness

2.3.2.1. Summary of analytical tools

3. Best Practices in TSM&O Planning
   3.1. State of the practice
      3.1.1. Scan Results
      3.1.2. Case studies
   3.2. Lessons learned
   3.3. Organizational/Institutional
      3.3.1. Incorporating TSM&O into TIP/STIP process
      3.3.2. Developing a TSM&O plan
      3.3.3. Mainstreaming TSM&O funding
         3.3.3.1. Project development
         3.3.3.2. Construction
         3.3.3.3. Operations and maintenance
      3.3.4. Program sustainability
      3.3.5. Outreach/raising awareness
4. Plan Development Guidance
   4.1. Document current system status
      4.1.1. Assets
      4.1.2. Activities
      4.1.3. Equipment/system life cycle
      4.1.4. Technologies
   4.2. Needs assessment
      4.2.1. System replacement needs
      4.2.2. Transportation system needs
         4.2.2.1. Congestion relief
         4.2.2.2. Safety
         4.2.2.3. Mobility improvements
         4.2.2.4. Environmental
      4.2.3. Defining potential TSM&O solutions
      4.2.4. Analytical tools and analysis techniques
         4.2.4.1. Summary of relevant guidance documents
         4.2.4.2. Best practice examples

4.2.4.3. Matrix of analytical tools/techniques and proposed solutions

4.3. Cost analysis

4.3.1. Replacement/life-cycle costs

4.3.2. System expansion costs

4.3.3. Integration with capital projects

4.3.4. Evaluating cost of new technologies/change management

4.4. Plan presentation

4.4.1. Plan summary

4.4.2. Integration with TIP/STIP

4.4.3. Public/decision-maker outreach materials

5. Document summary

IMPLEMENTATION of RESULTS

The existence of a formal guidance document would greatly facilitate implementation, but even without it, the results of this gap-filling project should be woven into the SHRP 2 implementation program. Because the topic of this project (short-term deployment planning) is closely related to the topic of gap-filling project #3 (*Best Practices for TSM&O Program and Budget Development*), it is recommended that the two projects be bundled together for implementation purposes. Both projects are based on examining current practices, so the best medium for implementation would be to establish a peer-to-peer program. Under this program, an agency would identify the practices of another agency it wishes to emulate and would either visit that agency or have representatives for that agency visit theirs.

This area is expected to evolve as agencies begin to incorporate deployment planning and budgeting into existing planning and programming practices. A periodic review of practice should be undertaken to ensure that best practices are up to date. This report provides the framework for efficiently conducting these reviews; the topics in Table 3.1 provide a basis for the reviews.