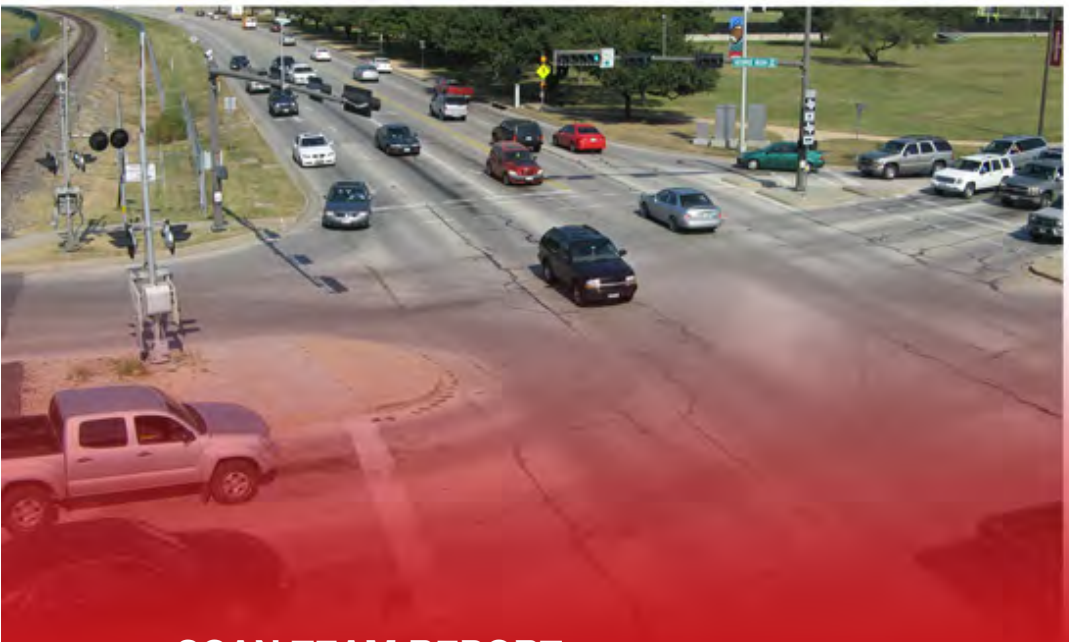


SCAN TEAM REPORT

NCHRP Project 20-68A, Scan 07-04

Best Practices In Regional, Multiagency Traffic Signal Operations Management

Supported by the

National Cooperative Highway Research Program


PROTECTED
LEFT ON
GREEN ARROW

Acknowledgments

The work described in this document was conducted as part of NCHRP Project 20-68A, the U.S. Domestic Scan program. This program was requested by the American Association of State Highway and Transportation Officials (AASHTO), with funding provided through the National Cooperative Highway Research Program (NCHRP). The NCHRP is supported by annual voluntary contributions from the state departments of transportation. Additional support for selected scans is provided by the U.S. Federal Highway Administration and other agencies.

The purpose of each scan and of Project 20-68A as a whole is to accelerate beneficial innovation by facilitating information sharing and technology exchange among the states and other transportation agencies, and identifying actionable items of common interest. Experience has shown that personal contact with new ideas and their application is a particularly valuable means for such sharing and exchange. A scan entails peer-to-peer discussions between practitioners who have implemented new practices and others who are able to disseminate knowledge of these new practices and their possible benefits to a broad audience of other users. Each scan addresses a single technical topic selected by AASHTO and the NCHRP 20-68A Project Panel. Further information on the NCHRP 20-68A U.S. Domestic Scan program is available at http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1570.

This report was prepared by the scan team for Scan 07-04, *Best Practices in Regional, Multiagency Traffic Signal Operations Management*, whose members are listed below. Scan planning and logistics are managed by Arora and Associates, P.C.; Harry Capers is the Principal Investigator. NCHRP Project 20-68A is guided by a technical project panel and managed by Andrew C. Lemer, Ph.D., NCHRP Senior Program Officer.

Brent Jennings, Idaho DOT, AASHTO Chair

Gene (Yancy) Bachmann, Georgia DOT

Eddie Curtis, FHWA Resource Center

Steve Misgen, Minnesota DOT

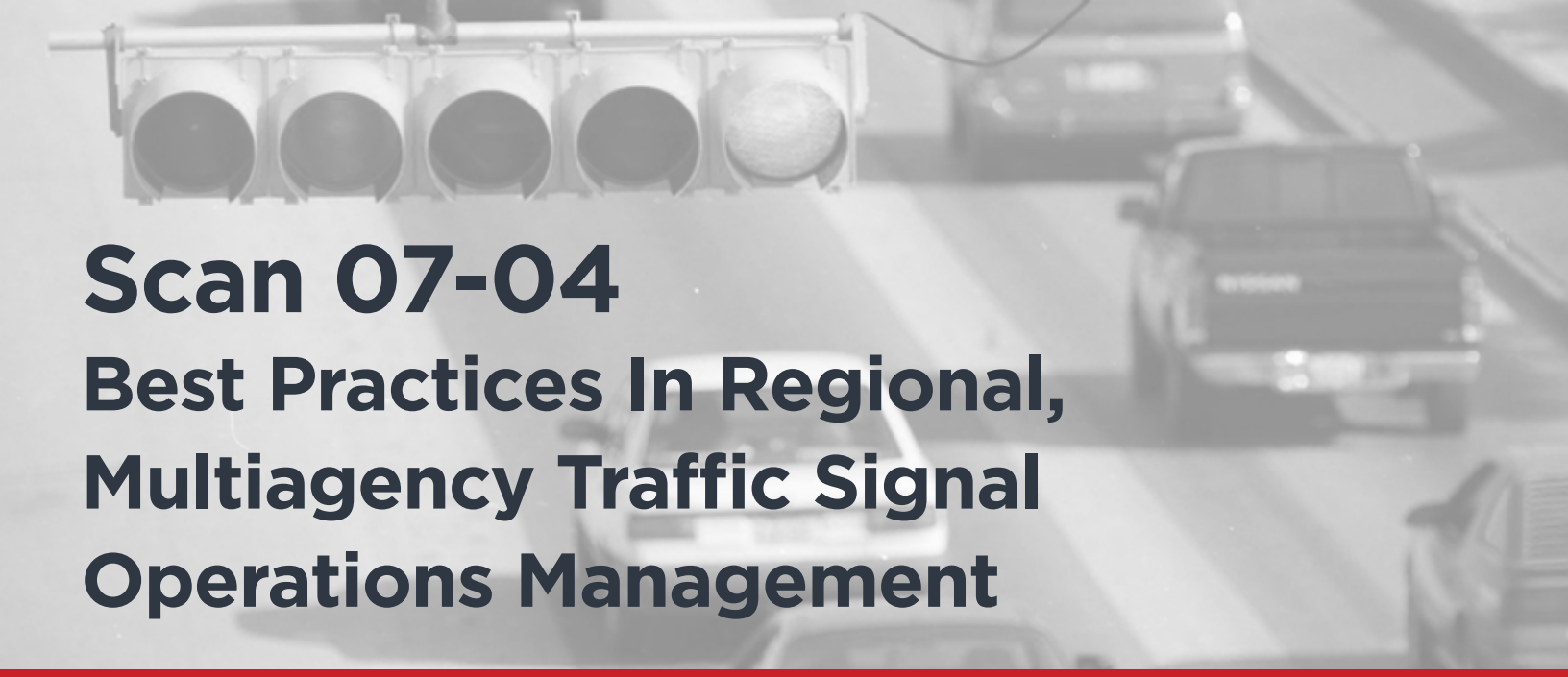
Vanloan Nguyen, Virginia DOT

Jacob B Renick, Mississippi DOT

Kevin N. Balke, Texas Transportation Institute, Subject Matter Expert

Disclaimer

The information in this document was taken directly from the submission of the authors. The opinions and conclusions expressed or implied are those of the scan team and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors. This document has not been edited by the Transportation Research Board.



Scan 07-04

Best Practices In Regional, Multiagency Traffic Signal Operations Management

REQUESTED BY THE

American Association of State Highway and Transportation Officials

PREPARED BY

Brent Jennings,
Idaho DOT, AASHTO Chair

Gene (Yancy) Bachmann,
Georgia DOT

Eddie Curtis,
FHWA Resource Center

Steve Misgen,
Minnesota DOT

Vanloan Nguyen,
Virginia DOT

Jacob B Renick,
Mississippi DOT

Kevin N. Balke,
Texas Transportation Institute, Subject Matter Expert

SCAN MANAGEMENT

Arora and Associates, P.C.
Lawrenceville, NJ

March 2013

TABLE OF CONTENTS

Table of Contents

List of Appendices

List of Figures

List of Tables

Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AMPO	Association of Metropolitan Planning Organizations
CMAQ	Congestion Mitigation/Air Quality
CSPI	Corridor Synchronization Performance Index (Orange County, California)
DRCOG	Denver Regional Council of Governments
GDOT	Georgia Department of Transportation
FAST	Freeway and Arterial System of Transportation (Las Vegas, Nevada)
FAST-TRAC	Faster and Safer Travel Through Routing and Advanced Controls (Oakland County/Southeast Michigan)
GPS	Global Positioning System
IMSA	International Municipal Signal Association
IT	Information Technology
ITS	Intelligent Transportation Systems
LACMTA	Los Angeles County Metropolitan Transportation Authority (aka Metro)
LVCTS	Las Vegas Computerized Traffic System
MAG	Maricopa Association of Governments (Phoenix, Arizona)
MARC	Mid-America Regional Council (Kansas City, Kansas/Missouri)
Metro	Metropolitan Transportation Authority (Los Angeles County)(aka LACMTA)
Metro COG	Fargo-Moorhead Metropolitan Council of Governments
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission (San Francisco Bay Area)
NCTCOG	North Central Texas Council of Governments
NTOC	National Transportation Operations Coalition
NDOT	Nevada Department of Transportation
NTCIP	National Transportation Communications for ITS Protocol
O&M	Operation and Maintenance
OCTA	Orange County Transportation Authority
OGL	Operation Green Light (Kansas City, Kansas/Missouri)
PAG	Pima Association of Governments
PASS	Program for Arterial System Synchronization (San Francisco Bay Area)
PSRC	Puget Sound Regional Council
RCOC	Road Commission for Oakland County
RCTO	Regional Concept of Traffic Operations (Puget Sound, Washington)
ROW	Right-of-Way

RTA	Regional Transportation Authority (Pima County, Arizona)
RTOP	Regional Traffic Operations Program (Atlanta, Georgia)
RTSOP	Regional Traffic Signal Operations Program
RTC	Regional Transportation Commission (of Southern Nevada)
RTOC	Regional Traffic Operations Center (Tucson, Arizona)
SEMCOG	Southeast Michigan Council of Governments
SINC	Signals in Coordination (Southwestern Pennsylvania)
SINC-UP	Signals in Coordination with Equipment Upgrades (Southwestern Pennsylvania)
SPC	Southwestern Pennsylvania Commission
SS&BSIP	Signal Synchronization and Bus Speed Improvements Program (Los Angeles, California)
STP	Surface Transportation Program
TIP	Transportation Improvement Program
TMC	Traffic Management Center
TSOP	Traffic Signal Optimization Program (Phoenix, Arizona)
TSSIP	Traffic Signal System Improvement Program
TSSP	Traffic Signal Synchronization Program
UDOT	Utah Department of Transportation

Executive Summary

This report summarizes the findings from a scan workshop of domestic regional traffic signal operations programs in the United States. The scan's purpose was to examine the different types of organizational structures, institutional agreements and arrangements, and operational policies that organizations throughout the United States use to manage and operate traffic signal systems from a regional perspective. Representatives from 17 different agencies met with the scan team in a peer exchange format over a three-day period to discuss how their agencies developed and sustain their regional traffic signal programs. Specifically, agencies were asked to discuss the following:

- The type and structure of any cooperative agreements that they use in their region to foster and enable communication and coordination among local signal operating authorities
- The benefits and risks associated with regionalizing traffic signal operations and maintenance in their jurisdictions
- The extent to which they use concepts like resource sharing and shared operations and maintenance to help improve the consistency of traffic signal system operations and performance in their region
- The certification and training needs of operations and maintenance staff involved in the effort
- The funding mechanisms implemented in their region to sustain regional traffic signal operations and the methods they use to contribute to management operations and maintenance expenses
- The strategies they use to overcome technical challenges to ensure the effective coordination of traffic signal timing across multiple jurisdictions

The scan team found that the goals and objectives of regional traffic signal operations programs vary considerably from region to region and reflect the needs and priorities of the local operating agencies. The manner in which programs are funded often drove how the agencies defined their goals and objectives. For example, agencies that have access to congestion mitigation/air quality funds often have program goals and objectives that are directed toward improving air quality and reducing emissions. Programs that utilize other sources of funding often have a more diverse set of program goals and objectives.

Many of the regional traffic signal operation programs (RTSOPs) that the scan team reviewed use multiple types of agreements. The type of agreement is highly dependent on the program's goals and functions.

- Program-level agreements (e.g., a memorandum of understanding or a memorandum of

agreement) are used to clarify the program's big picture intent, defining a vision and goals for the program and dealing more with organizational structure. These types of arrangements and agreements define the program's formal organizational structure.

- Program-level agreements (e.g., local partnership agreements, cooperative agreements, and cost-sharing agreements) are more likely to be used when regional partners are considering consolidating operations into a single entity.

- Project agreements, which also may be referred to as interlocal agreements, interagency agreements, or interjurisdictional agreements, are frequently used in RTSOPs to initiate a specific improvement project within a program (as opposed to being the program itself). Generally, these types of agreements are legally binding and are used when funds need to be exchanged between the agency responsible for distributing the funds (i.e., the RTSOP entity) and the agency responsible for performing the work (i.e., the local entity).

The team observed a variety of organizational structures during the workshop. Organizing the program into a structure that meets the agencies' needs and the region's objectives is of the utmost importance. It is possible for agencies to develop successful programs that distribute the authority for operating and developing regional traffic signal operations between various levels. In identifying the best structure for a program in a particular area, agencies should begin by conducting an inventory of assets, capabilities, and resources available within the region and structure the program around the strengths of these assets, capabilities, and resources.

The scan team also found that most of the programs use multiple sources of funds to develop and sustain their programs. Most of the agencies the team examined use the Congestion Mitigation and Air Quality (CMAQ) program as the primary source of funding for their programs; however, several of the agencies use Surface Transportation Program funds to fund all or a portion of their programs. Several locations, particularly those on the West Coast, indicated that they fund their programs through special tax revenues specifically earmarked for transportation operations and maintenance. Generally, the region's metropolitan planning organization or council of governments manages and implements these programs.

Agencies provided the scan team insight into the way their regional transportation signal operations program functions within their region and with respect to their local partners. The manner in which the programs operate varies considerably among the participants. While all of the programs focus on developing and installing interjurisdictional coordination timing plans, not all the programs actually operate the signals once the timings are installed. In some programs, the regional entities are responsible for just developing the timing plans. In other programs, the regional entity might also develop and implement timing plans. In other programs, the regional entity assumes the responsibility of installing, deploying, and maintaining the regional communications infrastructure. Only a few regions are responsible for performing real-time monitoring and signal timing adjustments functions.

The scan team also found that demonstrating the benefits of the programs is critical for sustaining the programs over time. Most of the agencies at the workshop reported that they often use performance measures to report the benefits achieved through individual projects. Providing programmatic assessments of the long-range benefits of regional traffic signal operations was also deemed critical to these programs. The type of performance measures the programs use to assess performance was directly related to the type of funding being used to make improvements. Having clear, definable performance measures allows agencies to market programs to decision makers, and marketing the successes of these programs is critical to being able to sustain and grow them.

CHAPTER 1

Introduction

Sustaining effective traffic signal coordination, both within and across jurisdictional boundaries, has proven to be a daunting task for an increasing number of transportation agencies responsible for managing and operating traffic signal systems. An increasing number of agencies are realizing that a regional approach to managing and operating traffic signal systems may be a viable alternative to independently sustaining the funding and technical expertise essential to effectively managing a traffic signal program. Interestingly, the challenges to regional traffic signal operations are typically not technical, but rather institutional.

Cross-jurisdictional traffic signal coordination provides substantial benefits to the road user by establishing consistent signal operations across a region, as well as making the typical reductions in travel times, stops, fuel consumption, emissions, and delays. Transportation agencies responsible for managing and operating traffic signals can benefit from a regionalized approach to traffic signal management by pooling resources to provide ongoing staff training, development of signal timing plans, operations, and performance of maintenance activities.

The purpose of the scan was to examine the different types of organizational structures, institutional agreements and arrangements, and operational policies that organizations use throughout the United States to manage and operate traffic signal systems from a regional perspective. The scan specifically examined the interactions of local, regional, and state agencies to develop, operate, and sustain RTSOPs. The specific objectives of the scan were to:

- Examine the components of cooperative agreements that foster and enable regional traffic signal coordination and management
- Examine if and how the regionalization of traffic signal coordination reduces travel times, stops, and delays on arterials that traverse multiple jurisdictions
- Examine how the concept of regional traffic signal management and operations allows resource sharing and consistent operations of traffic signals
- Examine the certification and training needs of operations and maintenance staff involved in the effort
- Explore the funding mechanisms in place to sustain regional traffic signal operations and how participating agencies contribute to management operations and maintenance expenses
- Identify technical challenges to overcome and strategies to ensure the effective coordination of traffic signal timing across multiple jurisdictions

Scan Format

The scan team used a reverse scan to collect this information. Rather than traveling to different locations around the country, the scan team met with representatives from the participating agencies in one location, where the agencies presented information about their respective systems in a workshop format. This format allowed the scan team to collect information from more sites than would have been possible in a normal scan, with the additional advantage of allowing participating agencies to participate in a peer-to-peer exchange about regional traffic signal operations. The reverse-scan format proved to be highly conducive to sharing information between agencies.

Scan Team

Brent Jennings, the State Highway Operations and Safety Engineer of the Idaho Transportation Department led the scan team and served as the scan team's AASHTO Chair. Other members of the scan team included:

- Steve Misgen, Traffic Engineer Metro District, Minnesota DOT
- Jacob Renick, Traffic Signal Engineer, Mississippi DOT
- Yancy Bachmann, Assistant State Traffic Engineer, Field Operations, Georgia DOT
- Vanload Nguyen, Assistant State Traffic Engineer, Traffic Engineering Division, Virginia DOT
- Eddie Curtis, Traffic Management Specialist, Federal Highway Administration (FHWA) Office of Operations and Resource Center

Kevin Balke of the Texas A&M Transportation Institute served as the subject matter expert for the scan team. The role of the subject matter expert is to help the scan team identify systems and programs to scan and facilitate the preparation of the reports documenting the scan's findings. Harry Capers and Melissa Jiang of Arora & Associates, P.C., provided administration, scan organization, and travel support for both the scan team and the workshop participants.

Scan team contact information is provided in Appendix A, and the team members' biographical sketches are provided in Appendix B.

Workshop Participants

Twenty-one individuals representing 17 regional traffic signal operations programs participated in the scan. These programs provided a sample of state and local regional traffic signal operations in terms of program size, responsible agency, and maturity. The individuals who participated in the workshop included:

- Brian Hoeft, Assistant Director, Regional Transportation Commission of Southern Nevada (RTC-FAST), Las Vegas, NV
- Ray Webb, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, Kansas City, MO
- Jane White, Senior Civil Engineer, Los Angeles County Department of Public Works, Alhambra, CA
- Marty Amundson, Senior Civil Engineer, Los Angeles County Department of Public Works, Alhambra, CA
- Steve Gota, Project Manager, Los Angeles County Metropolitan Transportation Authority (LACMTA), Los Angeles, CA
- Danielle Deneau, Signal Systems Engineer, Road Commission for Oakland County, Pontiac, MI
- Thomas Bruff, Manager, Transportation Programs, Southeast Michigan Council of Governments (SEMCOG)
- Paul Casertano, Transportation Safety and Operations Lean, Pima Association of Governments (PAG), Tucson, AZ
- Mark Taylor, Signal Systems Engineer, Utah DOT (UDOT), Salt Lake City, UT
- Greg MacKinnon, Transportation Operations Program Manager, Denver Regional Council of Governments (DRCOG), Denver, CO
- Domenic D'Andrea, Transportation Planner, Coordinator, Regional Traffic Signal Projects, Southwestern Pennsylvania Commission (SPC), Pittsburgh, PA
- Natalie Bettger, Senior Program Manager, North Central Texas Council of Governments (NCTCOG), Arlington TX
- Danielle Stanislaus, Senior Planner & Program Manager, Freeway Performance Initiative & Arterial Operations Program, Metropolitan Transportation Commission (MTC), Oakland, CA
- Vamsi Tabjulu, Arterial Operations Program Manager, Metropolitan Transportation Commission (MTC), Oakland, CA
- Sarath Joshua, Intelligent Transportation Systems (ITS) & Safety Program Manager, Maricopa Association of Governments (MAG), Phoenix, AZ

- Ronald Keith, Principal Traffic Engineer, Orange County Transportation Authority (OCTA), Orange, CA
- Anup Kulkami, Section Manager, Orange County Transportation Authority (OCTA), Orange, CA
- Stephanie Rossi, Principal Planner, Puget Sound Regional Council (PSRC), Seattle, WA
- Grant Waldrop, Atlanta Regional Traffic Operations Program Manager, Georgia DOT, Atlanta, GA
- Shahram Malek, Associate Vice President, ARCADIS US. Inc., Atlanta GA
- Wade Kline, Executive Director, Fargo-Moorhead Metro Council of Government, Fargo, ND

Participating agency key contact information is provided in Appendix C.

Workshop Format

Prior to the scan, a list of amplifying questions was sent to each participating agency so that the participants could prepare for the workshop. These questions are provided in Appendix D.

The scan workshop consisted of peer-to-peer exchange in the form of eight sessions spread over three days. In each session, representatives from two to three different state, regional, and local traffic signal operations programs made a formal, 30- to 40-minute presentation about their programs. This was followed by approximately 45 minutes of questions, answers, and discussion by both the scan team and the workshop participants.

An open discussion was held during the last day in which all the participants were engaged in developing a list of significant conclusions and findings from the scan. The scan team also engaged the workshop participants to solicit input in developing the scan's implementation and dissemination plan.

Report Organization

This report is organized into the following chapters:

- Chapter 1.0 describes scan's purpose and objectives and provides information about the scan team's members and the workshop participants.
- Chapter 2.0 provides a brief overview of the various agencies and programs examined during the scan.

- Chapter 3.0 examines the reasons why these agencies developed regional traffic signal operations and what they were hoping to accomplish through their programs.
- Chapter 4.0 provides a summary of the different types of institutional arrangements and agreements common to these programs.
- Chapter 5.0 discusses the different types of structure and governances associated with these programs.
- Chapter 6.0 describes the different types of mechanisms used to fund these programs.
- Chapter 7.0 presents topics related to operations, and maintenance.
- Chapter 8.0 discusses methods and techniques the various programs use to measure and report performance.
- Chapter 9.0 provides information on the strategies and techniques the agencies use to sustain and expand their programs.
- Chapter 10.0 provides a summary of the scan's key findings.
- Chapter 11.0 lists implementation activities to promote the scan's findings and advance its recommendations.

CHAPTER 2

Overview of Programs

This section provides a brief summary of the programs reviewed as part of this scan. The programs provide a good cross-section of the types of RTSOPs that exist in the United States.

Atlanta, Georgia

In the greater Atlanta area, the Georgia DOT (GDOT) is in the process of developing a regional traffic operations program (RTOP)[1,2,3]. The program's purpose is to increase travel throughput by minimizing congestion and reducing delays along regional commuter corridors through improved signal operations. In addition to focusing on actively managing traffic flow in major multijurisdictional arterials, the program is also intended to address traffic signal maintenance and repair issues that have developed in some of the major commuting corridors.

The program's vision is to actively improve the traffic signal systems by[4]:

- Providing preventive and routing traffic signal maintenance
- Improving communications to traffic signals
- Installing surveillance at key locations in corridors of regional significance
- Actively monitoring travel time and system performance during peak travel demand periods in these corridors
- Actively performing signal timing adjustments to match travel demands in the corridors
- Rapidly repairing and/or replacing malfunctioning equipment
- Providing transit and emergency vehicle preemption

GDOT is using a consultant team to augment agency staff to make repairs and operate the system. So far, the agency and its consultant team have been coordinating with local agencies to address outstanding maintenance needs in the corridor (e.g., repairing or replacing malfunctioning vehicle

1 Demidovich M, PE, Assistant State Traffic Engineer. Regional Traffic Operations Program, ITS Transpo, 2010, http://www.itstranspo.org/Mark%20Demidovich%20-%20Regional%20Traffic%20Ops_Transpo2.pdf

2 Waldrop G, Atlanta Regional Traffic Operaitons Program Manager, Georgia DOT, 2011

3 Georgia DOT, Regional Transportation Operations Program Concept of Operation. Regional Transportation Operations Program, cited May 18, 2011, http://www.dot.ga.gov/travelingingeorgia/trafficcontrol/Pages/Operations.aspx

4 Georgia DOT, Regional Transportation Operations Program Concept of Operation. Regional Transportation Operations Program, cited May 18, 2011, http://www.dot.ga.gov/travelingingeorgia/trafficcontrol/Pages/Operations.aspx

and pedestrian detection systems and addressing communications needs) and provide more than 500 offset/split adjustments and 50 time clock adjustments. GDOT has also been working with its local partners to draft and adopt a memorandum of understanding (MOU) between the local partners to formalize the program.

Denver, Colorado

The Denver Regional Council of Governments (DRCOG) is responsible for administering the regional traffic signal system improvement program (TSSIP) for the DRCOG Transportation Management Area[5,6]. The area has more than 3,800 traffic signals operating in 40 different jurisdictions.

Initiated in 1994, the TSSIP's goal is to reduce travel times and vehicle emissions by implementing cost-effective traffic signal improvements and coordination timings. When the program was first developed, the primary emphasis was on providing interjurisdictional coordination through such techniques as deploying a common cycle length, replacing unreliable equipment and controllers, and installing detection and monitoring systems for assessing demands. As it exists today, the TSSIP consists of two primary elements[7]:

- A capital improvement program designed to both
  - Raise the base functionality of the traffic signal equipment in the region to a specified standard
  - Provide communications linkages to traffic signals in high-traffic volume corridors
- A traffic signal improvement program that provides new and/or updated traffic signal timing and coordination plans every three to five years

Most of the capital projects focus on installing communication systems to support interconnection[8]. Over time and as improvements have been made, the priority has changed from upgrading the basic functionality of traffic signal equipment at critical intersections to deploying reliable communications systems to support the interconnection of traffic signals and other intelligent transportation systems (ITS). Between 2007 and 2010, the program assisted 22 operating agencies in 39 capital improvement projects by implementing new traffic signal control systems or extending and/or upgrading system communications to enhance traffic signal operations at key intersections. Furthermore, over the same period, the program completed 15 additional timing and coordination projects that were unrelated to capital projects, including one traffic-responsive control project[9].

5 Denver Regional Council of Governments, Traffic Signal Program, Transportation, Denver Regional Council of Governments, http://www.drcog.org/index.cfm?page=TrafficSignalProgram

6 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010

7 Denver Regional Council of Governments, Traffic Signal System Improvement Program, 2010 Update, Traffic Signal Program, August 2010, cited May 18, 2011, https://www.drcog.org/index.cfm?page=TrafficSignalProgram

8 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010

9 Denver Regional Council of Governments, Traffic Signal Program, Transportation, Denver Regional Council of Governments, http://www.drcog.org/index.cfm?page=TrafficSignalProgram

A fundamental component of the TSSIP continues to be the development of new time-of-day, scheduled-based timing plans. The program ensures coordination across jurisdictional boundaries by having all controllers and control systems synchronized with the Coordinated Universal Time (WWV time[10]) broadcast by the National Institute of Standards and Technology in Boulder[11].

Fargo/Moorhead, North Dakota/Minnesota

The cities of Fargo, North Dakota, and Moorhead, Minnesota, are in the process of developing a regional traffic signal operations concept through the regional Fargo-Moorhead Metropolitan Council of Governments (Metro COG)[12]. Metro COG conducted a study examining the feasibility of developing a regional traffic signal system[13] and found the following limitations associated with the current transportation system in terms of operations:

- A lack of coordination on interjurisdictional corridors
- Varying levels of resources for agencies in terms of training and number of staff dedicated to traffic operations
- Different field devices (i.e., software and hardware) being used by different agencies that might hinder integration and information sharing (i.e., traffic data and traffic images)
- No established regional practices for traffic control and dealing with large-scale special events, incidents, or emergencies (e.g., flooding)

To address these operational problems, Metro COG formed a traffic operations working group to begin addressing the issues of traffic signal coordination and other operational issues[14]. This committee is composed of representatives from the following agencies:

- North Dakota DOT
- Minnesota DOT
- City of Fargo
- City of Moorhead
- City of West Fargo
- Cass County Highway Department

10 Radio station WWV, The National Institute of Standards and Technology (NIST), http://www.nist.gov/pml/div688/grp40/wwv.cfm

11 Denver Regional Council of Governments, Traffic Signal Program, Transportation, Denver Regional Council of Governments, http://www.drcog.org/index.cfm?page=TrafficSignalProgram

12 Kline W, Executive Director, Fargo-Moorhead Metropolitan Council of Governments staff, 2011

13 Fargo-Moorhead Metropolitan Council of Governments, Fargo-Moorhead Metropolitan Traffic Operations Action Plan, Intellegent Transportation Systems, 2009, cited May 18, 2011, http://www.fmmetrocog.org/new/index.php?id=359

14 Kline W, Executive Director, Fargo-Moorhead Metropolitan Council of Governments staff, 2011

- Clay County Highway Department
- Metro Area Transit
- Fargo–Moorhead Council of Governments (the regional Metropolitan Planning Organization [MPO])

One of the first steps this committee took was to develop a Fargo-Moorhead traffic operations action plan,[15] which focused on improving signal operations, developing system performance, implementing incident management, and creating a traffic operations center. The committee identified the following functions of the traffic operations center:

- Collect and share information about traffic signal timings, traffic congestion, incidents, road construction, and real-time video monitoring among the partner agencies
- Implement interjurisdictional traffic control plans that coordinate traffic signal timings on major corridors and at freeway interchanges
- Implement traffic management strategies in response to traffic incidents, including modifying traffic signal timings and coordinating incident responses
- Provide information to travelers using different media, including dynamic message signs, Internet web pages, and traditional radio and television media

One of the unique features of this region is that unlike other areas that are building their programs in a piecemeal fashion, the Fargo–Moorhead area is taking a top-down approach. The idea of conducting a demonstration project was discussed during the initial program-planning phase; however, because the geographic area is not large, the local partners decided not to focus on just one initial corridor. Instead, the regional partners decided to focus the program on providing interconnection of the various deployed signal systems. Therefore, the current emphasis on building the regional infrastructure was set at the program's outset.

Kansas City, Kansas/Missouri

Operation Green Light (OGL) is a program operated by the Mid-America Regional Council's (MARC) Transportation Department to improve the coordination of traffic signals on major routes through the Kansas City area, especially those that cross-jurisdictional boundaries[16]. Its vision statement is: *"State and local governments work together through Operation Green Light using best practices in traffic management to provide safe and efficient movement for people and goods across a seamless regional transportation system."*[17]

15 Fargo-Moorhead Metropolitan Council of Governments, Fargo-Moorhead Metropolitan Traffic Operations Action Plan, Intellegent Transportation Systems, 2009, cited May 18, 2011, http://www.fmmetrocog.org/new/index.php?id=359

16 Webb R, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, 2011

17 Mid-America Regional Council, Concept of Operations: Roles and Responsibilities, Operation Green Light, Mid-America Regional

Through funding provided by the program, MARC has been able to accomplish the following[18]:

- Improve the cooperative relationships between local agencies to permit them to operate their traffic signals from a regional perspective
- Upgrade traffic signal controllers and equipment as required to provide effective operations of traffic signals in corridors of regional significance
- Develop, install, and maintain a regional fiber optic and a licensed and unlicensed wireless communications network to monitor and share operational data of traffic signals regionally[19]
- Develop and deploy cooperatively designed regional timing plans that promote interjurisdictional, multiagency coordination of traffic signal operations
- Develop and administer agency-approved traffic signal timing strategies to be deployed during incident conditions in conjunction with incident management strategies deployed through the Kansas City Scout[20] freeway management system.

Las Vegas, Nevada

The Freeway and Arterial System of Transportation (FAST) in Las Vegas is one of the nation's first truly integrated transportation management centers (TMCs)[21,22]. A department of the Regional Transportation Commission (RTC) of Southern Nevada, FAST is both a freeway management system and an RTSOP run from the same TMC. The FAST system combines elements of the Las Vegas Metropolitan Area Arterial Traffic Management System (formerly known as the Las Vegas Computerized Traffic System [LVCTS]) and the Nevada DOT (NDOT) freeway management system.

The FAST system consists of more than 100 video surveillance cameras, 52 dynamic message signs, 29 ramp control signals, and 1200 traffic signals. FAST manages most of the traffic signals in the City of Las Vegas, the City of North Las Vegas, the City of Henderson, and Clark County—all of which, along with NDOT and RTC, are partners in FAST.

Council, cited May 18, 2011, http://www.marc.org/transportation/ogl/documents.htm

18 Mid-America Council of Governments, Mission Statement, Operation Green Light, Mid-America Council of Governments, cited May 18, 2011, http://www.marc.org/transportation/ogl/pdfs/missionstatement.pdf

19 Mid-America Regional Council, Operation Green Light Committees, Operation Green Light, Mid-America Regional Council, cited May 18, 2011, http://www.marc.org/transportation/committees/ogl.htm

20 Kansas City Scout, Missouri DOT and Kansas DOT, http://www.kcscout.net/

21 Regional Transportation Commission of Southern Nevada, Welcome to NVFAST.org! Freeway & Arterial System of Transportation, cited May 18, 2011, http://www.nvfast.org/

22 Hoeft B, Assistant Director, Regional Transportation Commission of Southern Nevada, November 2011

Los Angeles, California

The Los Angeles County Department of Public Works has been completing traffic signal synchronization program (TSSP) projects since 1988[23,24]. The program was initiated at the request of a local county politician who demanded that the regional transportation provider begin operating its systems from a regional perspective. The TSSP's goal was to identify, develop, and implement innovative, low-cost operational improvements to the network of traffic signals on the major streets throughout Los Angeles County.

The TSSP's primary functions include the following[25]:

- Provide training/certification for traffic signal technicians and operational personnel
- Provide a forum for discussing regional traffic signal operations issues
- Develop traffic signal timing plans that facilitate cross-jurisdictional traffic flow
- Provide consistency in signal timing practices between agencies
- Identify and establish priorities, corridors of significance, performance goals, and measures for the region's traffic signals

Today, the TSSP is responsible for developing coordination timing plans for more than 2000 traffic signals[26].

North Central Texas

In 2002, the North Central Texas Council of Governments (NCTCOG) launched a thoroughfare assessment program[27,28] to improve traffic flow and enhance the capacity of existing arterial systems by implementing new signal timing and low-cost operational improvements along selected corridors[29,30,31]. Under the program, local agencies can apply for funding through NCTCOG to make operational improvements, such as:

23 Los Angeles County Department of Public Works, Traffic Signal Synchroniziation Program, cited May 18, 2011, http://dpw.lacounty.gov/Traffic/TSSP.cfm

24 White J, Senior Civil Engineer, Los Angeles County DOT, 2011

25 Los Angeles County Department of Public Works, San Gabriel Valley Traffic Signal Forum, Advanced Traffic Management System, http://dpw.lacounty.gov/tnl/sgvweb/index.cfm

26 White J, Senior Civil Engineer, Los Angeles County DOT, 2011

27 North Central Texas Council of Governments, Traffic System Management, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

28 Bettger N, Senior Program Manager, North Central Texas Council of Governments, 2011

29 North Central Texas Council of Governments, Executive Summary Thoroghfare Assessment Program Phase 2.0, Transportation Systems Management, July 2009, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

30 North Central Texas Council of Governments, Executive Summary Thoroughfare Assessment Program Phase 3.1, Transportation System Management, December 2010, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

31 North Central Texas Council of Governments, Executive Summary Thoroughfare Assessment Program Phase 3.2, Transportation System Management, June 2010, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

- Changing lane assignments
- Upgrading vehicle detection systems
- Adding pedestrian push-buttons
- Upgrading traffic signal heads
- Upgrading traffic signal controllers and cabinets, and communications to central monitoring computers
- Adding global positioning system (GPS) clocks to provide time-of-day coordination
- Performing minor restriping

NCTCOG's thoroughfare assessment program was divided into three phases:

- Phase 2.0, which included signal retiming and low-cost operational improvements at 482 signalized intersections in 20 corridors[32] (completed July 2009)
- Phase 3.1, which included 258 signalized intersections in 13 corridors in the Dallas–Fort Worth metropolitan area[33] (completed June 2010)
- Phase 3.2, which included 1178 signalized intersections in 60 corridors[34] (completed December 2009)

Oakland County/Southeast Michigan

While there is no formal RTSOP, the agencies in southeast Michigan have a long history of thinking about their traffic signal system from a regional perspective[35,36]. As early as 1999, state and regional agencies held a traffic signal summit to discuss the state of traffic signal operations and timings in southeast Michigan. The summit focused on three critical issues related to signal timings: signal timing and progression, timely installation of traffic signals, and all-red clearance intervals. This summit led to the development of a traffic signal retiming program.

The Road Commission for Oakland County (RCOC), one of the entities participating in the Southeast Michigan Council of Governments (SEMCOG) Regional Concept of Transportation Operations,

32 North Central Texas Council of Governments, Executive Summary Thoroghfare Assessment Program Phase 2.0, Transportation Systems Management, July 2009, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

33 North Central Texas Council of Governments, Executive Summary Thoroughfare Assessment Program Phase 3.1, Transportation System Management, December 2010, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

34 North Central Texas Council of Governments, Executive Summary Thoroughfare Assessment Program Phase 3.2, Transportation System Management, June 2010, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

35 Southeast Michigan Council of Governments, Regional Operations: Retiming Traffic Signal Regularly, cited May 18, 2011, http://www.semcog.org/RegionalOperations_TrafficSignalRetiming.aspx

36 Bruff T, Manager, Transportation Program, Southeast Michigan Council of Governments, 2011

operates its own RTSOP, known as Faster and Safer Travel Through Routing and Advanced Controls (FAST-TRAC) system[37,38]. Operated by RCOC, FAST-TRAC is an arterial monitoring and control system designed to optimize traffic flow and squeeze out as much additional capacity as possible from the existing roadway. FAST-TRAC utilizes the Sydney Coordinated Adaptive Traffic System as the primary signal management system.

Seven regional computers monitor network-wide traffic flow and balance traffic flows between major corridors. In this way, RCOC can adjust traffic signal operations area-wide to accommodate for traffic backups caused by traffic restrictions (e.g., incidents and work zones). These regional computers are connected to a central management computer where RCOC traffic managers can monitor operations on the network and make adjustments to signal timing strategies as needed.

Orange County, California

Orange County has developed a program to specifically address regional traffic signal operations and coordination issues[39,40]. Run through the Orange County Transportation Authority (OCTA), the traffic light synchronization program builds upon the success of two demonstration projects: the Euclid Street Demonstration Project and the Oso Parkway/Pacific Park Drive Demonstration Project[41]. Through these two demonstration projects, OCTA showed that managing signal operations from a regional perspective resulted in significant reductions in travel times and stops and dramatic improvements in air quality.

The successful completion of these projects allowed OCTA to develop a full-scale traffic light synchronization program. In turn, the program developed a traffic light synchronization master plan that outlines the goals, strategies, and components for operating traffic signals countywide[42].The master plan's goals include:

- Developing a strategic plan to achieve optimized performance of traffic signals along important traffic corridors throughout Orange County
- Building consensus among multiple cities and agencies to reach common operational goals
- Establishing a multiyear method for implementing the strategic plan
- Maintaining optimized traffic light synchronization in the future

37 Road Commission for Oakland County, Faster and Safer Travel Through Routing and Advanced Control, Commuters, Road Commission for Oakland County, cited May 18, 2011, http://www.rcocweb.org/Commuters/FAST-TRAC.aspx

38 Deneau D, Signal System Engineer, Road Commission for Oakland County, 2011

39 Orange County Transportation Authority, Traffic Light Synchronization Overview, cited May 18, 2011, http://www.octa.net/signal_overview.aspx

40 Keith R, Principal Traffic Engineer, Orange County Transportation Authority, November 2011

41 Orange County Transportation Authority, Signal Demonstration, Orange County Transportation Authority, 2010, cited May 18, 2011, http://www.octa.net/signal_demonstration.aspx

42 Orange County Transportation Authority, Master Plan, Streets and Highways, cited May 18, 2011, http://www.octa.net/signal_master.asp

The OCTA board of directors approved the master plan in the summer of 2010. Beginning in 2011, the program initiated the process of synchronizing 2000 signalized intersections in the county.

OCTA administers the program. Agencies will submit applications for funding through the program and can develop their own signal timing plans or have OCTA develop the timing plans for them. Each individual agency will be responsible for maintaining the coordination timing plans, as well as the system's hardware and communications infrastructure.

Phoenix, Arizona

The Maricopa Association of Governments (MAG) is responsible for administering the traffic signal optimization program (TSOP) for the entities in the greater Phoenix, Arizona, metropolitan area[43]. The program began in 2003 when MAG developed a regional concept of transportation operations that serves as an overall plan for improving transportation operations in the region. This plan led to the establishment of the TSOP in 2004.

Through TSOP, MAG provides assistance to local agencies that own and operate traffic signal systems to ensure that they are operating efficiently. The assistance is through an on-call consultant services contract with approximately 15 consultants who provide the local agencies with the following technical services:

- Hands-on training in signal timing optimization and evaluation software (e.g., Synchro[44] and HCS[45])
- Development and optimization of timing plans for traffic signals
- Evaluation of traffic signal operations before and after they are modified
- Development and updating of Synchro network models used by agency staff for signal timing optimization
- Adjustment of field offset and timing following implementation of initial timing plan settings
- Acquisition of turning movement counts for the morning, evening, and off-peak periods

Puget Sound Area, Washington

Beginning in 2007, the Puget Sound Regional Council (PSRC) has been working to develop an

43 Maricopa Association of Governments, FY 2011 MAG Traffic Signal Optimization Program Request for Projects, Traffic Signal Optimaztion Program, 2010, http://www.azmag.gov/Projects/Project.asp?CMSID=1050&CMSID2=1138

44 Synchro 8, Trafficware, http://www.trafficwareinc.com/transportation/product/synchro-8-0

45 HCS, McTrans Moving Technology, McTrans Center, University of Florida, http://mctrans.ce.ufl.edu/hcs/

RTSOP for the Puget Sound area, near Seattle, Washington[46,47]. An FHWA-led assessment of the region's current state-of-the-practice of traffic signal operations revealed the need for this program. The assessment found that the limited focus on support for operations at all levels and the absence of regional agreements on operations of traffic signals limited the effectiveness of the region's traffic signal operations.

To address these issues and begin creating the foundation for an RTSOP in the Puget Sound area, PSRC developed an advisory group, the Regional Traffic Operations Committee, which comprises representatives from more than 30 agencies, including cities, counties, and the Washington State DOT. Building upon the success of the regional freeway management/ITS system, this committee has been working to develop a regional concept of traffic operations and identifying strategies for improving the operations of the arterial network.

Much of the work so far has focused on creating two region-wide planning documents: the Regional ITS Implementation Plan and the Regional Concept of Traffic Operations (RCTO). The former identifies ITS improvements for 25 key multijurisdictional arterial corridors, while the latter identifies the relationships, procedures, and resource arrangements needed to operate these corridors. Regional signal coordination is a core function to be used in these corridors.

Recently, PSRC completed an effort to develop a memorandum of agreement template that agencies can use in implementing and operating multijurisdictional coordinated signal operations projects. The template, which was patterned after agreements from operational RTSOPs, is intended to help local agencies solidify relationships, procedures, and resource arrangements needed to operate multijurisdictional arterial corridors. PSRC envisioned that the template would be used by agencies wanting to pursue:

- The cooperative development of signal timing plans by all partners
- ITS, communications, and signal upgrades identified as needed to support remote corridor operations from a TMC
- Corridor visibility from any partner agency TMC
- Center-to-center communications (if feasible) between partner agency systems
- Operations coverage and support during off-hours
- One agency identified as the lead agency with primary responsibility for coordinating and championing the project (Ideally, the lead agency would also have sole/primary operating responsibility for the corridor, although this may vary depending on the location and system in the corridor.)
- Ongoing performance monitoring and reporting of project benefits

46 Pugent Sound Regional Council, Regional Concept of Transportation Operations Signal Operations Agreement Template, May 2010

47 Rossi S, Principal Planner, Puget Sound Regional Council (PSRC), 2011

PSRC envisions that as agencies begin to move forward with implementing these types of projects, the templates can be used to assist in the preparation and adoption of the institutional agreements that are needed for multijurisdictional operations.

San Francisco Bay Area, California

The Program for Arterial System Synchronization (PASS) is the RTSOP for the San Francisco Bay Area[48,49,50,51]. The Metropolitan Transportation Commission (MTC), which manages and administers the program, is the transportation planning, coordinating, and financing agency for the nine-county San Francisco Bay area. PASS's purpose is to provide technical and financial assistance to Bay Area agencies to help improve the safe and efficient operation of certain traffic signal systems and corridors. The program's goals and objectives are to provide technical assistance and financial support for projects that do the following[52]:

- Coordinate local and state-owned signal systems and retime signal systems in response to changes to the state-owned system, including changes resulting from:
  - Widening a freeway
  - Reconfiguring an interchange or intersection
  - Implementing ramp metering
  - Altering lane configurations on state highways
- Establish and maintain communications between systems owned by the California DOT (Caltrans) and local agencies, which could entail provisions of GPS units, signal interconnect cable, or other technology to enable two-way communications and coordination, as well as retiming the signals once the new communications system is activated
- Retime traffic signal systems to support priority for transit vehicles, which could include active priority through signal preemption systems and passive priority through signal timing plans, and could include providing transit vehicles with rapid access/egress from major transit hubs

48 Metropolitan Transportation Commission, Arterial Operations, Services, cited May 18, 2011, http://mtc.ca.gov/services/arterial_operations/

49 Stanislaus D, Senior Planner & Program Manager, Freeway Performance Initiative & Arterial Operations Program, Metropolitan Transportation Commission, 2011

50 Metroplitan Transporation Commission, Program for Aterial System Synchronization (PASS), Arterial Operations, cited May 18, 2011, http://www.mtc.ca.gov/services/arterial_operations/pass.htm

51 Metropolitan Transportation Commission, Program Guidelines for 2011/2012 Cycle of Projects, Progam for Arterial System Synchronization (PASS), January 2011, cited May 18, 2011, http://www.mtc.ca.gov/services/arterial_operations/downloads/PASS_Guidelines_2011-12.pdf

52 Metropolitan Transportation Commission, Program Guidelines for 2011/2012 Cycle of Projects, Progam for Arterial System Synchronization (PASS), January 2011, cited May 18, 2011, http://www.mtc.ca.gov/services/arterial_operations/downloads/PASS_Guidelines_2011-12.pdf

- Retime traffic signal systems in conjunction with other established regional programs (e.g., Safe Routes to Schools, Safe Routes to Transit, SMART Corridors, and Traffic Incident Management)

Southwestern Pennsylvania

The Southwest Pennsylvania Commission (SPC) has developed a traffic signal program that provides technical assistance (i.e., traffic signal retiming and other improvements that will result in optimized operations) to municipalities in a 10-county region in southwest Pennsylvania[53,54]. The program's goals and objectives are to provide the necessary funding, high-quality training, technical assistance, and streamlined management that will facilitate the implementation of optimized traffic signal systems along corridors in the southwestern Pennsylvania.

The program provides funding for two types of projects: regional Signals in Coordination (SINC) projects and regional SINC with Equipment Upgrades (SINC-UP) projects[55]. For a corridor to be eligible for SINC funding, it has to have two or more signals that have controller clocks that can be synchronized to a common reference (via, for example, interconnect or GPS) and that are currently operating in a free mode or where the coordination timing plans have not been updated in the past three years. SPC and its planning partners favor key arterial corridors in the region where a SINC project could be beneficial.

SINC-UP projects involve projects that require minor traffic signal equipment upgrades to improve traffic signal coordination and optimization. Eligible traffic signal equipment upgrades are limited to the controller, communications, signal indications, and other electrical components that directly affect optimizing operations. Examples of the types of improvements that are permitted through SINC-UP projects include[56]:

- Modifications to :
  - Traffic signal timing settings
  - Traffic signal phasing
- Replacement of or modifications to:
  - Traffic signal coordination equipment and cables
  - Traffic signal controller, controller cabinet assemblies, electrical service, and related electronic equipment

53 Southwestern Pennsylvania Commission, Transportation: Regional Traffic Signal Program, cited May 18, 2011, http://www.spcregion.org/trans_ops_traff.shtml

54 D'Andrea D, Transportation Planner, Coordinator, Regional Traffic Signal Projects, Southwestern Pennsylvania Commission, 2011

55 Southwestern Pennsylvania Commission, Regional Traffic Signal Program Guidelines and Applications Instructions, cited May 18, 2011, http://www.spcregion.org/pdf/signals/rtsp_guideandapp.pdf

56 Southwestern Pennsylvania Commission, Regional Traffic Signal Program Guidelines and Applications Instructions, cited May 18, 2011, http://www.spcregion.org/pdf/signals/rtsp_guideandapp.pdf

- Pavement markings on the roadway
- Vehicular detectors and associated hardware
- Traffic control signage
- Electrical and communication conduit and junction boxes that do not impact, disturb, or modify pedestrian usability
- Traffic signal electrical cabling

- Replacement of incandescent vehicular and pedestrian signals with LED vehicular and pedestrian signals
- Removal of existing signal installations that are no longer warranted
- In-kind replacement or repair of existing sidewalks and accessibility ramps only to the extent that is necessary due to the above-mentioned work (Maintenance and protection of traffic and other incidental items related to the above-mentioned work

Improvements that are not eligible under this program include:

- Relocating and replacing traffic signal poles or mast structures
- Installing new traffic signals at intersections where none previously existed
- Adding pedestrian features to an intersection where none currently exist (e.g., new sidewalks, accessible ramps, and/or new pedestrian signals where none currently exist)
- Widening roadway approaches
- Performing any work that will permanently impact, disturb, or modify pedestrian usability
- Completely replacing the signal infrastructure (unless otherwise authorized by the project selection committee)

Tucson, Arizona

Through its Regional Traffic Operations Center (RTOC), the City of Tucson monitors and controls more than 500 traffic signals in the region, including those installed and operated by the City of Tucson, Arizona DOT, Pima County, Town of Marana, Oro Valley, Town of Sahuarita, and the

City of South Tucson[57],[58],[59]. The RTOC provides real-time monitoring of traffic and emergency response, both of which have been enhanced by the introduction of video surveillance cameras at strategic locations along arterials of regional significance. From its RTOC, the City of Tucson can monitor signal status, communications status, and flash status from a single location. The city can also monitor deployed timing plans in the region. The standard operating procedures require that city staff notify other entities when maintenance is required or when operational deficiencies are observed.

In addition, the Pima Association of Governments (PAG) administers a regional traffic signal services contract that allows local entities access to traffic signal timing expertise[60]. These entities work with the local agencies to develop coordinated traffic signal timing plans for major arterials in the region.

57 City of Tucson, Regional Traffic Operations Center, cited May 18, 2011, http://dot.tucsonaz.gov/traffic3/rtoc.php

58 Pima Association of Governments, 2011-2015 5-Year Regional Transportation Improvement Program, cited May 18, 2011, http://www.pagnet.org/documents/TIP/TIP2011-2015/TIP-2011-2015-Complete.pdf

59 Casertano P, Transportation Safety and Operations Lead, Pima Association of Governments, April 5, 2010

60 Casertano P, Transportation Safety and Operations Lead, Pima Association of Governments, April 5, 2010

CHAPTER 3

Program Goals and Objectives

Goals and objectives are critical to the development and sustainability of RTSOPs and define the region's high-priority needs at the beginning. The goals and objectives of RTSOPs vary considerably from region to region and reflect the needs and priorities of the local operating agencies. Table 3.1 lists the goals and objectives of some of the RTSOPs that participated in this scan.

Table 3.1 RTSOP goals and objectives

Location	Stated program goals and objectives
North Central Texas Council of Governments	To maximize the efficiency of the existing transportation system by implementing low-cost capital improvements and signal coordination[61]
DRCOG (Denver, CO)	To ensure that the region's traffic signals operate in a safe manner that makes the most efficient use of arterial street capacity[62]
Georgia DOT	To increase travel throughput by minimizing congestion and reducing delays along regional commuter corridors through improved signal operations[63]
Maricopa Association of Governments (Phoenix, AZ)	To improve traffic signal coordination and operations across the region by providing technical assistance to member agencies for improving traffic signal coordination and optimization
Metropolitan Transportation Commission (San Francisco Bay Area, California)	Goal: To provide assistance to Bay Area jurisdictions in their efforts to improve traffic operations on arterial streets. This is achieved by: ■ Sponsoring various projects that deal with signal coordination and other arterial operations issues ■ Developing and implementing initiatives to provide arterial operations ■ Supporting the Arterial Operations Committee as a forum for discussion of shared issues and lessons learned for both public and private agencies
Southwestern Pennsylvania Commission	To provide the necessary funding, high-quality training, technical assistance, and streamlined management in order to facilitate implementation of optimized traffic signal systems through traffic signal improvements along corridors in the southwestern Pennsylvania region. The results of these corridor improvements would be improved safety, reduced fuel consumption, reduced vehicle stops, and reduced emissions.

61 Bettger N, Senior Program Manager, North Central Texas Council of Governments, 2011

62 Denver Regional Council of Governments, Traffic Signal System Improvement Program, 2010 Update, Traffic Signal Program, August 2010, cited May 18, 2011, https://www.drcog.org/index.cfm?page=TrafficSignalProgram

63 Waldrop G, Atlanta Regional Traffic Operaitons Program Manager, Georgia DOT, 2011

Table 3.1 RTSOP goals and objectives (continued)

Location	Stated program goals and objectives
Los Angeles County Metropolitan Transportation Authority	To identify, develop, and implement innovative, low-cost operational improvements to the network of traffic signals on the major streets throughout Los Angeles County. The primary functions of the program include the following[64]: ■ Provide training/certification for traffic signal technicians and operational personnel ■ Provide a forum for discussing regional traffic signal operations issues ■ Develop traffic signal timing plans that facilitate cross-jurisdictional traffic flow ■ Provide consistency in signal timing practices between agencies ■ Identify and establish priorities, corridors of significance, performance goals, and measures for the region's traffic signals
Orange County Transportation Authority Regional	Synchronize traffic signals across jurisdictions Monitor and regularly improve the synchronization Synchronize signals on a corridor basis reflecting existing traffic patterns
Operation Green Light (Kansas City, Kansas/Missouri)	OGL exists to significantly reduce air pollution, stops, delays, driver frustration, and fuel consumption in the Kansas City area by optimizing the travel times, safety, and traffic flow along arterial corridors.
Southeast Michigan Council of Governments	Southeast Michigan will have reliable and managed transportation operations across jurisdictional, geographic, and modal boundaries for both routine traffic operations and traffic incident management that saves lives, time, and money for its travelers.

The type of funding that is available for agencies to use often drives the goals and objectives that are established for their programs. For example, agencies that have access to CMAQ funds often have program goals and objectives directed toward improving air quality and reducing emissions. Programs that utilize other sources of funding often have a more diverse set of program goals and objectives.

64 Department of Public Works, Los Angeles County, San Gabriel Valley Traffic Signal Forum, Advanced Traffic Management System, http://dpw.lacounty.gov/tnl/sgvweb/index.cfm

CHAPTER 4

Institutional Arrangements and Agreements

Many of the RTSOPs reviewed indicated that they use multiple types of agreements. The type of agreement is highly dependent on the goals and functions of the program.

Program-level agreements are intended to clarify the program's big picture intent, defining a vision and goals for the program and dealing more with organizational structure. These types of arrangements and agreements define the program's formal organization structure.

Program-level agreements are more likely to be used when regional partners are considering consolidating operations into a single entity. RTSOPs that are proposed to keep control with the local entities will generally rely on project-level agreements among a subset of participating agencies.

Program-level arrangements are intended to extend beyond the needs that are specific to an individual project or corridor where improvements are being implemented, while project-level agreements are designed to cover the needs of an individual project or corridor improvement.

Program-level agreements tend to be focused on the longer term and tend to be bigger in scope, while project-level arrangements are short-term, lasting only long enough to implement a specific set of improvements to a corridor.

Program-level arrangements can be either formal or informal and typically develop from long-term relationships among stakeholders. Project-level agreements are usually formal and represent a contractual arrangement between two entities.

Program-Level Agreements

At the program level, four types of institutional arrangements are common with RTSOPs:

- Local partnerships
- Memoranda of understanding
- Cooperative agreements
- Cost-sharing agreements

Each of these arrangements is briefly discussed in the following sections. Note that during an RTSOP's lifespan, programs can use any and, more likely, all of the arrangements.

Local Partnerships

Most RTSOPs begin through a local partnership arrangement. With many local partnerships, agencies work cooperatively, often without any type of written agreement. Instead, they build upon existing working relationships between key personnel to identify and implement traffic signal improvements and timing in corridors of strategic importance.

The catalyst for forming these partnerships can vary, ranging from a major highway construction project to political pressures to individual initiative. Often, agencies will band together through spoken or handshake agreements to formalize the agreed-upon signal timing strategy or solution. These types of arrangements are often used where long-term relationships exist between key personnel at agencies. In some cases, the informal partnerships can evolve into a more formalized program.

Memoranda of Understanding

MOUs are often used as the formative stage of many RTSOPs. An MOU is a written agreement between two or more entities that describes an agreed-upon course of action to be pursued by each entity to address a common situation or approach as a common goal. MOUs are often used to outline an RTSOP's basic tenets and purpose and generally contain concise statements that describe the purpose and intent of the collaboration, the relationship between the partner agencies, and the planned governance of the collaboration.

Other important items that an MOU might address include the:

- Important terms and phrases that are used throughout the MOU
- Organizational and governance structure and membership of the agencies involved in the program
- Functions, activities, and responsibilities of each of the program's partner agencies
- Duration and terms of renewal of the agreement
- Terms and conditions for dissolving the partnership

Typically, an MOU is a multiagency agreement. A representative from each partner agency signs the same document, signifying their agreement to participate in the effort. MOUs are often the first step taken to develop a formal RTSOP.

MOUs are generally nonbinding agreements and are intended to describe general relationships between entities. An MOU may be used to signify an agency's intent to commit funding to a program; however, because of their nonbinding nature, MOUs do not include specific funding amounts or cost-sharing formulas. Agencies frequently prefer other, more formal documents to describe cost-sharing arrangements.

Cooperative Agreements

A cooperative agreement is similar in concept to an MOU, but is considered a legally binding document. A cooperative agreement contains many of the same basic elements as an MOU (e.g., a description of the program's organizational structure, the program's functions, and the roles and responsibilities of each partner agency).

A cooperative agreement is often used where one agency will be responsible for performing specific services or functions for another agency, usually for a fee. Because a cooperative agreement is a formalized contract between agencies, it generally is used to obligate one or more of the agencies to making a financial commitment to the program.

Cost-Sharing Agreements

Cost sharing is typically an issue when the organizational structure is one in which the local agencies have decided to create a regional entity that is responsible for the day-to-day operations and maintenance of the traffic signals on either corridors of regional significance or for all signalized intersections. Generally, when the local decision is to operate the traffic signal system through a regional entity, the local partners are asked to share the responsibility of funding the costs for the functions and services that the regional entity performs (e.g., developing timing plans, monitoring arterial performance, improving infrastructure, or maintenance).

A number of approaches exist for determining an equitable way of sharing costs. The most common methods appear to be based on the percentage (or ratio) of traffic signals within a single jurisdiction compared to the total number of traffic signals under the control of the regional entity. For example, if 25 of 100 intersections are within the jurisdiction of City A, then City A would be responsible for 25% of the total operating costs needed to operate the regional system.

In areas where transit priority is also provided, either the metropolitan transit agency or the regional entity may be responsible for providing the cost share associated with operating the transit priority system (e.g., developing priority timing plans or purchasing and deploying the transit signal priority detection systems).

Project-Level Agreements

Many of the agencies interviewed use project-level agreements as part of the normal course of business for their RTSOPs. Project agreements, which also may be referred to as interlocal, interagency, or interjurisdictional agreements, are frequently used in RTSOPs to initiate a specific improvement project within a program (as opposed to being the program itself).

Generally, these types of agreements are legally binding and are used when funds need to be exchanged between the agency responsible for distributing funds (i.e., the regional entity) and the agency responsible for performing the work (i.e., the local entity). Project agreements usually only

exist between two governmental entities and not between a public entity and a private consultant firm; a different type of contracting mechanism is used for this arrangement.

While the exact content can vary from location to location, the project agreement generally describes the roles, responsibilities, and relationships between the regional and local entities. Specific items usually covered in a project agreement related to an RTSOP include defining the following.

- Who is responsible for:
    - Purchasing and deploying any necessary communications and field equipment upgrades
    - Testing and inspecting any field equipment deployed as part of the project
    - Fine-tuning timing plans once they have been implemented
    - Conducting the different types of evaluations associated with the project
    - Operating and maintaining the field equipment and/or timing plans installed as part of the project
    - Preparing specific documentation (e.g., expense reports, final reports, and outreach documentation) associated with the project
- Who has ownership of which pieces of equipment deployed as part of the project
- Who will:
    - Perform the data collection necessary to develop timing plans
    - Develop the timing plans
    - Implement the timing plans in the field
- Who must be notified if timing plans are to be changed and what restrictions, if any, exist on when timing plans can be changed (i.e., how long before timing plans can be changed after deployment)

Project agreements also specify the amount of money that each agency is responsible for contributing to the project. This includes the amount and type of matching requirements (i.e., hard match, soft match, or in-kind match) that the local entity is to provide, if any. Many times, these project agreements also contain a payment reimbursement schedule and a project delivery timeframe.

Other Types of Agreements

Other types of agreements sometimes are used with specific RTSOPs. The most common of these are

the contract for consultant services and the agency waiver of liability and indemnification.

Consultant Scope of Services and Contract

In several of the agencies interviewed, the regional entity engages consultants to develop and assist local agencies with the implementation of recommended timing plan changes for interjurisdictional coordination. The regional entity typically uses a consultant services contract to outline not only the specific project scope, but also the consultant's roles and responsibilities in the regional retiming projects and their contractual and working relationships with the local entities.

Typical items covered in a consultant contract include:

- Expectations for communications among, meetings with, and solicitations of input from the local entities and other stakeholders impacted by the project(s)
- Data collection roles and responsibilities
- Acceptable processes and procedures for analyzing existing conditions
- Permitted tools and techniques for analyzing and optimizing corridor-level traffic signal operations
- Acceptable processes and procedures for developing optimal initial and actuated timing plan settings
- Requirements for developing coordination timing plans
- Expectations for assisting in the deployment and fine-tuning of implemented signal timings
- Before-and-after evaluation roles and responsibilities
- Expected type and schedule for deliverables
- Regulatory restrictions, insurance requirements, and other legally binding language specific to the contracting agency

Waiver of Claims and Indemnification

Liability is a common concern for both regional and local entities when it comes to establishing and implementing an RTSOP. Common liability issues and concerns that agencies must be worked through during the process of establishing an RTSOP include:

- Who has the authority to implement agreed-upon timing plans in other agency cabinets and equipment

- Who is responsible for:
  - Establishing minimum vehicle and pedestrian phase setting and clearance intervals
  - Maintaining the physical hardware (both the traffic signal hardware and the communications hardware) at each intersection
  - Maintaining the coordination timing plans once they have been implemented
  - Responding to citizen inquiries and complaints about traffic signal operations at intersections of regional importance
- What authority do local agencies have to change regional traffic signal timing plans and what is the process for making those changes (e.g., who must be notified and what records need to be kept)

CHAPTER 5

Structure and Governance

Successful programs come in many shapes and forms. Some programs are structured whereby the regional entity is only a funding mechanism for the region. In other programs, the regional entity is responsible for developing, but not implementing, traffic signal timing plans. In still other programs, the regional entity assumes responsibility for developing and installing timing plans and communications infrastructure for obtaining regional coordination, but leaves the actual operations and maintenance to the local entities. A fourth structure involves a regional entity that jointly monitors and implements improvements agreed upon by local entities. The final example of ways that programs can be structured is a regional entity that assumes all operational and maintenance responsibilities within a corridor or a region.

Organizational Structure

The scan team observed a variety of organizational structures during the scan. Organizing the program into a structure that meets the agencies' needs and the region's objectives is of the utmost importance. Successful programs can be developed that distribute the authority for operating and developing regional traffic signal operations between various levels. In identifying the best structure for a program in a particular area, agencies should begin by conducting an inventory of assets, capabilities, and resources available within the region, then structure the program around the strengths of these assets, capabilities, and resources.

The knowledge, skills, and abilities of the lead (or champion) agency often dictate a program's structure and governance. In areas where local agencies do not have a high level of knowledge, skills, and abilities, regional or state entities often provide leadership in formulating regional traffic signal programs. In areas where local agencies have a high level of knowledge, skills, and abilities, programs are often structured more to emphasize local control and coordination.

The authority and capability of the lead agency to operate and maintain the system can also influence the program's structure. For example, those programs where the regional entity is not an actual traffic signal operator tend to focus on the development of timing plans and the deployment of communications systems (e.g., the DRCOG in Denver[65] and OGL in Kansas City[66]). Those programs where the lead agency is a traffic signal operator tend to focus more on the real-time management of traffic signal timings (e.g., GDOT[67]).

The type of organizational structure in a region varies significantly, depending upon a number of factors, such as the:

65 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010
66 Webb R, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, 2011
67 Waldrop G, Atlanta Regional Traffic Operaitons Program Manager, Georgia DOT, 2011

- Local goals and objectives for regional traffic operations
- Size and number of local entities in a region
- Type and amount of funds available to the region for addressing operational issues
- Presence of a strong regional entity (e.g., an MPO, a regional transportation authority, a council of governments, or a county transportation entity)
- Existing level of cooperation and collaboration between local entities in the region
- Existence and use of other advanced traffic management systems (i.e., freeway management/its centers) in the region
- Degree of local knowledge and expertise present in the region's local operating agencies

Roles and Responsibilities

The activities and functions performed by different RTSOPs depend on how those programs are structured. The most common functions of these programs include:

- Developing traffic signal timing plans to facilitate cross-jurisdictional traffic flow
- Providing a forum for discussing the region's traffic signal operations issues
- Identifying and establishing priorities, corridors of significance, and performance goals and measures of the region's traffic signals
- Facilitating the deployment of advanced traffic management concepts and control strategies (e.g., adaptive traffic signal control and integrated corridor management)
- Providing consistency in signal timing practices between agencies (e.g., using similar clearance intervals, phasing patterns, and pedestrian timings)
- Providing outreach to the public and decision makers

Table 5.1 shows the levels of control supported by the RTSOPs that were reviewed. Most programs support only the development of coordinated timing plans across regions, while only a few programs provide full-scale regional control of part or all of the region's traffic signals.

Table 5.1 Level of operational control performed by various RTSOPs

Location	Levels of control				
	Timing plan development	Real-time monitoring	Emergency control	TOD control	Full control
Denver	✓				
Kansas City	✓	✓	✓	✓	✓
Las Vegas	✓	✓	✓	✓	✓
Los Angeles County	✓	✓	✓	✓	
North Central Texas	✓				
Oakland County/Southeast MI	✓	✓	✓	✓	✓
Orange County	✓	✓			
Phoenix	✓				
San Francisco	✓				
Southwest PA	✓				
Tucson	✓	✓	✓	✓	

Lead Agency

Creating a successful RTSOP requires agencies to take a regional perspective on operating traffic signals. This often requires that old agencies take on new roles or that new agencies be formed to serve with a more regional perspective. As shown in Table 5.2, the lead agency in most of the RTSOPs reviewed were MPOs, although successful RTSOPs have been established by organizations at all levels, including state, county, and local departments of transportation. .

As part of the process of developing a regional concept of operations, regional traffic signal programs need buy-in from agencies outside the normal transportation engineering domain. For example, agency information technology (IT) groups often have control and are responsible for operating communications networks.

Agencies need more guidance on how to incorporate arterial management and regional traffic signal operations into the long-range planning process. Several of the participants recommended that agencies include in their long-range transportation plans a section that addresses regional traffic signal operations, even if that section is only a placeholder. Furthermore, it was suggested that the long-range plan should require agencies to develop an RCTO that defines the program's structure.

Table 5.2 Lead agencies associated with reviewed RTSOPs

Location	Lead agency			
	MPO/COG	State DOT	County DOT	Local/ municipal DOT
Atlanta		✓		
Denver	✓			
Kansas City	✓			
Las Vegas	✓			
Los Angeles County	✓		✓	
North Central Texas	✓			
Oakland County/ Southeast MI	✓		✓	
Orange County	✓			
Phoenix	✓			
San Francisco	✓			
Southwest PA	✓			
Tucson	✓	✓		✓

Most programs have a technical and/or steering policy committee composed of regional transportation operators. These committees help define project selection criteria, priority needs, and other issues. To keep people engaged in the process, local agencies need to know that they are relevant in discussions and in the decision-making process.

A relationship seems to exist between structure and funding, particularly when CMAQ funds are being used. A common thread appears to be that when CMAQ funds are involved, the MPO is more directly involved. Pima County, AZ, is atypical in that it is not a nonattainment area and Surface Transportation Program (STP) funds were being used. The development of an RCTO motivated the development of the Pima County Association of Governments' RTSOP[68].

68 Casertano P, Transportation Safety and Operations Lead, Pima Association of Governments, April 5, 2010

CHAPTER 6

Funding

Most of the agencies use one or more of the following sources to provide funding for their programs:

- CMAQ funds
- STP funds
- Cooperative agreements
- Sales tax revenues

This section provides examples of how the agencies participating in this scan use these various sources to fund their RTSOPs.

Congestion Mitigation/Air Quality Funds

Most of the agencies examined as part of this scan use CMAQ as the primary source of funding for their programs. The CMAQ program provides funds for transportation projects and programs that will contribute to attainment or maintenance of national ambient air quality standards for ozone, carbon monoxide, and particulate matter. In many programs, local agencies are required to provide a minimum match of 20% of the total project costs. Some agencies require this match to be a hard-cash match, while others permit soft match. Soft match can be achieved by using either in-house agency staff or outside consultants.

Southwestern Pennsylvania

SPC's Regional Traffic Signal program uses CMAQ funds for two types of projects through their program[69]:

- Regional SINC projects
- Regional SINC-UP projects

SINC projects only deal with achieving coordination between two or more signals. To be eligible for

69 Southwestern Pennsylvania Commission, Regional Traffic Signal Program Guidelines and Applications Instructions, cited May 18, 2011, http://www.spcregion.org/pdf/signals/rtsp_guideandapp.pdf

SINC funding, the traffic signal controllers must already have the capability of providing coordination (e.g., via interconnect or GPS), but are operating in a free mode or whose coordination plans have not be updated in the past three years. With SINC-UP projects, agencies can implement minor traffic signal controller equipment upgrades necessary to provide traffic signal coordination and optimization.

An SPC engineering consultant performs all the work. The commission has consultants perform the following tasks:

- Field reconnaissance and data collection, including turning movement counts during typical weekday and/or weekend peak period conditions
- Capacity analysis of existing conditions utilizing Synchro/SimTraffic and HCS software
- Development of revised signal phasing, optimized signal timings, and offsets
- A review of the corridor's collision history
- Assistance with implementing new traffic signal settings and timings, fine-tuning timings in the field, recording any changes, and monitoring the effectiveness of the changes
- Developing a final implementation report summarizing the benefits in terms of the estimated reduction in delay, number of stops, travel time, and emissions

With SINC-UP projects, SPC consultants also perform preliminary engineering and design work for those projects requiring infrastructure or equipment modifications.

San Francisco Bay Area, California

The MTC uses CMAQ funding to support its PASS program[70]. Local agencies define the projects; MTC staff members evaluate the projects and assign them to consultants retained by MTC. Under the PASS program, technical assistance and financial support are provided to traffic signal projects that:

- Interact with freeways and state highways
- Involve traffic signals from multiple jurisdictions
- Operate on corridors with established regional significance
- Provide priority for transit vehicles

70 Metropolitan Transportation Commission, Arterial Operations, Services, cited May 18, 2011, http://mtc.ca.gov/services/arterial_operations/

- Have been developed in conjunction with other regional programs

Typical tasks performed under the PASS program to meet the above goals and objectives include, but are not limited to, the following[71]:

- Improve reliability and predictability of travel along arterial roads
    - Develop and implement signal coordination plans (morning, evening, and/or midday) that reduce travel time and delay on corridors that contain state and local signals
    - Collect peak period turning movement counts at all study intersections, including pedestrian and bicycle counts, and seven-day 24-hour machine counts at strategic locations to determine periods of coordination
    - Develop and implement signal coordination plans based on the throughput of people rather than vehicles
    - Develop and implement flush plans for arterials that are used as diversion routes in the event of freeway incidents, in conjunction with other incident management actions
    - Develop and implement optimized actuated settings for fully actuated signals to minimize queuing during nonpeak periods
- Improve air quality through decreased motor vehicle emissions and fuel consumption
    - Develop and implement signal coordination plans that reduce starts and stops and promote uniform travel speeds
    - Develop and implement transit signal priority plans to make transit a more attractive travel option
- Improve the safety of motorists, pedestrians, and bicyclists
    - Collect pedestrian and bicyclist volume data at the same time as vehicle count data at intersections to be coordinated
    - Develop and implement signal coordination plans that promote uniform travel speeds, thereby reducing rear-end collisions
    - Review existing pedestrian crossing times and bicycle detection at intersections to be coordinated; recommend adjustments as necessary

71 Metropolitan Transportation Commission. Program Guidelines for 2011/2012 Cycle of Projects, Progam for Arterial System Synchronization, January 2011, cited May 18, 2011, http://www.mtc.ca.gov/services/arterial_operations/downloads/PASS_Guidelines_2011-12.pdf

- Review collision history for patterns that are susceptible to correction through signal timing; recommend adjustments as necessary

- Provide streamlined program administration and project management
  - Provide high-quality technical assistance in a cost-effective manner
  - Require local agency review and approval of timing plans prior to implementation
  - Provide a peer review option to small agencies that do not have in-house traffic engineering staff
  - Use data on the quality of the deliverables and the number of projects completed within schedule and budget to guide assignment of projects to consultants in subsequent cycles
  - Facilitate interagency communication and coordination

North Central Texas

Recently, the North Central Texas Council of Governments (NCTCOG) completed Phase 3 of its Thoroughfare Assessment Program/Traffic Signal Integration and Monitoring Program[72]. As part of this program, NCTCOG provided funds to retime traffic signals and develop low-cost operation improvements at select locations to reduce vehicular emissions and improve mobility. As with other programs, agencies are required to provide a 20% local fund match. They also are required to provide hard match to the program funds since a consultant has been hired to develop and implement the timing plans. A cash match is needed to pay for the contracted services performed by the consultant.

Denver, Colorado

The DRCOG also uses CMAQ as the primary source for funding its traffic signal system improvement program (TSSIP). However, DRCOG administers the program as a federally funded pooled fund project, whereby agencies can apply for funding to support critical needs identified by local agencies[73]. These programs' funds can be used to make capital improvements to signal systems as well as to support other projects, including traffic signal retiming and coordination studies. DRCOG has been allocated $3.7 million for fiscal years 2012-2015 in support of this program. For the typical annual total of $3.7 million, the funding breakdown for these activities is about:

- $2.2 million for capital improvements

72 Central Texas Council of Governments, Executive Summary Thoroughfare Assessment Program Phase 3.1, Transportation System Management, December 2010, cited May 18, 2011, http://www.nctcog.org/trans/tsm/

73 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010

- $200,000 for contingency and miscellaneous equipment purchases
- $1.1 million for signal timing and coordination
- $200,000 for system engineering and design

A call-for-projects process is used to identify local agencies' needs and priorities. A working group composed of representatives from the traffic signal operating agencies in the region, the Regional Transportation District, and FHWA assist DRCOG staff members select regional projects. Projects and activities are selected based on regional considerations and a consensus from the stakeholders and DRCOG. Projects are prioritized using the following criteria[74]:

- The criticality of the need (i.e., a higher priority was assigned to corridors/projects addressing key signals not on the system, insufficient communications, and/or obsolete systems)
- Cost effectiveness (i.e., lower priority was assigned to improvements with a high cost per signal)
- The importance of the corridor (i.e., priority based on roadway classifications)
- Strategic communications links
- Local priorities and synergies among projects

One of the unique features of the DRCOG program is how contingency funds are used to purchase miscellaneous and emergency traffic signal equipment[75]. As part of every project, DRCOG sets aside a portion of the program's funds (between $200,000 and $250,000 per year) to ensure that projects can proceed to construction if actual costs exceed the estimated costs. Once it is certain that identified construction projects can progress within budget, DRCOG releases the remaining contingency funds to be used to purchase miscellaneous traffic signal equipment, which are typically smaller capital projects that address issues with obsolete and unreliable equipment[76].

Kansas City, Kansas/Missouri

The OGL program is another example where multiple sources of funds were used to establish the

74 Denver Regional Council of Governments, Traffic Signal System Improvement Program, 2010 Update, Traffic Signal Program, August 2010, cited May 18, 2011, https://www.drcog.org/index.cfm?page=TrafficSignalProgram

75 Denver Regional Council of Governments, Traffic Signal Program, Transportation, Denver Regional Council of Governments, http://www.drcog.org/index.cfm?page=TrafficSignalProgram

76 Denver Regional Council of Governments, Traffic Signal System Improvement Program, 2010 Update, Traffic Signal Program, August 2010, cited May 18, 2011, https://www.drcog.org/index.cfm?page=TrafficSignalProgram

program[77,78]. Under OGL, MARC is responsible for providing day-to-day support and operation of strategic corridors in the Kansas City area. Through the program, MARC installed and operates a region-wide traffic signal and communications network designed to promote traffic signal coordination across jurisdictional boundaries. MARC was responsible for overseeing the construction of the system as well as operates the system from a regional perspective.

A combination of STP, CMAQ, Kansas ITS set-aside funds, and construction funds were used to establish the initial program[79]. Currently, the program operates using STP funds with an 80/20 matching requirement (i.e., local agencies are required to provide the 20% match) with a tapered reduction of federal funds so that, by 2014, the STP/local split will be 50/50. Figure 6.1 shows the source of funds MARC used to construct and establish the program.

Table 6.1 Sources of funding used to establish Operation Green Light[80]

Funding source	Amount
CMAQ	$8.2 M
STP	$2.1 M
ITS Integration Program	$0.4 M
KDOT ITS	$0.2 M
MoDOT + local agencies	$2.2 M
TOTAL	$13.2 M

In addition to providing a match of installation of capital improvements, each agency is also responsible for providing funds to MARC to operate their traffic signals that are included in the OGL program. The annual operating budget set by MARC is approximately $1.2 million to operate 681 traffic signals. MARC apportions these operating costs to its local partners based on the number of signals it operates within that jurisdiction.

Cooperative Agreements

Cooperative agreements are common with many RTSOPs. In general, cooperative agreements are similar to MOUs; however, cooperative agreements are legally binding because they obligate funding associated with a project.

Oakland County/Southeast Michigan

In Michigan, RCOC uses project participation agreements to fund installation, maintenance, and

77 Mid-America Regional Council, Concept of Operations: Roles and Responsibilities, Operation Green Light, Mid-America Regional Council, cited May 18, 2011, http://www.marc.org/transportation/ogl/documents.htm

78 Webb R, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, 2011

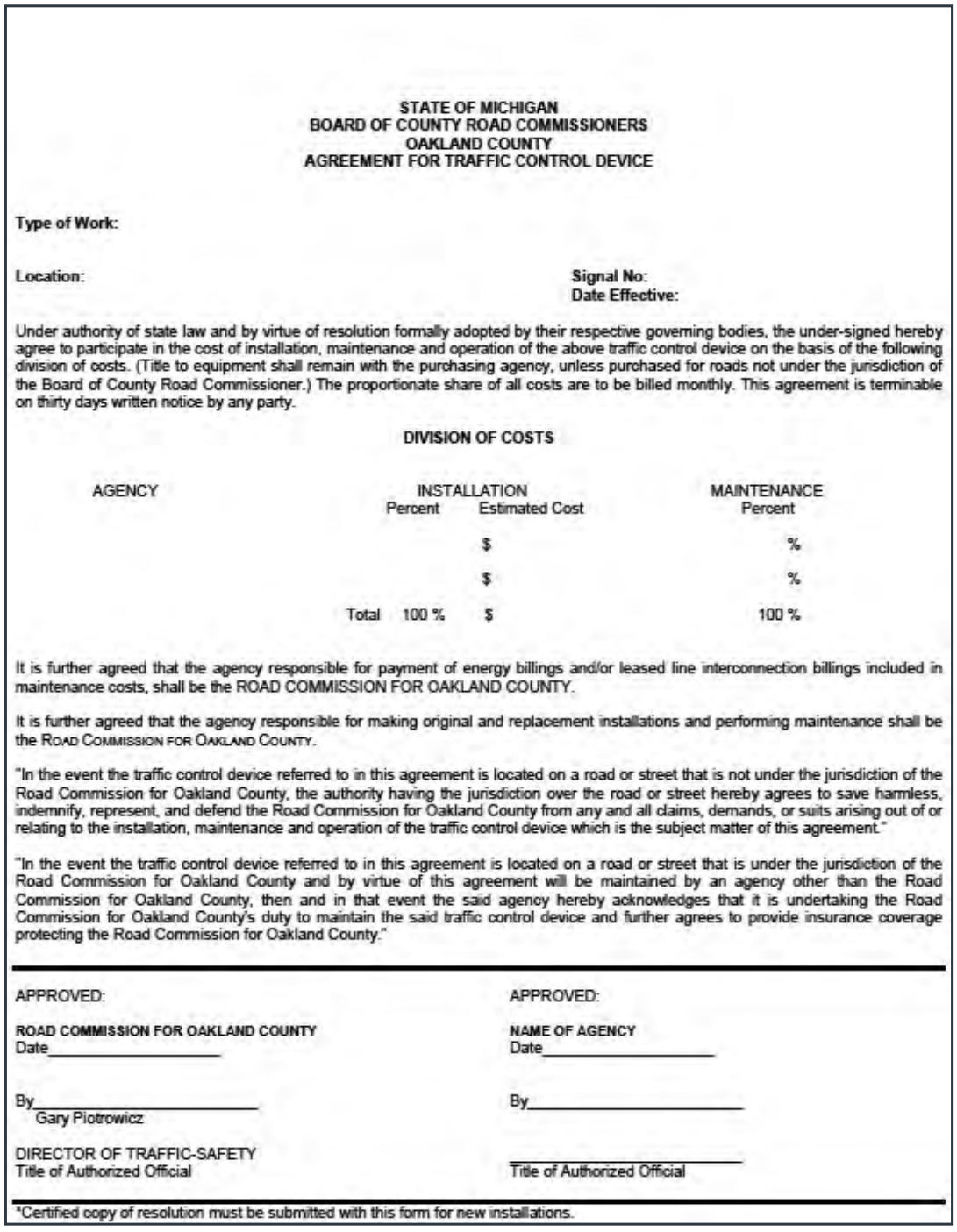
79 Mid-America Regional Council, Cooperative Agreement for Funding Operations of Operation Green Light Traffic Control System, 2009

80 Webb R, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, 2011

operations of regional traffic signal assets[81,82]. The project agreements divide the installation, maintenance, and operations costs between the participating agencies. Costs are distributed based on the number of approaches in each jurisdiction (e.g., if a county road intersects a city street, then the distribution of costs would be 50/50). Included in the maintenance costs are items such as preventive maintenance, lamp-out repairs, emergency repairs, and re-lamping, as well as all electrical energy and leased-line telecommunications costs. Each jurisdiction is billed monthly for its portion of the accrued maintenance costs from the previous month. Agencies can terminate the agreement with 30 days written notice. Figure 6.1 is a sample project agreement used by the Road Commission.

81 Road Commission for Oakland County, Agreement for Traffic Control Devices, 2008

82 Deneau D, Signal System Engineer, Road Commission for Oakland County, 2011



STATE OF MICHIGAN
BOARD OF COUNTY ROAD COMMISSIONERS
OAKLAND COUNTY
AGREEMENT FOR TRAFFIC CONTROL DEVICE

Type of Work:

Location: **Signal No:**
Date Effective:

Under authority of state law and by virtue of resolution formally adopted by their respective governing bodies, the under-signed hereby agree to participate in the cost of installation, maintenance and operation of the above traffic control device on the basis of the following division of costs. (Title to equipment shall remain with the purchasing agency, unless purchased for roads not under the jurisdiction of the Board of County Road Commissioner.) The proportionate share of all costs are to be billed monthly. This agreement is terminable on thirty days written notice by any party.

DIVISION OF COSTS

AGENCY	INSTALLATION Percent	Estimated Cost	MAINTENANCE Percent
		$	%
		$	%
Total	100 %	$	100 %

It is further agreed that the agency responsible for payment of energy billings and/or leased line interconnection billings included in maintenance costs, shall be the ROAD COMMISSION FOR OAKLAND COUNTY.

It is further agreed that the agency responsible for making original and replacement installations and performing maintenance shall be the ROAD COMMISSION FOR OAKLAND COUNTY.

"In the event the traffic control device referred to in this agreement is located on a road or street that is not under the jurisdiction of the Road Commission for Oakland County, the authority having the jurisdiction over the road or street hereby agrees to save harmless, indemnify, represent, and defend the Road Commission for Oakland County from any and all claims, demands, or suits arising out of or relating to the installation, maintenance and operation of the traffic control device which is the subject matter of this agreement."

"In the event the traffic control device referred to in this agreement is located on a road or street that is under the jurisdiction of the Road Commission for Oakland County and by virtue of this agreement will be maintained by an agency other than the Road Commission for Oakland County, then and in that event the said agency hereby acknowledges that it is undertaking the Road Commission for Oakland County's duty to maintain the said traffic control device and further agrees to provide insurance coverage protecting the Road Commission for Oakland County."

APPROVED:

ROAD COMMISSION FOR OAKLAND COUNTY
Date_____

By_____
Gary Piotrowicz

DIRECTOR OF TRAFFIC-SAFETY
Title of Authorized Official

APPROVED:

NAME OF AGENCY
Date_____

By_____

_____
Title of Authorized Official

*Certified copy of resolution must be submitted with this form for new installations.

Figure 6.1 Sample project agreement used by the Road Commission for Oakland County for traffic signal installation, maintenance, and operations[83]

83 Road Commission for Oakland County, Agreement for Traffic Control Devices, 2008

Kansas City, Kansas/Missouri

Funding for ongoing, day-to-day operations of the OGL program is provided through a cost-sharing agreement[84]. MARC staff is responsible for developing an annual operations budget for the program. The costs are then distributed to each member agency based on the number of traffic signals that each agency has being operated by the program. Figure 6.2 shows a sample cost-sharing apportionment for the City of Overland Park.

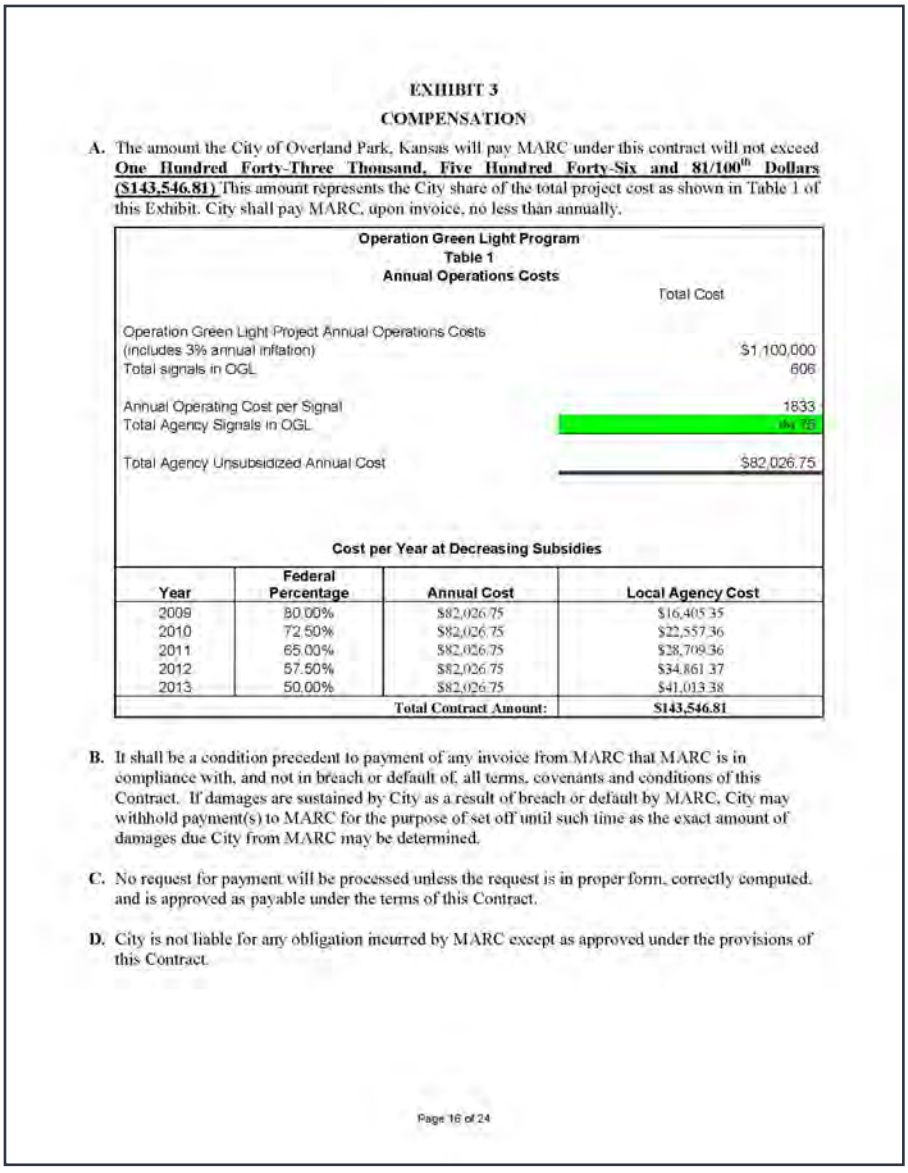


EXHIBIT 3

COMPENSATION

A. The amount the City of Overland Park, Kansas will pay MARC under this contract will not exceed **One Hundred Forty-Three Thousand, Five Hundred Forty-Six and 81/100th Dollars ($143,546.81)** This amount represents the City share of the total project cost as shown in Table 1 of this Exhibit. City shall pay MARC, upon invoice, no less than annually.

Operation Green Light Program
Table 1
Annual Operations Costs

	Total Cost
Operation Green Light Project Annual Operations Costs (includes 3% annual inflation)	$1,100,000
Total signals in OGL	606
Annual Operating Cost per Signal	1833
Total Agency Signals in OGL	[illegible] 75
Total Agency Unsubsidized Annual Cost	$82,026.75

Cost per Year at Decreasing Subsidies

Year	Federal Percentage	Annual Cost	Local Agency Cost
2009	80.00%	$82,026.75	$16,405.35
2010	72.50%	$82,026.75	$22,557.36
2011	65.00%	$82,026.75	$28,709.36
2012	57.50%	$82,026.75	$34,861.37
2013	50.00%	$82,026.75	$41,013.38
		Total Contract Amount:	**$143,546.81**

B. It shall be a condition precedent to payment of any invoice from MARC that MARC is in compliance with, and not in breach or default of, all terms, covenants and conditions of this Contract. If damages are sustained by City as a result of breach or default by MARC, City may withhold payment(s) to MARC for the purpose of set off until such time as the exact amount of damages due City from MARC may be determined.

C. No request for payment will be processed unless the request is in proper form, correctly computed, and is approved as payable under the terms of this Contract.

D. City is not liable for any obligation incurred by MARC except as approved under the provisions of this Contract.

Page 16 of 24

Figure 6.2 Sample cost-sharing agreement used to fund daily operation of the intersection included in the Operation Green Light program[85]

84 Mid-America Regional Council, Cooperative Agreement for Funding Operations of Operation Green Light Traffic Control System, 2009

85 Mid-America Regional Council, Cooperative Agreement for Funding Operations of Operation Green Light Traffic Control System, 2009

Surface Transportation Program Funds

Several of the programs investigated during this scan are using surface transportation program funds to fund all or a portion of their programs. These funds are allocated to the states from the Highway Trust Fund based on a specific formula. Generally, these funds are used to fund the construction, reconstruction, rehabilitation, resurfacing, and restoration of federal-aid highways.

Beginning in mid-1990s, Congress authorized the U.S. DOT to permit states to use STP funds to make operational improvements for highways as well. While states generally use the funds to upgrade signal equipment as part of highway construction or reconstruction efforts, a few states are using a portion of these funds to develop and implement programs to regionalize traffic signal operations. For example, beginning in 2012, the GDOT ITS RTOP will be fully funded using federal STP funds[86].

GDOT's RTOP was created specifically to continuously and consistently invest dedicated resources into improving traffic signal operations in the Atlanta area. GDOT uses these funds to hire consultant teams responsible for day-to-day operations and maintenance of more than 750 intersections in 15 corridors in the Atlanta region at their optimal level of efficiency. Currently the program is funded at $16.5 million dollars annually and is funded until 2020 as a lump sum project in the Atlanta region's transportation improvement plan. GDOT anticipates its funding to continue at this level well past 2020,.

Tax Revenue

Several locations examined during the scan utilize sales tax revenues as a means of funding their programs.

Los Angeles County, California

In Los Angeles County, the Los Angeles County Metropolitan Transportation Authority (LACMTA or Metro) is responsible for funding many of the region's traffic signal system improvement projects[87]. Proposition A and C and Measure R local sales taxes provides most of Metro's funding.

The Proposition A sales tax, approved by voters in 1980, is a one-half of 1% tax on most retail sales in the county. Metro returns 25% of the Proposition A tax to the cities in the county for transportation purposes. The balance of the Proposition A tax is restricted to 35% for rail development and 40% for discretionary purposes. Almost the entire discretionary portion is used to fund bus service provided by Metro and 16 other municipal bus operators within the county[88].

86 Waldrop G, Atlanta Regional Traffic Operaitons Program Manager, Georgia DOT, 2011

87 Gota S, Program Manager, Los Angeles County Metropolotan Transportation Authority, 2011

88 Los Angeles County Metropolitan Transportation Authority, Proposition A. Projects & Programs, http://www.metro.net/projects/measurer/proposition_a/

The Proposition C sales tax, approved by voters in 1990, is an additional one-half of 1% tax on retail sales in the county. Metro returns 20% of the Proposition C tax to the cities in the county for transportation purposes. The balance of the Proposition C tax is restricted to:

- 40% for construction and operation of the bus transit and rail system
- 5% to expand rail and bus security
- 10% for commuter rail, construction of transit centers, park-and-ride lots, and freeway bus stops
- 25% for transit-related improvements to freeways and state highways[89]

Two-thirds of the Los Angeles County voters approved Measure R in the November 2008 election. Measure R is an ordinance authorizing an additional one-half of 1% sales tax to fund traffic relief and rail expansion according to an expenditure plan contained in the ordinance. The Measure R sales tax became effective July 1, 2009, and will remain in effect for 30 years[90].

The portion of the sales tax revenue that is returned to the cities for transportation improvements is distributed to local agencies through a call for projects[91]. Only capital projects that fall into one of the following modal categories are eligible to compete for funds. Each category has specific eligibility requirements that must be met before funding can be provided. The categories of funding include:

- *Regional Surface Transportation Improvements* – These are capital improvement projects on arterial highways of regional significance that are intended to improve traffic flow and reduce congestion by eliminating arterial bottlenecks at intersections, closing gaps in the arterial system, and making other arterial improvements.
- *Good Movement Improvements* – These are capital improvement projects, such as grade separations, roadway geometric and operational improvements, intersection improvements, traffic access improvements, and other capacity enhancement on major and secondary arterials, high-truck-volume arterials, dedicated truck routes, de-facto truck routes, and/or other major freight corridors and facilities.
- *Signal Synchronization and Bus Speed Improvements* – These include capital improvement projects that use traffic signal synchronization, transit preferential treatments and priority systems, bottleneck intersection improvements, traffic control and monitoring systems, and intelligent transportation system projects to improve traffic flow on arterials.

89 Los Angeles County Metropolitan Transportation Authority, Proposition C, Projects and Programs, http://www.metro.net/projects/measurer/proposition-c/

90 Los Angeles County Metropolitan Transportation Authority, Measure R, Projects and Programs, May 18, 2011, http://www.metro.net/projects/measurer/

91 Los Angeles County Metropolitan Council of Governments, Call for Projects, Projects and Programs, http://www.metro.net/projects_studies/call_projects/images/2011_call_for_projects_application.pdf

- *Transportation Demand Management Improvements* – These involve the deployment of technology- and/or innovation-based strategies, such as ridesharing incentive/disincentive programs, parking management programs, transportation facilities amenities, commuter service centers, and new and unique demonstration projects to reduce travel demand on arterials.

- *Bicycle Improvements* – These are projects that:

  - Provide access and mobility for local and regional bicycle travel
  - Close gaps that connect bikeway networks
  - Provide on-street improvements to transit hubs
  - Promote high-capacity bicycle parking and other innovative projects that promote bicycling

- *Pedestrian Improvements* – These are capital funds for the construction of projects that improve the pedestrian environment to promote walking as a viable form of transportation.

- *Transit Capital* – These funds are used to purchase buses and to construct or improve transit facilities, such as transit centers, bus layover areas, park-and-ride lots, transit stops, commuter rail stations, and transit maintenance facilities.

- *Transportation Enhancement Activities* – These include provisions for pedestrian and bicycle facilities, preservation of abandoned railway corridors, acquisition of scenic or historic sites, landscaping and streetscaping, and the preservation and rehabilitation of historic transportation facilities.

Since 1995, LACMTA has provided more than $245 million in traffic signal synchronization and intelligent transportation system deployments in the region. Substantial funding for the program was provided through Los Angeles County's Proposition C local sales tax.

The focus of LACMTA's Signal Synchronization and Bus Speed Improvements Program (SS&BSIP) funds is to achieve the following policy objectives[92]:

- Advance sub-regional/regional deployment of signal synchronization and bus speed improvement systems
- Expand the ITS infrastructure while ensuring and maintaining compatibility and functionality among existing systems

92 Los Angeles County Metropolitan Council of Governments, Call for Projects, Projects and Programs, http://www.metro.net/projects_studies/call_projects/images/2011_call_for_projects_application.pdf

- Fill in system gaps based on regional and sub-regional needs, project readiness, and capacity to deploy
- Promote innovations in advanced traffic management systems and advanced traveler information systems on regional arterials
- Ensure coordination between signal synchronization programs, signal priority systems, arterial improvements, and goods movement efforts to increase efficiency and achieve maximum benefit
- Support the integration and distribution of arterial-level traffic signal control data between agencies to further enhance multijurisdictional signal coordination and transportation system operations

SS&BSIP projects cover a wide variety of traffic engineering measures that can be categorized into four tiers:

- Tier 1: Conventional Traffic Engineering, such as coordinated traffic signal timing and functional intersection improvements
- Tier 2: Transit Preferential Treatment and Priority Systems, such as traffic signal priority and bottleneck intersection improvements
- Tier 3: Computerized Traffic Control and Monitoring Systems, such as central traffic control, adaptive traffic control, advanced transportation management, enhanced detection, and arterial performance measurement systems
- Tier 4: Intelligent Transportation Systems (ITS), such as multiagency system integration, advanced traveler information systems, changeable message signs, and CCTV distribution networks

All projects approved for funding in the SS&BSIP category are required to provide their real-time traffic data to the County Information Exchange Network and allow for archiving through the Regional Integration of ITS Network for regional corridor performance evaluation and monitoring purposes. Furthermore, local agencies must provide operation and maintenance (O&M) plans to be eligible to receive program funds. These plans should address staffing, budget, affected changes, and future needs and their potential funding sources as related to the project improvements. Additionally, specific policies and commitments that responsible agencies have adopted to provide long-term continuation of the project must be outlined. Projects are evaluated based on local agencies' commitment to proper operation and maintenance over the life of the project. For multijurisdictional projects, the O&M plan must detail interjurisdictional cost-sharing agreements. Project applications that are submitted without thoroughly detailed O&M plans and letters of commitment are disqualified.

All identifiable costs related to capital projects are eligible for funding. These costs include, but are not limited to:

- Costs incurred for the preparation of engineering plans, systems engineering documents, and specifications and estimates
- Construction engineering
- Project management upon project commencement (not to exceed 10% of the total project cost)
- Construction management
- Construction
- Signal timing plans and the installation of signal control, monitoring, and communication equipment and systems, including leased-line communication systems, which are subject to LACMTA approval and must be consistent with LACMTA-adopted policies

LACMTA funds in this category shall not be used for right-of-way (ROW) engineering, land acquisition, or routine O&M costs. Feasibility studies are also ineligible for program funds. It is LACMTA policy to provide funding for capital expenditures only; however, locally funded ROW (e.g., ROW needed for construction), engineering, and land acquisition costs pertaining directly to the proposed project may be used as a soft match above the required 20% local hard cash match. LACMTA requires a 20% local hard cash match for all SS&BSIP projects.

Orange County, California

Orange County is another example where regional traffic signal operations are supported through sales tax revenue. Approved by Orange County voters in 1990, Measure M (M1) implemented a one-half cent sales tax dedicated to transportation infrastructure improvements. The tax was sunset in 2011.

In November 2006, voters approved a Renewed Measure M (M2), to begin in April 2011[93]. This measure extended the one-half cent sales tax through 2041. Of the net revenue from this tax, 32% was to be channeled to street and road programs in the county. Four percent of these funds was specifically allocated for the OCTA's Regional TSSP (or Project P) improvements. In 2011, OCTA awarded $8 million to local agencies to provide funding for traffic signal operations improvements for more than 520 traffic signals over 141 miles in 17 different corridors. Project funds require a 20% local match by local agencies. All projects funded by this program must be corridor-based and have a signal coordination component that includes the following:

93 Orange County Tranpsortation Authority, M2 Investment Plan, Measure M, http://www.octa.net/Measure-M/

- Develop and implement new signal synchronization timing and parameters based on current travel patterns
- Monitor (minimum quarterly, maximum monthly) and regularly improve the signal synchronization timing and parameters after the project signal timing is implemented for the remainder of the project
- Make before and after comparisons of travel times, average speed, green lights to red lights, average stops per mile, and greenhouse gases

In addition to developing optimized signal timing, projects may also include other improvements as long as they contribute to the goal of multiagency signal synchronization of corridors throughout Orange County. Items eligible for funding under this OCTA program include[94]:

- New or upgraded detection (including inductive loops and video detection or other types of detection system) necessary to achieve signal synchronization along the corridor
- New or upgraded communication, including contemporary communication system improvements (e.g., Ethernet), replacement fiber optic or copper cabling for network communication, software and hardware for system control, and control and monitoring interconnect conduit
- Communication and detection for a maximum of three years for monitoring, maintaining, and repairing communications and detection along the corridor
- Intersection/field system modernization and replacement, including antiquated traffic signal control equipment, traffic signal controller cabinet replacements, and CCTV
- Minor signal operational improvements, such as emergency vehicle preemption, transit signal priority, channelization improvement, traffic signal phasing improvements, and improvements needed to comply with new federal and state standards for traffic signal design related to signal synchronization
- TMC/traffic operation center deployments and upgrades
- Real-time traffic-actuated operation and demonstration projects, such as an adaptive traffic signal system

In addition, expenditures related to the design of systems, permitting, and environmental clearance are eligible for funding using Project P funds. Improvements that are not eligible for funding through the program include:

94 Orange County Transportation Authority, RCP RTSSP Call, Transportation Funding, http://www.octa.net/About/Transportation-Funding/Calls-for-Projects/RCP-RTSSP-Call/

- Isolated traffic signal improvements
- Traffic hardware upgrades (e.g., poles, mast arms, lights, electrical, and signs)
- Regular signal operations and maintenance (e.g., bulb replacements)
- Feasibility studies
- Relocation studies
- Battery backup systems
- ROW

Pima County, Arizona

Funding for regional traffic signal operations in Pima County is provided through a combination of Transportation Improvement Program (TIP) funding sources and funds provided through the Regional Transportation Authority (RTA). The RTA was formed in April 2004 after legislation creating the authority was signed by then-Governor Janet Napolitano[95]. The RTA became effective August 25, 2004.

The RTA is governed by a nine-member board that includes representatives for the Cities of South Tucson and Tucson; Pima County; the Towns of Marana, Oro Valley, and Sahuarita; the Pascua Yaqui Tribe; the Tohono O'odham Nation; and the Arizona State Transportation Board. Representatives of these agencies developed a 20-year, $2.1 billion plan for roadway, safety, transit, and environmental and economic vitality projects. Elements of the plan include intersection and capacity improvements, elderly and pedestrian safety improvements, transit-corridor bus pullouts, signal technology upgrades, and improvement to at-grade railroad crossings and bridges. A one-half cent sales tax over a 20-year period is the funding source for these improvements. Fifteen million dollars has been set aside for improving signal and communication technologies. The region's voters approved the plan and the sales tax increase in 2006.

Beginning in 2013, $700,000 in RTA funds has been programmed to the PAG over the next three years to support the RTSOP[96]. PAG has taken a cooperative approach to funding its regional program. It has secured funding through traditional TIP sources as well as transportation sales tax funding by developing grouped signal projects on behalf of and endorsed by all jurisdictions in the region for various equipment purchases and signal timing/operations services. This approach lends weight to the funding submittal and gives it a regional endorsement, which helps the project compete more effectively with traditional construction projects.

95 Pima County Regional Transportation Authority, About RTA, RTA: Delivering Our Promise to You, http://www.rtamobility.com/Home/tabid/38/Default.aspx

96 Casertano P, Transportation Safety and Operations Lead, Pima Association of Governments, April 5, 2010

Las Vegas, Nevada

Traffic signal operations in Las Vegas are also supported through a regional sales tax. Southern Nevada's RTC receives funding supported by a one-eighth cent transportation tax[97,98]. These funds are used to finance major roadway capital improvements and other transportation improvements.

A small portion of this tax revenue is used to fund the arterial management portion of the RTC's Freeway and Arterial System for Transportation (FAST) program. These funds are used primarily to provide staffing support for the FAST center. They are also used to provide support for improving and upgrading the region's signal program, maintaining the communications network, and facilitating repairs to controller equipment. NDOT provides funding for the freeway management side of FAST.

97 Hoeft B, Assistant Director, Regional Transportation Commission of Southern Nevada, November 2011

98 Regional Transportation Commission of Southern Nevada, Welcome to NVFAST.org! Freeway & Arterial System of Transportation, cited May 18, 2011, http://www.nvfast.org/

CHAPTER 7

Operations

Agencies were asked to provide insight into the way their regional transportation signal operations program functions both within their region and with respect to their local partners. The manner in which the programs operate varied considerably. While all of the programs focused on developing and installing interjurisdictional coordination timing plans, not all of the programs actually operated the signals once the timings were installed. In some programs, the regional entities were responsible for just developing the timing plans. In others, the regional entity might also develop and implement timing plans. In other programs, the regional entity assumed the responsibility of installing, deploying, and maintaining the regional communications infrastructure. Only a few regions were responsible for performing real-time monitoring and signal timing adjustment functions.

Base Level of Operations

Operational capabilities and decisions are highly dependent on the base level of control equipment. For example, without time clocks, agencies cannot provide basic coordination functions between multiple intersections.

Some agencies (e.g., DRCOG) have been successful in providing funding to local agencies for infrastructure upgrades by establishing a base level of functionality. Agencies should define a base level of functionality and performance expectations for their traffic signals and strive to bring all traffic signals up to a certain level of performance. Conducting a comprehensive system inventory will help agencies identify what base equipment they have (or wish they had) to achieve certain performance goals.

Agencies need to discuss what regional timing parameters need to be implemented. In many systems, local agencies are responsible for establishing basic signal timing parameters (e.g., minimum greens, clearance intervals, and left-turn phasing); regional entities build coordination timing plans around these policies and preferences. Agencies need to define a clear regional concept of operations, supported by standard operating procedures.

Having an RTSOP allows agencies to be more cautious about adopting and implementing new and unproven technologies. Because systems have to operate from a regional perspective, consensus is needed before agencies can adopt cutting-edge or unproven systems or technologies that might not be consistent with regional goals, objectives, or operational concepts or are beyond the region's knowledge, skills, and abilities to support.

Centralized Regional Control

The need for a regional operations center is highly dependent on the way agencies plan to operate

their system. If agencies are just setting coordination timing plans, a regional center may not be needed. However, if agencies are planning to manage traffic signal timings in real-time, agencies need an infrastructure that supports this type of operation and the agency's commitment to operate the center.

Las Vegas, Arizona

In the FAST system, all traffic signals in the region are managed through a single traffic-management system software[99]. Except for communications failures, FAST operators do little real-time monitoring of traffic signal operations. Instead, FAST signals are designed to operate on a time-of-day pattern. Seven time-of-day plans are used to manage arterial flows (i.e., early morning, morning peak, midday, evening peak, evening, late night, and free operations). Operators can call special timing plans or make real-time adjustments to traffic signals during incident conditions.

FAST operators are responsible for developing the coordination timing plans for each of the major corridors, which includes establishing the cycle length, splits, and offsets associated with each coordination plan. RTC attempts to review timing plans from approximately two-thirds of the network annually.

Kansas City, Kansas/Missouri

OGL is example of a program that has shared responsibility[100]. Under normal traffic operating conditions, each member agency retains the responsibility of operating the traffic signals in its own jurisdiction. However, OGL provides weekday operations monitoring for system malfunctions and dispatches the appropriate agencies' personnel.

Under incident conditions, MARC has the authority to implement special timing plans. These plans were developed specifically for incident conditions using cooperatively developed criteria to identify the conditions and circumstances under which MARC would invoke these plans.

MARC is required to notify each impacted agency immediately when these incident timing plans have been implemented[101]. MARC is responsible for developing the timing plans that are deployed in the corridors in conformance to each member agency's operating policies for yellow and all-red clearance, pedestrian timing, and signal phasing. Each agency had the authority to approve or disapprove of the developed timing plans, and is responsible for final approval of the signal timing plan, which OGL then implements. Three of the 21 agencies require downloading the traffic signal timing plans in their own jurisdictions.

To facilitate regional monitoring of traffic signal operations and the implementation of incident-

99 Hoeft B, Assistant Director, Regional Transportation Commission of Southern Nevada, November 2011
100 Webb R, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, 2011
101 Achelpohl R, Assistant Director of Transportation, Mid-America Regional Council, April 2010

related traffic signal timing plans, MARC also developed new advanced traffic-management system software that provides multiuser, multijurisdictional access to ITS field devices[102]. The software uses current National Transportation Communications for ITS Protocol[103] (NTCIP) specifications to allow agencies to communicate and control Type 170, 2070 and 2070N actuated traffic controllers, and NTCIP compliant National Electrical Manufacturers Association (NEMA) controllers. This software provides:

- Regional incorporation of traffic signals into a traffic-coordinated network in the MARC area among member cities
- Continuous, automatic central monitoring of priority corridors in the MARC area
- Implementation of optimized regional timing plans across multiple jurisdictions
- The ability for workstations to be connected to the central traffic operations center through local area network, wide area network, and virtual private network (LAN, WAN, and VPN), thus facilitating monitoring of traffic behavior from a regional perspective
- Operational failure monitoring, logging (including failure by date, time, nature, and location), and appropriate response
- Real-time monitoring of the status of all controllers in the system, including phase status (both vehicle and pedestrian), flash status, local and master timers, preempt on or off, current timing plan details, mode of operation, and controller status
- Automatic and user-defined reporting of failures and alarms
- Incident management through central deployment of appropriate timing plans to impacted signals
- Camera software that is shared throughout the region (The control software is housed with the OGL servers [shared space with Kansas City Scout]. The region shares hundreds of traffic-monitoring CCTVs that can be viewed on smart phones.)

Staffing

The type and level of staffing used in the reviewed programs varied considerably from location to location and depend primarily on the functions performed by the RTSOP. Programs whose primary function is to distribute funds to local agencies tend to have relatively small staffing needs (i.e., one to two individuals), while programs that are more involved in developing and implementing timing plans tend to have larger staff sizes.

102 Mid-America Regional Council, Functional Specifications for System Integrator, Operation Green Light, cited May 18, 2011, http://www.marc.org/transportation/ogl/documents.htm

103 National Transportation Communications for ITS Protocol, http://www.ntcip.org/

Denver, Colorado

The DRCOG employs four engineers and three technicians as well as consultant assistance through its program. However, in the Denver area, local agencies are responsible for the day-to-day operations of their signals; DRCOG staff members provide traffic signal timing development and project evaluation services[104].

Kansas City, Kansas/Missouri

OGL is staffed by three full-time signal analysts and a traffic signal engineer[105]. MARC staff is also responsible for day-to-day operations and maintenance of the overall regional communications networks that connects all traffic signals in the defined OGL signal network. MARC maintains the field communications equipment it purchased while constructing the regional communications network, while the individual entities maintain the pre-existing, city-owned communications equipment that was used as part of the construction.

Phoenix, Arizona

Many programs use consulting services to supplement the ability of the local agencies to generate timing plans. For example, in the Phoenix area, MAG has several on-call local consultants who have extensive experience developing multijurisdictional timing plans for local agencies[106]. Once a plan is approved, MAG works with the local agencies to develop a final scope of work for the project. MAG then issues a task order to one of its consultants under the terms of the on-call project. The consultant firm is then responsible for coordinating the development of the timing plans with the local entity and making recommendations to the local entity for signal timing improvements that promote interjurisdictional operations. Local agencies are not required to approve and implement the required timing plans; however, as the local agencies have numerous opportunities to provide input throughout the process, the likelihood of a local agency rejecting the recommended timing plans is minimized.

By applying for funding through the program, local agencies are required to:

- Appoint a project manager to be the point of contact between the agency and the assigned consultant
- Provide all necessary background information to the consultant, including local requirements and policies concerning phasing sequencing, clearance intervals, and speed limits for all intersections within the project's boundary

104 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010
105 Webb R, Manager of Traffic Operations, Operation Green Light, Mid-America Regional Council, 2011
106 Josua S, ITS & Safety Program Manager, Maricopa Association of Governments, November 2011

- Coordinate required traffic counts during the morning and evening peaks and during off-peak periods (This is a requirement only if the agency volunteered to do so in the application.)
- Implement the signal timing plans recommended by the program in field devices
- Provide the agency's implemented signal timing data to MAG to share with adjacent jurisdictions via the Regional Archive Data Server.

North Central Texas

NCTCOG was responsible for procuring the consultant responsible for assessing corridor operations[107]. The consultant was responsible for:

- Assessing corridor operations prior to initiating improvements
- Collecting all necessary volume and turning movement counts needed to establish new timing plans
- Developing new timing plans for the corridors
- Identifying any needed changes to lane assignment or restriping that would improve operational efficiency
- Conducting a before-and-after assessment of the improvements in operational performance

San Francisco Bay Area, California

MTC is responsible for contracting with local consultants to perform the work and pays the consultant directly[108]. MTC is also responsible for assigning a consultant it has retained to each project. This consultant is responsible for completing these tasks[109]:

- Collecting and analyzing all information necessary to thoroughly understand existing traffic conditions in the study area and developing optimal time-of-day traffic signal coordination plans and transit signal priority plans, including:
    - Collecting existing timing sheets, coordination plans, as-built plans, aerial photographs, maps, collision diagrams, and other pertinent documentation

107 Bettger N, Senior Program Manager, North Central Texas Council of Governments, 2011

108 Stanislaus D, Senior Planner & Program Manager, Freeway Performance Initiative & Arterial Operations Program, Metropolitan Transportation Commission, 2011

109 Metropolitan Transportation Commission. Program Guidelines for 2011/2012 Cycle of Projects, Progam for Arterial System Synchronization, January 2011, cited May 18, 2011, http://www.mtc.ca.gov/services/arterial_operations/downloads/PASS_Guidelines_2011-12.pdf

  - Conducting peak-period turning movement counts (including pedestrian and bicycle counts) and seven-day 24-hour machine counts
  - Conducting field review of all study intersections and street segments to verify lane geometry, speed limits, storage lengths, signal phasing, distance between intersections, and crosswalk lengths
  - Observing typical traffic patterns during the weekday peak period for which coordination plans are being developed
  - Verifying the signal coordination and transit priority capabilities of the existing equipment and communications infrastructure
  - Conducting travel time and delay studies, including number of stops, during times and days that are representative of "before" conditions
- Developing a model of the study area and calibrating it to existing conditions based on field observations
- Developing recommended optimal timing plans, including initial and actuated settings, time-of-day coordination plans and hours of coordinated operation, and transit signal priority plans
- Implementing and evaluating the approved improvements, including:
  - Preparing appropriate timing sheets based on approved timing plans
  - Assisting with the deployment of GPS clocks, if required by the project
  - Implementing or assisting local agencies to implement new traffic signal settings and timings
  - Fine-tuning or assisting local agencies in fine-tuning new traffic signal timing settings and parameters
  - Conducting travel time and delay studies for the "after" evaluation
  - Calculating measures of effectiveness of the improved system

In addition to traditional signal timing plans, program consultants may be requested to perform additional services (e.g., developing incident management flush plans, transit signal priority plans, traffic responsive timing plans, or weekend timing plans).

The assigned consultants work directly with the local agency (or agencies) sponsoring the project. MTC's role is to ensure that high-quality, timely, and within-budget technical assistance is provided

for the agreed-upon scope of work. Local agencies agree to review and approve project deliverables and assist the consultant with implementing the timing plan within one year of the award date.

System and Hardware Maintenance

The program's organizational structure and the functions it performs define the agencies' maintenance roles and responsibilities. With most programs, the local agencies retain the responsibility for operating and maintaining the traffic signal hardware at the intersections (e.g., cabinets, controllers, signal heads, and basic timing parameters), while regional entities are responsible for operating and maintaining the regionally based assets (e.g., communications infrastructure, regional coordination timing plans, and GPS clocks). Only a few locations have looked at regionalization as a resource sharing opportunity for maximizing maintenance capabilities.

Table 7.1 shows a summary of the level of maintenance performance by the different RTSOPs. Most RTSOPs do not perform routine or preventive maintenance or emergency repair of traffic signals. In most cases, the RTSOP requires that the local entities in whose jurisdiction the traffic signal is located perform maintenance activities associated with the traffic signals and/or the traffic signal cabinets. This includes emergency repairs or knock-downs, as well as routine maintenance (e.g., re-lamping traffic signal heads or preventive maintenance activities). In some cases, local entities will have either maintenance contract agreements with private maintainers, or state or county DOTs to perform their after-hour emergency repairs and preventive maintenance.

Table 7.1 Types of maintenance activities performed by various RTSOPs

Location	Maintenance activities				
	Timing plans	Communications	Central software	Routine/ preventive field device	Emergency field repairs
Atlanta	✓	✓		✓	✓
Denver	✓				
Kansas City	✓	✓	✓		
Las Vegas	✓	✓	✓		
Los Angeles County	✓	✓	✓		
North Central Texas	✓				
Oakland County/Southeast MI	✓	✓	✓	✓	✓
Orange County	✓				
Phoenix	✓				
San Francisco	✓	✓			
Southwest PA	✓				
Tucson	✓	✓	✓	✓	

System operations concepts can be used to establish performance goals and requirements (e.g., system uptime and time between trouble calls), which helps drive requirements for maintenance.

Agencies have developed performance requirements that can help ensure funding for equipment upgrades and replacement. Agencies should consider setting performance/response time standards to ensure equipment is maintained to a base level of functionality. Setting a base level of operations can be used to help ensure that regional benefits are maintained over time. The development of a regional concept of operations and regional architectures allow agencies opportunities to establish regional performance goals and requirements.

Some programs (i.e. Bay Area Metro[110], LA County[111], and DRCOG[112]) permit minor upgrades to equipment (e.g., controller replacements/upgrades and GPS clock installation) needed to support implementation of regional coordination. An inventory of intersections' capabilities should be part of a project assessment to ensure that the timing plans can be implemented, including the basic timing parameters (e.g., minimum greens and clearance intervals).

Hardware standardization increases operational flexibility. Having standardized equipment is most common within regional programs where the lead agency has operational authority or traffic signal systems (e.g., state DOTs or county agencies). Once signal systems have all reached the same base level of operations, agencies need to review equipment standards periodically to ensure that signal design standards are consistent with operational objectives. Establishing a base level of functionality (e.g., DRCOG[113]) provides the potential to equitably distribute funding to member agencies. The base level of functionality should be tied to the system objectives.

Agencies should incorporate the development and replacement of hardware and software traffic signal life cycles into their long-range plan. Research is needed to help identify "complete" costs associated with the hardware and software for monitoring operations and timings. These life-cycle costs need to include a regional benefit-cost calculation.

110 Stanislaus D, Senior Planner & Program Manager, Freeway Performance Initiative & Arterial Operations Program, Metropolitan Transportation Commission, 2011

111 White J, Senior Civil Engineer, Los Angeles County DOT, 2011

112 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010

113 MacKinnon G, Transportation Operations Manager, Denver Regional Council of Governments, April 2010

CHAPTER 8

Performance Measures and Monitoring

Demonstrating the benefits of the programs is essential to successfully sustaining the program over time. Most of the agencies at the workshop reported that they often use performance measures to report the benefits achieved through individual projects. Few agencies reported providing programmatic assessments of the long-range benefits of regional traffic signal operations. The type of performance measures that are used is directly related to the type of funding being used to make improvements.

Three levels of performance measures are needed:

- *Operational measures* – Operators use operational measures for a real-time assessment of the arterial system's current performance and to help them make operational decisions.
- *Project-level assessments* – These are generally before and after assessments of the benefits received by making an improvement in a corridor. Project-level performance measures are generally dictated by the type of funding used for the improvements (e.g., assessing air quality improvements is directly linked to the use of CMAQ funds).
- *Programmatic performance measures* – These are used to assess the overall benefits of having a program to address regional traffic signal operations. These measures generally focus on large-scale (i.e., macroscopic-level) benefits and include such measures as the number of traffic signal timing plans developed each year and the number of miles of communications interconnection. Programmatic performance measures should be tied directly to the long-range transportation plan.

Performance Measures

Table 8.1 shows the performance measures agencies commonly use to assess the effectiveness of their RTSOP improvements. Most regions use pilot or demonstration projects to generate support and establish the potential benefits of an RTSOP. Generally, these pilot or demonstration projects include a before-and-after comparison of travel times and delays associated with trips through a particular corridor. The pilot's results are often published in a report and/or presented to the program's technical advisory board or traffic forum.

Table 8.1 Performance measures agencies use to assess RTSOP strategies' effectiveness

Location	Performance measures					
	Travel times/ speed	Delays	Stops	Fuel con-sumption	Emissions	Others
Denver	✓			✓	✓	User savings
Kansas City	✓		✓	✓	✓	
Las Vegas	✓	✓	✓			Vehicle throughput
Los Angeles County	✓					Citizen complaints
North Central Texas	✓		✓	✓	✓	
Oakland County/ Southeast MI	✓	✓	✓			Citizen complaints, crash frequency and rates, throughput
Orange County	✓	✓	✓	✓	✓	Corridor synchronization performance index
Phoenix/MAG	✓	✓				
San Francisco	✓	✓	✓	✓	✓	Benefit cost; effects on transit
Southwest PA	✓	✓	✓	✓	✓	Benefit cost
Tucson/PAG	✓	✓				Throughput

Pilot or demonstration projects allow a regional entity to illustrate the potential benefits to be derived from the program and to build political and institutional support with local stakeholders. These projects also allow regional entities to validate and fine-tune the processes and procedures that they will implement in a full-fledged program.

Operators and policy decision makers need different types of performance metrics. The performance measures used in a region should directly relate to the region's long-range transportation plan and be traceable back to program goals and objectives.

The Orange County Corridor Synchronization Performance Index (CSPI) is an example of a performance measure that can be used to address multiple stakeholder groups[114,115]. In addition to standard traffic signal performance measures (e.g., intersection stops and delays and reduction in emissions), OCTA uses three primary measures of effectiveness: speed, the "green/red" ratio[116], and the number of stops per mile. OCTA combines these three measures to provide the CSPI. Because it is a composite score, the CSPI it allows OCTA to compare the effectiveness of different synchronization projects that have been designed to address different operational issues (e.g., different

114 Orange County Transportation Authority, Signal Demonstration, Orange County Transportation Authority, 2010, cited May 18, 2011, http://www.octa.net/signal_demonstration.aspx

115 Keith R, Principal Traffic Engineer, Orange County Transportation Authority, November 2011

116 The "green/red" ratio is the number of intersections through which a floating car can pass on a green indication compared to the number of intersections at which the vehicle is stopped by a red indication.

progression patterns for alternate times-of-day and directions of flow).

OCTA uses a performance standard for acceptable level of operations for roadways operating in its RTSOP. Roadways that have a CSPI score of 70 or more are considered to be operating well. A report on the performance of the system is produced every three years.

Agencies need to be more aggressive in measuring a corridor's performance (e.g., by driving the street more often to determine if signal timing is still being maintained and monitoring current operations). The quality of progression needs to be proactively assessed from a programmatic standpoint. For example, after completing a retiming project it took me X minutes to complete a trip. Does it still take me X minutes?

Some agencies are trying to identify hardware maintenance issues proactively, before they are observed by the motoring public. For example, GDOT has established a performance goal of identifying 70% of all hardware performance issues before they are reported by the public.

Performance Reporting

Having clear, definable performance measures allows agencies to market programs to decision makers. Marketing the successes of programs is critical to sustaining and growing them.

Denver, Colorado

Every year, DRCOG produces an annual benefits summary of projects, which it posts on its web site[117]. The report summarizes the travel time, fuel reduction, pollution benefits, and user savings associated with each project conducted that calendar year. Figure 8.1 shows the annual benefits summary report for 2010[118].

117 Denver Regional Council of Governments, Traffic Signal Program, Transportation, Denver Regional Council of Governments, http://www.drcog.org/index.cfm?page=TrafficSignalProgram

118 Denver Regional Council of Governments, Traffic Signal Program, Transportation, Denver Regional Council of Governments, http://www.drcog.org/index.cfm?page=TrafficSignalProgram

Project (Click on the project name below to access the *Signal Timing Brief*)		Limits	Number of Signals	Jurisdictions (Operators*)	Project Type	Benefits				
						Travel Time Reduction (Hours/day)	Fuel Consumption Reduction (Gal/day)	Pollutant Emissions Reduction (lbs/day)	Greenhouse Gas Emissions Reduction (lbs/day)	User Savings ($/day[1])
T11-1	Hampden Avenue/Havana Street	Colorado Boulevard to Parker Road	27	Denver*, Aurora	Capital Improvement Traffic Signal Timing	1,146	594	143	12,334	$24,900
T11-2a	72nd Avenue	Indiana Street to Lamar Street	27	Arvada*, CDOT	Capital Improvement Traffic Signal Timing	388	205	54	4,234	$8,450
T11-2b	Ward Road	44th Avenue to 64th Avenue	8	CDOT*, Wheat Ridge	Traffic Signal Timing	373	175	38	3,666	$8,100
T11-2c	64th Avenue	Quaker Street to Yank Way	9	Arvada*, CDOT*	Traffic Signal Timing	99	46	14	962	$2,150
T11-3a	North Sheridan Boulevard	Sheridan Boulevard: 120th Avenue to 72nd Avenue 88th Avenue: Lamar Drive to Sheridan Avenue	27	Westminster*, CDOT	Traffic Signal Timing	1,021	513	135	10,635	$22,150
T11-3b	92nd Avenue	Pierce Street to Lowell Boulevard	9	Westminster*	Traffic Signal Timing	198	91	22	1,861	$4,300
T11-3c	Sheridan Boulevard	52nd Avenue to 72nd Avenue	11	CDOT*, Westminster	Capital Improvement Traffic Signal Timing	395	209	54	4,350	$8,600
T11-4	North Colorado Boulevard	88th Avenue to 136th Avenue	22	Thornton*	Traffic Signal Timing	250	121	30	2,518	$5,450
T11-5a	Broadway (Boulder)	University Avenue to Greenbriar Boulevard	23	Boulder*	Capital Improvement Traffic Signal Timing	322	179	46	3,680	$7,000
T11-5b	Baseline Road (Boulder)	17th Street to 30th Street	7	Boulder*	Capital Improvement Traffic Signal Timing	99	69	18	1,412	$2,200
T11-6	Colfax Avenue	Welch Street to Kendall Street	14	Lakewood*	Capital Improvement Traffic Signal Timing	478	250	63	5,206	$10,400
T11-7	Easter Avenue/Broncos Parkway	Havana Street to Jordan Road	11	Centennial*, Arapahoe County*, CDOT	Capital Improvement Traffic Signal Timing	170	88	24	1,820	$3,700
T11-8	Colorado Boulevard	Alameda Avenue to 48th Avenue	25	Denver*	Traffic Signal Timing	614	324	89	6,688	$13,300
T11-9	Vasquez Boulevard	56th Avenue to 77th Avenue	9	CDOT*, Commerce City	Traffic Signal Timing	323	169	39	3,308	$7,050
T11-10a	104th Avenue	Federal Boulevard to Colorado Boulevard	21	Northglenn*, Thornton*, Westminster*, Federal Heights*, CDOT*	Traffic Signal Timing	139	66	16	1,364	$3,000
T11-10b	Washington Street	102th Avenue to 120th Avenue	10	Northglenn*, Thornton*	Traffic Signal Timing	388	200	52	4,149	$8,450
T11-11	88th Avenue	Huron Street to Dahlia Street	13	Thornton*	Traffic Signal Timing	373	184	47	3,775	$8,050
T11-12	Central Colfax Avenue	Sheridan Boulevard to I-25	11	Denver*	Capital Improvement Traffic Signal Timing	215	162	39	3,333	$5,100
		Total	**284**			**6,991 Hours**	**3,634 Gallons**	**922 lb**	**76,296 lb**	**$162,350**

1. Fuel @ $2.71/Gal., Time Value @ $20.34/Hr.

Figure 8.1 Annual benefits summary of projects completed by DRCOG[119]

In addition to the annual benefits summary report, DRCOG also prepares a *Signal Timing Brief* immediately after each signal timing project. (Figure 8.2 is an example of these briefs[120].) Each brief provides a more in-depth analysis of the benefits generated by individual projects. DRCOG distributes these briefs to project stakeholders and decision makers and makes them available as hyperlinks from the annual benefits summary report.

119 Denver Regional Council of Governments, Projects Completed in 2011, Traffic Signal Program, December 2012, http://www.drcog.org/documents/2011%20projects.pdf

120 Denver Regional Council of Governments, 72nd Avenue: Indiana Street to Lamar Street, Traffic Signal *Timing Brief*: March 2011 – T11-2a, http://www.drcog.org/documents/T11-2a_Signal_Timing_Briefs_72Avenue.pdf

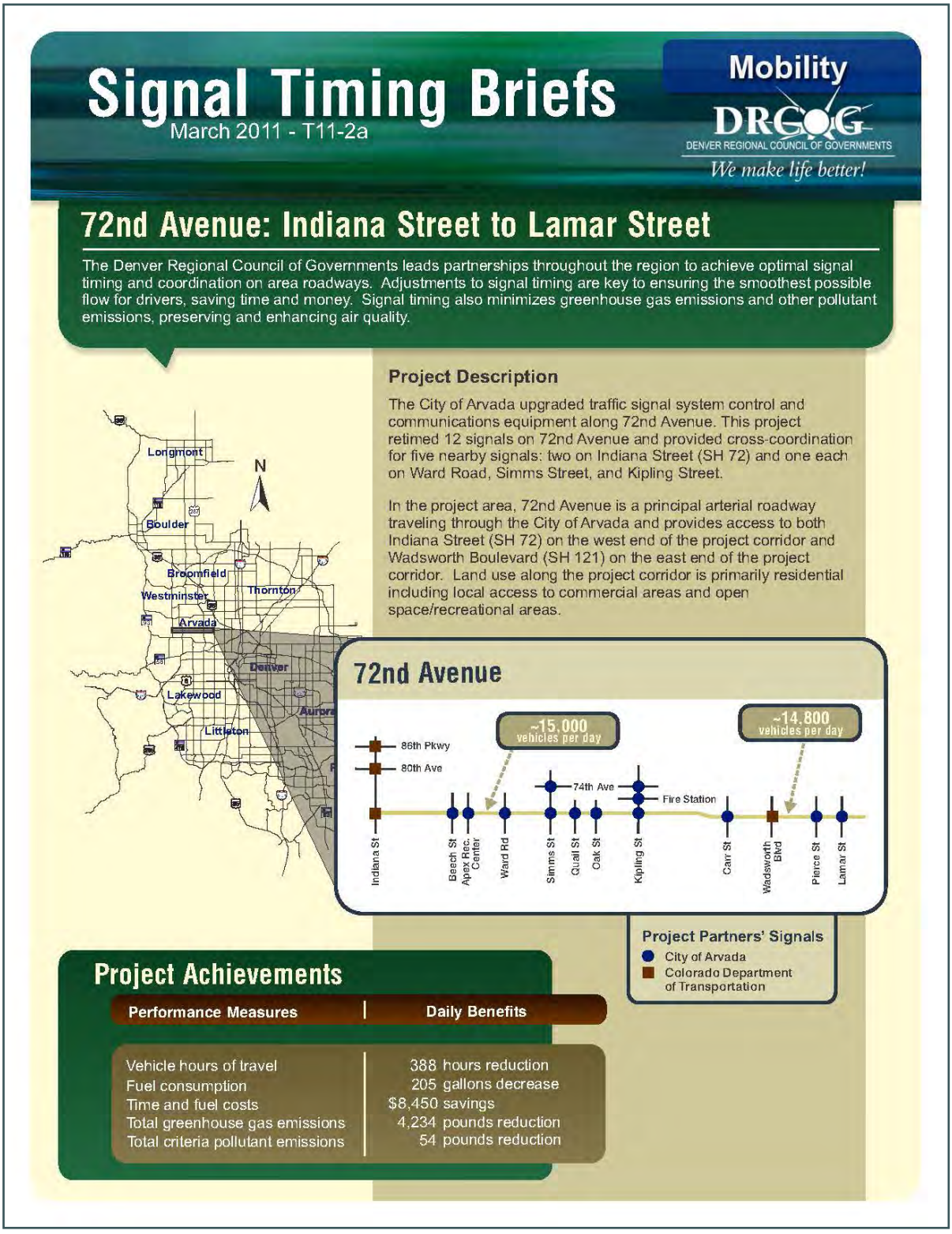


Figure 8.2 Sample Signal Timing Brief produced by DRCOG on traffic signal retiming project[121]

121 Denver Regional Council of Governments, 72nd Avenue: Indiana Street to Lamar Street, Traffic *Signal Timing Brief*: March 2011 – T11-2a, http://www.drcog.org/documents/T11-2a_Signal_Timing_Briefs_72Avenue.pdf

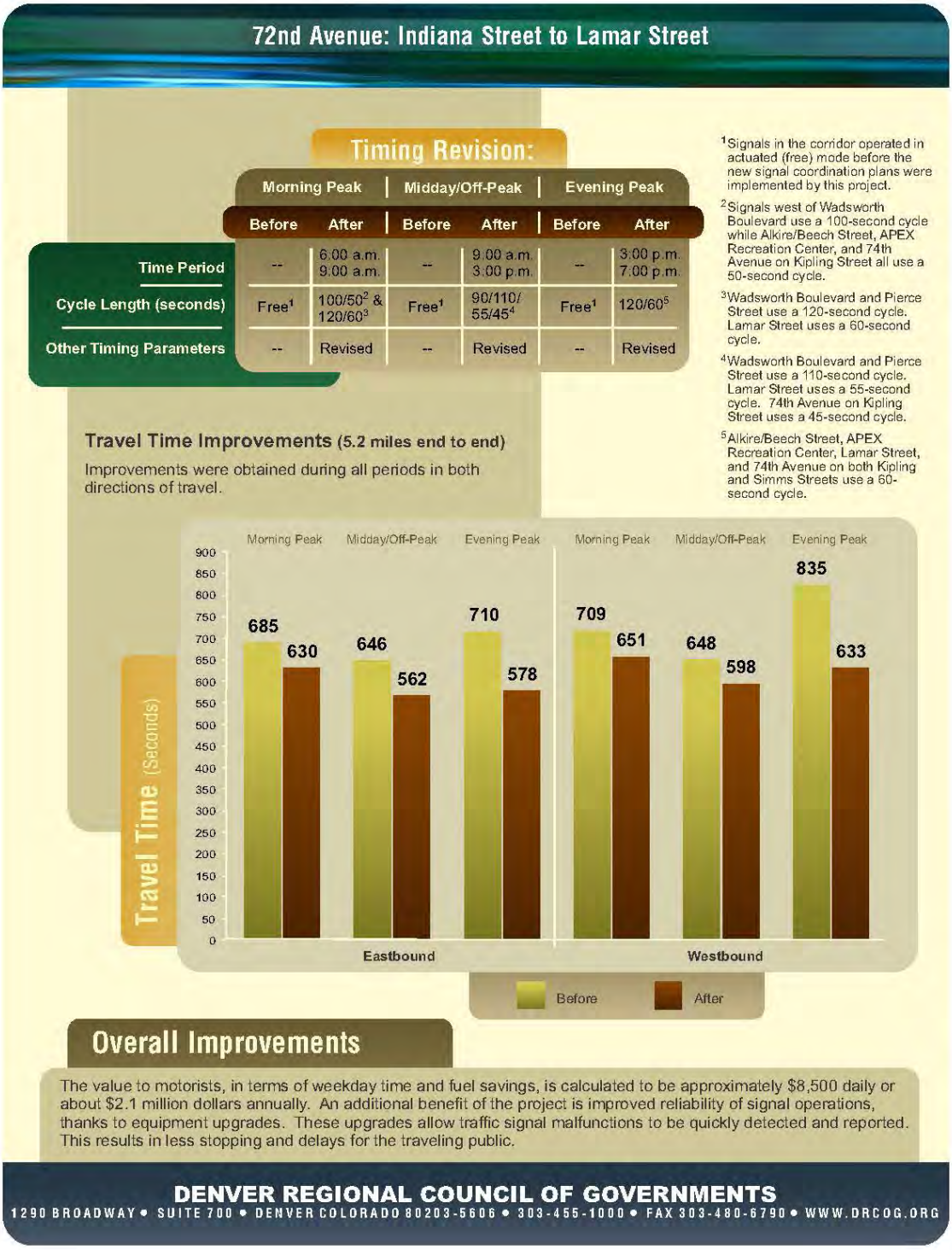


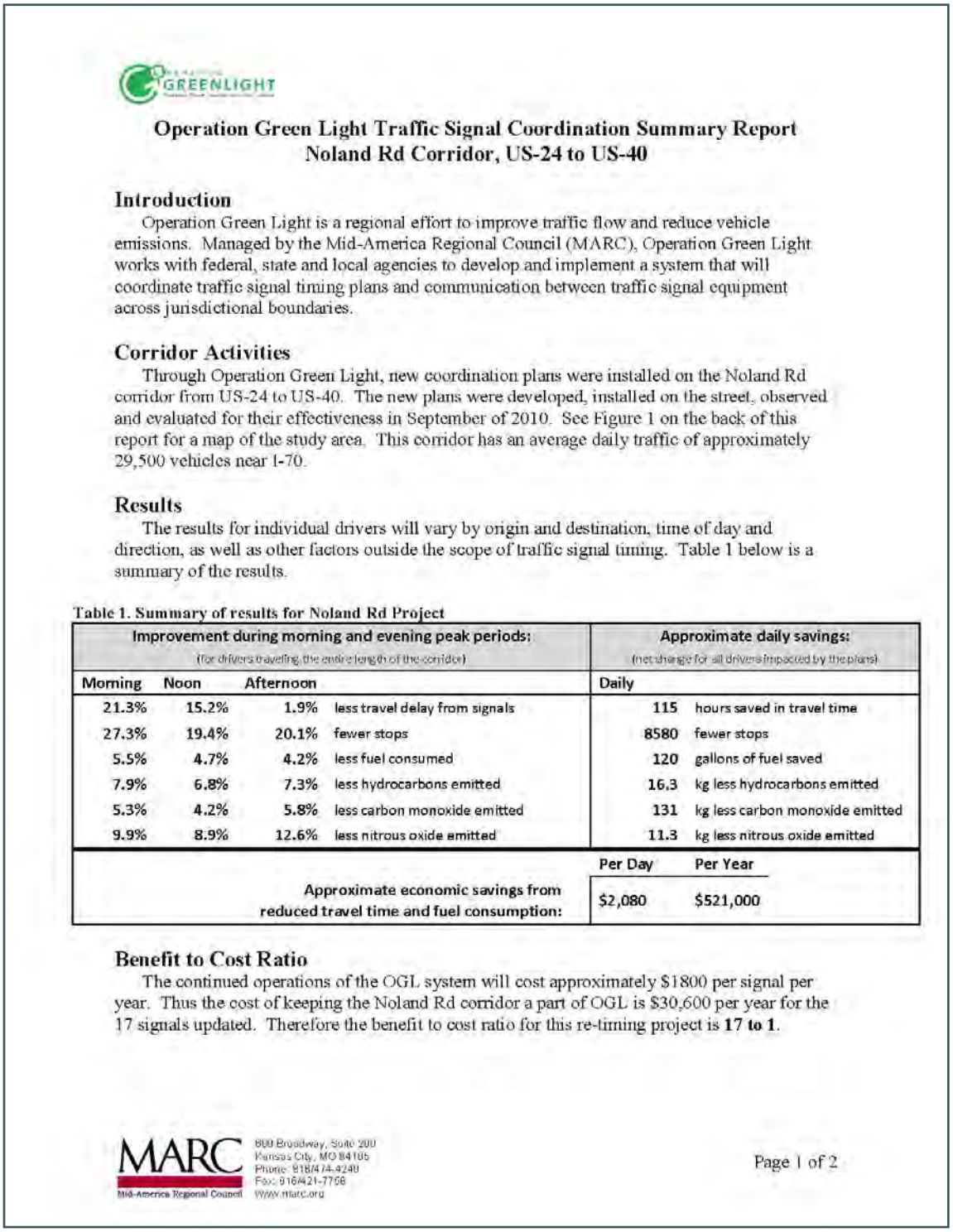
Figure 8.2 Sample Signal Timing Brief produced by DRCOG on traffic signal retiming project (continued)

Kansas City, Kansas/Missouri

After new timing plans have been implemented in a corridor, MARC performs an evaluation study of the effectiveness of the improvements on traffic flow and vehicle emissions[122]. MARC conducts before and after travel times during the corridor's morning, noon, and evening peak periods to measure changes in travel time, number of stops, speed of travel, fuel consumed, and harmful emissions for a single vehicle driving the length of the corridor. Travel delay is computed by taking the difference between the measured and the ideal travel times at the speed limit. The results of the analysis are then summarized in a written report documenting the effects of the traffic signal timing improvements. An example of a MARC summary report is provided in Figure 8.3[123].

122 Mid-America Regional Council, Traffic Signal Coordination Measures of Effectiveness Methodology, Operation Green Light: Signal Coordination Project, http://www.marc.org/transportation/ogl/pdfs/signal/OGL-MOE-Methodology.pdf

123 Mid-America Regional Council of Governments, Noland Road Corridor, US-24 to US-40, Operation Green Light Signal Cordination Projects, http://www.marc.org/transportation/ogl/pdfs/signal/Noland-Road-Basic-Report.pdf



GREENLIGHT

Operation Green Light Traffic Signal Coordination Summary Report
Noland Rd Corridor, US-24 to US-40

Introduction

Operation Green Light is a regional effort to improve traffic flow and reduce vehicle emissions. Managed by the Mid-America Regional Council (MARC), Operation Green Light works with federal, state and local agencies to develop and implement a system that will coordinate traffic signal timing plans and communication between traffic signal equipment across jurisdictional boundaries.

Corridor Activities

Through Operation Green Light, new coordination plans were installed on the Noland Rd corridor from US-24 to US-40. The new plans were developed, installed on the street, observed and evaluated for their effectiveness in September of 2010. See Figure 1 on the back of this report for a map of the study area. This corridor has an average daily traffic of approximately 29,500 vehicles near I-70.

Results

The results for individual drivers will vary by origin and destination, time of day and direction, as well as other factors outside the scope of traffic signal timing. Table 1 below is a summary of the results.

Table 1. Summary of results for Noland Rd Project

Improvement during morning and evening peak periods: (for drivers traveling the entire length of the corridor)				Approximate daily savings: (net change for all drivers impacted by the plans)	
Morning	Noon	Afternoon		Daily	
21.3%	15.2%	1.9%	less travel delay from signals	115	hours saved in travel time
27.3%	19.4%	20.1%	fewer stops	8580	fewer stops
5.5%	4.7%	4.2%	less fuel consumed	120	gallons of fuel saved
7.9%	6.8%	7.3%	less hydrocarbons emitted	16.3	kg less hydrocarbons emitted
5.3%	4.2%	5.8%	less carbon monoxide emitted	131	kg less carbon monoxide emitted
9.9%	8.9%	12.6%	less nitrous oxide emitted	11.3	kg less nitrous oxide emitted

	Per Day	Per Year
Approximate economic savings from reduced travel time and fuel consumption:	$2,080	$521,000

Benefit to Cost Ratio

The continued operations of the OGL system will cost approximately $1800 per signal per year. Thus the cost of keeping the Noland Rd corridor a part of OGL is $30,600 per year for the 17 signals updated. Therefore the benefit to cost ratio for this re-timing project is **17 to 1**.

MARC Mid-America Regional Council
600 Broadway, Suite 200
Kansas City, MO 64105
Phone: 816/474-4240
Fax: 816/421-7758
www.marc.org

Page 1 of 2

Figure 8.3 Example benefits summary report produced by Operation Green Light[124]

124 Mid-America Regional Council of Governments, Noland Road Corridor, US-24 to US-40, Operation Green Light Signal Cordination Projects, http://www.marc.org/transportation/ogl/pdfs/signal/Noland-Road-Basic-Report.pdf

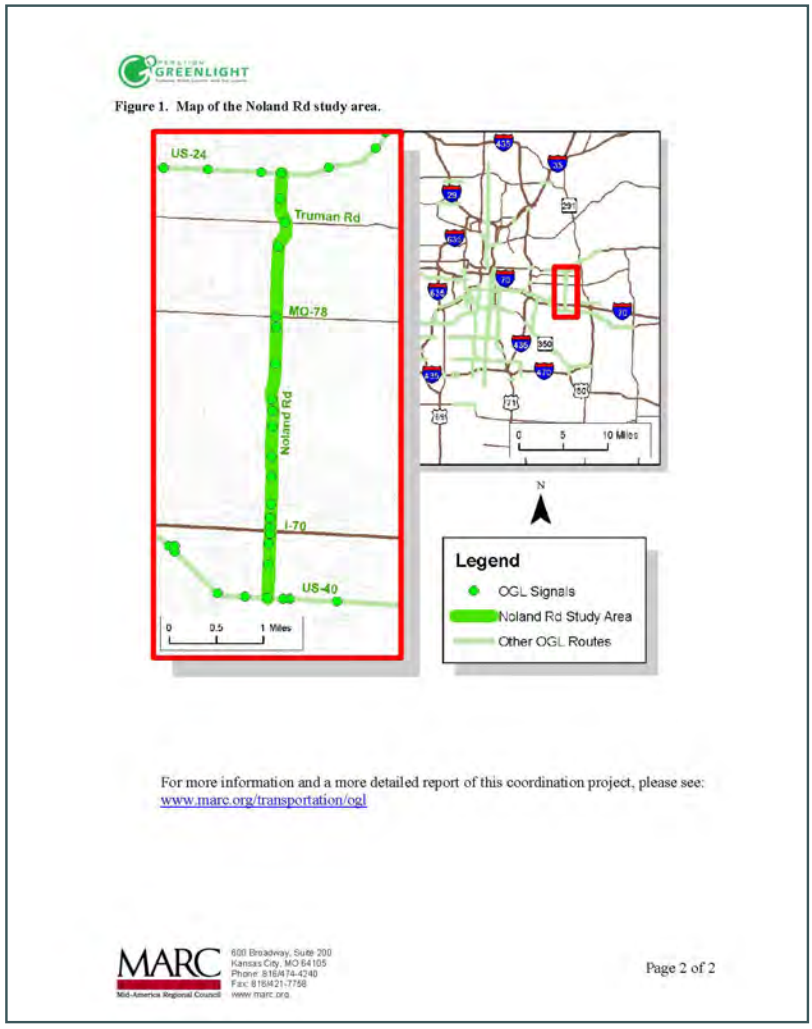


Figure 8.3 Example benefits summary report produced by Operation Green Light 125 (continued)

Video

In addition to generating a written report summarizing the results of the improvements, SPC takes the unique approach of making before and after videos of a single car trip in a corridor that has been retimed to illustrate the benefits of traffic signal retiming projects. These videos provide a side-by-side view of a trip before and after the improvements have been made and are synchronized to a common time clock. The videos show the vehicle's progress as it travels the corridor without and with the revised traffic signal timings. The technique allows the public and decision makers to see the time savings and the improvement in the quality of trips. Figure 8.4 is a screen capture of a typical video file[126].

125 Mid-America Regional Council of Governments, Noland Road Corridor, US-24 to US-40, Operation Green Light Signal Cordination Projects, http://www.marc.org/transportation/ogl/pdfs/signal/Noland-Road-Basic-Report.pdf

126 Southwestern Pennsylvania Commission, Signal Re-timing Before and After Videos, Transportation: Regional Traffic Signal Program, http://www.spcregion.org/trans_ops_traff_vids.shtml

Figure 8.4 Screen capture of video tool used to disseminate results of signal retiming project[127]

127 Southwestern Pennsylvania Commission, Signal Re-timing Before and After Videos, Transportation: Regional Traffic Signal Program, http://www.spcregion.org/trans_ops_traff_vids.shtml

CHAPTER 9

Program Sustainability and Expansion

Several of the programs examined provided information on how to sustain and expand RTSOPs. Critical elements to being successful in sustaining and expanding RTSOPs include:

- Having a champion that understands operations and can communicate not only program successes, but also what the program does to decision makers, political bodies, and the public (For example, Las Vegas FAST is oriented around meeting the expectations of decision makers and promoting a positive image.)
- Having clearly identified, relatable, and attainable goals and objectives for the program
- Obtaining buy-in and political support at all levels and taking steps to keep that political support (e.g., being responsive for requests for information)
- Providing clear and consistent outreach to citizen advisory committees, other operating agencies, and regional transportation policy boards
- Having a systematic way of tracking the program's performance and effectiveness and using the assessment outputs to make midcourse corrections to ensure success
- Identifying a dedicated or stable funding source

All of the workshop participants indicated that keeping agencies involved in the process is essential to sustaining the programs. Funding is critical to keeping agencies engaged; however, agencies need to show that they are committed to achieving the goals and objectives set for the program.

Several of the agencies reported that they have found it difficult to sustain programs when the programs lack a strong vision. Agencies commented that many local policy makers are hesitant to commit funding to agencies across multiple election cycles.

Key findings and recommendations the scan team identified relating to sustaining and expanding an RTSOP include the following:

- Outreach is critical for sustaining and expanding program funds. Outreach must be public and private, exist at all levels (i.e., decision makers, agency administrators, and operations personnel), and focus on sharing successes. The message provided in this outreach effort must be ongoing and consistent to be effective.

- Providing secure funding is the mechanism by which an RTSOP can be institutionalized. Several agencies reported using legislation (e.g., dedication of sales tax monies) as a means of institutionalizing programs.

- Once a construction project of an arterial is done, retiming of signals (and making infrastructure upgrades) should be included in the construction process. Agencies need to include ITS projects/ signal timing improvements as a component of other projects, including, for example, construction and transit projects. This should be part of the normal plan development process that agencies use.

- Local MPOs should include the assessment of regional traffic signal operations as part of their Unified Planning Work Program. At the MPO level, MPOs need to be staffed with individuals who understand operational issues to make sure that operations are considered in plan development. FHWA should review the traffic signal timing assessment as part of the MPO's recertification process.

- Base level functionality of equipment and performance standards should be established for the region. Use the performance standards to define a minimum acceptable level of operations and hold individuals and agencies accountable to these standards.

- Program successes should be illustrated by leveraging media outlets, including social media. Agency and staff should be responsive and accountable to media outlets.

Traffic Signal Forums

Traffic signal forums are one strategy that regions use to sustain and promote regional traffic signal operations. Agencies use these forums to set goals and objectives for regional programs, set priorities, and establish criteria for selecting projects. Some locations require agencies to participate in forums to be eligible for traffic signal improvement funding. Traffic signal forums are also used to develop consensus among regional stakeholders and highlight issues and areas of concerns to be address in the region.

In Los Angeles County, the Los Angeles County Department of Public Works has been using traffic signal forums as tools for discussing regional traffic signal operations since 1995[128]. These forums were intended to allow groups of bordering agencies to work together to promote interagency cooperation. The traffic forums have enabled funding to be targeted at infrastructure improvements along arterial and arterial/freeway corridors in the county's subregions. These projects are a critical part of what will eventually be a network of integrated ITS projects in Los Angeles County and Southern California.

Orange County is another example of the how traffic signal forums can be used to build support

128 White J, Senior Civil Engineer, Los Angeles County DOT, 2011

for and sustain an RTSOP[129]. These forums were designed to facilitate implementation of OCTA's Regional TSSP and to promote a cooperative approach to managing traffic signal operations in Orange County. The forums allow participating agencies to express and address comments and concerns related to regional traffic signal operations. Through these forums, agencies assist OCTA in prioritizing and phasing various projects needed to improve regional traffic signal operations. Agencies must participate in regional transportation forums to receive project funds from OCTA. This requires cities to balance local traffic policies with neighboring cities, for selected streets, to promote more efficient traffic circulation overall.

Most regional programs also have committees comprised of local signal operators that provide oversight for their regional operations initiatives. For example, in the San Francisco Bay Area, MTC uses an Arterial Operations Committee to provide oversight for their regional signal operations program[130]. This committee is composed of local traffic engineers and consultants who meet once every two months to discuss various programs performed by MTC that may affect arterials. The committee also provides local perspectives to relevant regional issues, such as air quality conformity, status of funding obligations, upcoming grant and training opportunities, and new publications.

Training

Training is often the first thing to be cut when funds get tight; however, in those areas where training is provided through their RTSOPs, agencies are able to provide maximum benefits for their training dollars. The workshop revealed that several locations have provided regular training as one component of their program. These training activities varied from periodic meetings and forums for discussing traffic signal operations, to specific training on operational concepts and theory, to training in traffic signal optimization tools.

Typically, the training provided by these regional agencies focuses on a number of topics, including:

- Regional traffic signal operations concepts and theories, including traffic signal optimization tools
- Regional transportation planning and planning for operations, including how the long-range transportation process works and what types of funding are available to local agencies to support regional operations
- Recent advances in traffic signal technologies and equipment, especially those related to the use of performance measures to support monitoring f regional traffic signal operations
- Information technologies and network communications

129 Keith R, Principal Traffic Engineer, Orange County Transportation Authority, November 2011

130 Stanislaus D, Senior Planner & Program Manager, Freeway Performance Initiative & Arterial Operations Program, Metropolitan Transportation Commission, 2011

MAG, in Phoenix, provides a three-day training workshop on SYNCHRO[131]. The training is provided free to MAG member agency personnel who are directly involved in developing signal timing for regional traffic signals. MAG routinely hosts training webinars for member agencies to ensure that regional personnel are aware of industry best practices.

In the Los Angeles region, Metro has developed a comprehensive program in signal operation and maintenance to upgrade the skills of local traffic engineers and signal maintenance personnel[132]. This program consists of several training courses on the following topics of interest to agencies in their region:

- Advanced traffic signal operations
- Transit signal priority
- Computerized traffic signal control systems
- Signal system and homeland security
- Video detection and surveillance
- Highway capacity analysis

Metro implemented the program because of the significant investment it was making in the region through its Traffic System Management Program[133]. Metro considers the training an important element in its continuing Traffic System Management Program to achieve its congestion relief objectives and to maintain the skills of signal personnel.

OCTA also develops and sponsors seminars and training courses that benefit operations personnel[134]. OCTA utilized local and national experts to provide training for member agencies on traffic signal operation, telecommunication systems design and operations, current and innovative operations and maintenance practices, and advances and future functionality of new technologies. OCTA provides this training to ensure that regional partners have the skills, knowledge, and abilities to keep the timings and system they deploy performing at a high level.

Some regional/statewide entities that have initiated training programs in the past are now inactive due to cuts in funding; however, several agencies reported that training can improve operations. UDOT has found that splice failures were greatly reduced after contractors were required to attend a half-day training course on loop splicing; the course is offered two to three times per year. UDOT

131 Josua S, ITS & Safety Program Manager, Maricopa Association of Governments, November 2011

132 Gota S, Program Manager, Los Angeles County Metropolotan Transportation Authority, 2011

133 Stanislaus D, Senior Planner & Program Manager, Freeway Performance Initiative & Arterial Operations Program, Metropolitan Transportation Commission, 2011

134 Keith R, Principal Traffic Engineer, Orange County Transportation Authority, November 2011

enforces compliance by having a project specification that requires contractors to be certified in loop splicing by UDOT[135].

Some agencies are providing operational personnel with incentives (i.e., financial and job advancement) for completing training and achieving certain levels of certification. For example, UDOT provides an Electronic Technical Specialist Certification Program[136], which recognizes and rewards outstanding individuals in UDOT and allows them to obtain technical and leadership skills to advance within the agency. Upon completion of the program, individuals can obtain up to an 18% maximum increase in pay during their career.

135 Taylor M, Signal Systems Engineer, Utah DOT, 2011

136 Taylor M, Signal Systems Engineer, Utah DOT, 2011

CHAPTER 10

Summary of Findings

The following represents a summary of the major findings and recommendations the scan team developed as a result of the workshop.

Goals and Objectives

- The process of developing a comprehensive regional traffic signal program begins with agencies conducting a comprehensive inventory of the capabilities and desires of all the agencies in the region. This inventory includes not only type and state of the signal and communications equipment, but also the current and potential resources available to the region, the capabilities of agency staff, and basic signal timing parameters used by local agencies in the region.

- Agencies need to develop goals and objective early in the program development process, with the understanding that some agencies may have short-term, specific needs, deployment, or situations that they want to address through the program.

- The manner in which goals are stated generally is related to what the local agencies wanted to achieve. For example, if local agencies want to conduct a series of retiming projects, they may develop a program with a goal of improving coordination between local entities.

- Programs need to identify a champion who is dedicated to the program's success. To some degree, the level of the champion's influence (who is stating the goal) determines the programs' success.

- Those programs that tend to be successful regional traffic signal management programs have recognized the importance of their programs by incorporating them into their long-range transportation plan, either at the state level or at the metropolitan planning level. Using their long-range transportation plan process, which regional policy-makers approve, allows agencies to identify regional traffic signal operations as a priority to address congestion and management issues. By incorporating and defining regional traffic signal operations as a priority in the long-range transportation plan, agencies often find it easier to secure program funds and political support for regional traffic signal operations. Program goals and objectives should relate to the priorities defined in the long-range transportation plan.

- The process of developing an RCTO is a good mechanism for developing goals and objectives. This process requires local traffic engineers to have vision beyond their boundaries and to link local and regional goals and objectives back to state-level goals and objectives. The RCTO process allows agencies to develop consensus around base goals and objectives.

- Not every agency in a region may have formalized goals and objectives. Agencies need to reach agreement on goals and objectives if they want to improve their chances of being awarded project funding. Agencies that are more successful at being awarded project funds generally have consensus on what the goals and objectives should be for the region.

- Regional programs where the state DOT(s) assume a leadership role tend to focus more on short-term project-oriented goals that standardize equipment, provide communications infrastructure, or engage in other activities that enable more consistent management and operation of traffic signal systems (e.g., GDOT's FAST Forward[137] program, statewide standardization of controllers and software, and UDOT's communication and retiming program).

- The regional traffic signal reviews conducted by the FHWA were instrumental in catalyzing the development of goals and objectives in several regions (e.g., Fargo, North Dakota, and Puget Sound, Washington).

- Developing performance measures that correlate to objectives is important, particularly for MPOs where public support is being built on past achievements to guide future decisions.

- FHWA's Regional Concept for Transportation Operations[138] document facilitated the development of key goals and objectives in several regions. The initial effort to establish goals and objectives in several regions was the outcome of pilot efforts funded by FHWA during the development of its RCTO document.

- Agencies that have operational authority/responsibility for managing and operating traffic signals (i.e., city, county, or state) tend to invest less effort in the development of formal goals and objectives and expend more effort on the actual day-to-day operation and maintenance of signal systems.

Institutional Arrangements and Agreements

While some programs have detailed, comprehensive agreements, others do not have any formal agreements at all and operate quite successfully on handshake agreements. Generally, the workshop

137 FAST Forward – Georgia's Congestion Relief Program, Georgia DOT, http://www.dot.ga.gov/informationcenter/programs/transportation/fastforward/Pages/default.aspx

138 Regional Concept for Transportation Operations: A Blueprint for Action, FHWA, http://ops.fhwa.dot.gov/publications/rctoprimer/rcto_primer.pdf

participants agreed that the need for agreements depends upon the goals and objectives of the program; the people and their willingness to cooperate and compromise; their history; their level of trust; and the agencies' knowledge, skills, and abilities.

- The RCTO sets a foundation for what types of agreements and with whom agreements are needed; however, the RCTO does not replace the need for formal agreements. The RCTO is a consensus document that defines, among other things, the program's goals and objectives and agency roles and responsibilities. The RCTO is critical to bringing agencies to a higher level of understanding.

- Most challenges in developing RTSOPs are not technical. Most challenges are institutional and involve building relationships. The consensus of the workshop participants was that some things in an RTSOP need agreements and others do not—it depends on the relationships between the local partners.

- Developing and processing formal agreements is a time-consuming process in many jurisdictions, and can often highjack the original intent of programs: cooperatively operating traffic signals from a regional perspective. If formal institutional agreements are needed, agencies need to allocate additional time in the project and program development process. Agencies should be careful not to allow the process of developing institutional agreements to impede their ability to get things done. As a rule, agencies should only use agreements when they are necessary.

- Agencies use many different types of agreements in developing programs. The most common types of agreements include institutional agreements, funding agreements, and operations agreements. Institutional agreements are used to define the roles and responsibilities of the various agencies as well as the structure of their programs. Funding agreements are often used to identify the cost-sharing or matching requirements of different agencies. Operations agreements are often used to define the criteria and processes through which signal timing strategies can be deployed or modified. All agreement types are also commonly used to define limits of liability.

- Agreements should be kept as simple as possible. Formal agreements can be beneficial for the right area; however, unless structured correctly, they can be inflexible if situations change. Agencies found that agreements are needed for things like installing and operating fiber optics, defining maintenance responsibilities, or for dealing with a difficult partner.

- Overall, the KISS principle applies when establishing agreements between agencies. When informal agreements do not suffice, keep formal agreements as simple as possible and avoid lengthy deliberation before they are officially put in place.

Structure and Governance

Successful programs come in many shapes and forms. Some programs are structured whereby the regional entity is only a funding mechanism for the region. In other programs, the regional entity is responsible for developing, but not implementing, traffic signal timing plans. In still other programs, the regional entity assumes responsibility for developing and installing timing plans and communications infrastructure for obtaining regional coordination, but leaves the actual operations and maintenance to the local entities. A fourth structure involves a regional entity jointly monitoring and implementing improvements agreed upon by local entities. The final example of ways that programs can be structured is that a regional entity assumes all operational and maintenance responsibilities within a corridor or a region.

Following are some specific findings and recommendations related to RTSOP structure and governance.

- The scan team observed a variety of organizational structures during the scan. Organizing the program into a structure that meets the needs of the agencies and objectives of the region is of the utmost importance. Successful programs can be developed that distribute the authority for operating and developing regional traffic signal operations between various levels. In identifying the best structure for a program in a particular area, agencies should begin by conducting an inventory of assets, capabilities, and resources available within the region and structure programs around the strengths of these assets, capabilities, and resources.

- Each agency needs to define for itself what level of participation is best. Lead agencies need to be adaptable to meet the needs of local agencies.

- As part of the process of developing a regional concept of operations, regional traffic signal programs need to get buy-in from agencies outside the normal transportation engineering domain. For example, agency IT groups often have control and are responsible for operating communications networks.

- Agencies need more guidance on how to incorporate arterial management and regional traffic signal operations into the long-range planning process. Several of the participants recommended that agencies include a section specifically addressing regional traffic signal operations in their long-range transportation plans, even if it is only a temporary placeholder. Furthermore, it was suggested that the long-range plan require agencies to develop an RCTO that defines the program's structure.

- The lead agency's authority to and capability of operating and maintaining the system influences the program's structure. For example, those programs where the regional entity is not an actual traffic signal operator tend to focus on the development of timing plans and the deployment of communications systems (e.g., DRCG in Denver and OGL in Kansas

City). Those programs where the lead agency is a traffic signal operator tend to focus more on the real-time management of traffic signal timings (e.g., GDOT).

- Most programs have a technical and/or steering policy committee composed of regional transportation operators. These committees help define project selection criteria, priority needs, and other aspects of the program. To keep people engaged, local agencies need to feel that they are relevant in discussions and in the decision-making process.

- The knowledge, skills, and abilities of the lead (or champion) agency often dictate the program's structure and governance. In areas where local agencies do not have a high level of knowledge, skills, and abilities, regional or state entities often provide leadership in formulating regional traffic signal programs. In areas where local agencies have a high level of knowledge, skills, and abilities, programs are often structured to emphasize local control and coordination.

- A relationship seems to exist between structure and funding, particularly when CMAQ funds are being used. A common thread appears to be that when CMAQ funds are involved, the MPO is involved more directly. Pima County, Arizona, is atypical in that it is not a non-attainment area and STP funds were being used. The development of an RCTO motivated the development of the Pima County Association of Governments' RTSOP.

Funding

The workshop revealed that agencies use a variety of mechanisms for funding an RTSOP. Examples of funding sources include CMAQ funds, special sales tax revenues, and STP funds. Following are some of the scan team's major findings related to funding.

- Because each type of funding has its own advantages and disadvantages, agencies need to have a better understanding of what they are while developing a program. Agencies should consider diversifying its program funding as much as possible to guard against challenging economic conditions. All the participants agreed that it is hard to provide for the security of operational performance when the funding mechanism is unstable.

- The use of CMAQ was most prevalent amongst the agencies participating in this scan. CMAQ has a set of requirements intended to ensure that air-quality improvement is an outcome. In regions where air quality is within attainment goals, other sources of funding were used. For example, Pima County Arizona uses STP funds to support its RTSOP.

- Agencies get power by unity. Regional traffic signal programs allow smaller individual projects to compete with construction projects.

- Regions should not only strive to develop a standalone signal operations program, but also try to incorporate regional traffic signal operational needs and equipment into other programs. For example, local and regional entities should develop a standard practice of

incorporating regional traffic signal timing elements and communication infrastructure as part of normal construction activities. This allows agencies to spread the expenses of regional traffic signal improvements over multiple sources.

- Agencies should also look for partnership arrangements to find opportunities to coordinate resources. This includes wireless networks that have excess capacity and public-private partnerships (e.g., local community investment districts and development corporations).
- Funding for traffic signal operations and maintenance (e.g., how to incorporate operations and maintenance into initial project costs) is its own dilemma and will continue to be in the future. Currently, operations and maintenance costs—and an agency's ability and willingness to maintain it—should be included with capital costs in scoring projects.
- Local traffic agencies are often not aware of the planning and funding process that occurs within the MPO and need to be educated on the funding process and how to work within the MPO process (e.g., what types of projects are eligible through the different types of funding mechanisms).
- Regions should consider using the long-range transportation planning process to obtain long-term funding for their programs. Several agencies advocated adding a placeholder to the transportation plans for a regional signal operations program, even if the specifics of the program are not clear yet. Adding this placeholder allows agencies to bring the need for funding to support regional traffic signal operations to the forefront.
- MPOs tend to have a longer-range view of funding. Many MPOs include management and operations in the long-range transportation plan.

System Operation

The manner in which the programs operate can vary considerably between regions. While all of the programs focused on developing and installing interjurisdictional coordination timing plans; not all the programs actually operated the signals once the timings were installed. In some programs, the regional entities were responsible for just developing the timing plans. In other programs, the regional entity might also develop and implement timing plans. In some programs, the regional entity assumed the responsibility of installing, deploying, and maintaining the regional communications infrastructure. Only a few regions were responsible for performing real-time monitoring and signal timing adjustment functions.

The following summarizes the scan team's major findings related to system operations.

- Operational capabilities and decisions are highly dependent on the base level of control equipment. For example, without time clocks, agencies cannot provide basic coordination functions between multiple intersections. Some agencies (e.g., DRCOG) have been successful in providing funding to local agencies for infrastructure upgrades by establish-

ing a base level of functionality. Agencies should define a base level of functionality and performance expectations for their traffic signals and strive to bring all traffic signals up to a certain level of performance. Conducting a comprehensive system inventory will help agencies identify what base equipment they have—or wish they had—to achieve certain performance goals.

- Agencies need to discuss what regional timing parameters need to be implemented. In many systems, local agencies are responsible for establishing basic signal timing parameters (e.g., minimum greens, clearance intervals, and left-turn phasing); the regional entities build coordination timing plans around these policies and preferences. Agencies need to define a clear regional concept of operations, supported by standard operating procedures.

- The need for a regional operations center is highly dependent on the way agencies plan to operate their system. If agencies are just setting coordination timing plans, a regional center may not be needed. However, if agencies are planning to manage traffic signal timings in real-time, agencies need an infrastructure that supports this type of operation and the agency's commitment to operate the center.

- Many programs use consulting services to supplement the ability of the local agencies to generate timing plans. It is important to match the consulting expertise to agency needs. This is an example of how agencies are filling knowledge/personnel resource gaps in certain areas.

- Having an RTSOP allows agencies to be more cautious about adopting and implementing new and unproven technologies. Because systems have to operate from a regional perspective, consensus is needed before agencies can adopt cutting-edge or unproven systems or technologies which might not be consistent with regional goals, objectives, or operational concepts or are beyond the region's knowledge, skills, or abilities to support.

System and Hardware Maintenance

The program's organizational structure and the functions it performs define the agencies' maintenance roles and responsibilities. With most programs, the local agencies retain the responsibility for operating and maintaining the traffic signal hardware at the intersections (e.g., cabinets, controllers, signal heads, and basic timing parameters), while regional entities are responsible for operating and maintaining the regional-based assets (e.g., communications infrastructure, regional coordination timing plans, and GPS clocks). Only a few locations have looked at regionalization as a resource sharing opportunity for maximizing maintenance capabilities.

The following highlights some of the scan team's major findings and recommendations from the workshop related to RTSOP system and hardware maintenance.

- Some programs (i.e., Bay Area Metro, LA County, and DRCOG) permit minor upgrades to equipment (e.g., controller replacement/upgrades and GPS clock installation) needed to support implementation of regional coordination. An inventory of intersections' capabilities should be part of a project assessment to ensure that the timing plans can be implemented, including the basic timing parameters (e.g., minimum greens and clearance intervals).

- System operations concepts can be used to establish performance goals and requirements (e.g., system uptime and time between trouble calls), which helps drive requirements for maintenance. Agencies have developed performance requirements that can help ensure funding for equipment upgrades and replacement. Agencies should consider setting performance/response time standards to ensure that equipment is maintained to a base level of functionality. Setting a base level of functionality can be used to help ensure that regional benefits are maintained over time. Developing a regional concept of operations and regional architectures give agencies opportunities to establish regional performance goals and requirements.

- Standardization of hardware increases operational flexibility. Having standardized equipment is most common within regional programs where the lead agency has operational authority or traffic signal systems (e.g., state DOTs or county agencies). Once signal systems have all reached the same base level of operations, agencies need to periodically review the equipment standards to ensure that signal design standards are consistent with operational objectives.

- Agencies should incorporate development and replacement of hardware and software traffic signal life cycles into their long-range plan. Research is needed to help identify "complete" costs associated with the hardware and software for monitoring operations, timings, and other functions. These life-cycle costs need to include a regional benefit-cost calculation.

- The establishment of a base level of functionality (e.g., DRCOG) provides the potential to distribute funding equitably to member agencies. The base level of functionality should be tied to the system's objectives.

Performance Measures

Most of the agencies at the workshop reported that they often use performance measures to report the benefits achieved through individual projects. Few agencies reported on providing programmatic assessments of the long-range benefits of regional traffic signal operations. The type of performance measures used is directly related to the type of funding being used to make improvements.

Key findings and recommendations related to performance measures and performance measurement from the workshop include the following:

- Operators and policy decision makers require different types of performance metrics. The

performance measures used in a region should directly relate to the region's long-range transportation plan and be traceable back to the program's goals and objectives.

- The methodology used to collect performance metric data needs to be standardized so that program and project-level benefits can be compared across programs.
- Some agencies are trying to identify hardware maintenance issues proactively, before the motoring public observes them. For example, GDOT has established a performance goal of identifying 70% of all hardware performance issues before they are reported by the public.
- Standardized methodology for calculating benefit/costs related to RTSOPs needs to be developed. The assessment needs to incorporate diminishing traffic signal timing benefits over time. The methodology needs to compare the results to the expected system performance if nothing is done to improve regional signal timing operations.
- Agencies need to be more aggressive in measuring the corridor's performance: driving the street more often to determine if signal timing is still being maintained and monitoring current operations. There is a need to assess the quality of progression proactively, from a programmatic standpoint. For example, after completing a retiming project it took me X minutes to complete a trip. Does it still take me X minutes?
- The Orange County CSPI is an example of a performance measure that can be used to address multiple stakeholder groups. The CSPI was not developed through a stakeholder process, but was developed to address stakeholder needs that were understood based on issues with previous performance measures.
- Performance measures can guide the prioritization of funding. Large performance gaps can be identified quickly and should be funded more readily than locations where negligible improvements can be realized.
- Having clear, definable performance measures allows agencies to market programs to decision makers. Marketing the successes of programs is critical to sustaining and growing programs.

Training

The workshop revealed that several locations have provided regular training as one of the components of their program. These training programs were designed to get knowledge back to local agencies. They varied from periodic meetings and forums for discussing traffic signal operations to specific training on operational concepts and theory to training in traffic signal optimization tools. Training is often the first place that is cut when funds get tight. Agencies need to have access to training.

- A wide range of knowledge gaps exist. Training should be focused on:

  - Regional traffic signal operations concepts and theories, including traffic signal optimization tools
  - Regional transportation planning and planning for operations, including how the long-range transportation process works and what types of funding are available to local agencies to support regional operations
  - Recent advances in traffic signal technologies and equipment, especially those related to the use of performance measures to support monitoring regional traffic signal operations
  - Information technologies and network communications

- Some agencies are providing incentives (financial and job advancement) to operational personnel for completing training and achieving certain levels of certification. For example, UDOT provides an Electronic Technical Specialist Certification Program. This program is designed to recognize and reward outstanding individuals in UDOT and allows them to obtain technical and leadership skills to advance within the agency. Upon completion of the program, individuals can obtain up to an 18% maximum increase in pay during their career.

- FHWA is developing National Traffic Signal Training Curriculum. This will permit agencies to develop a base level of knowledge and core competencies for long-term support of operations. Regions can also use vendor-provided training to keep knowledge about new techniques and equipment fresh.

- Some regional/statewide entities that have initiated training programs in the past are now inactive due to cuts in funding and UDOT University, which offers training on a variety of operations and maintenance activities.

- Training programs can improve operations. UDOT saw a significant reduction in splice failures after it required contractors to attend a half-day training course on loop splicing. UDOT offers the course two to three times per year. UDOT enforces compliance by having a project specification requiring that contractors be certified by UDOT in loop splicing.

Program Sustainability and Expansion

All of the workshop participants indicated that keeping agencies involved in the process is essential to sustaining the programs. Funding is critical to keeping agencies engaged; however, agencies need to show that they are committed to achieving the goals and objectives set for the program. Several of the agencies reported that they have found it difficult to sustain programs that lack a strong vision. Agencies also commented that many local policy makers are hesitant to commit agencies to funding across multiple election cycles.

Key findings and recommendations that the scan team identified relating to sustaining and expanding RTSOPs include the following.

- Outreach is critical for sustaining and expanding program funds. Outreach must be public and private at all levels (i.e., decision makers, agency administration, and operations personnel) and focus on sharing successes. The message provided in this outreach effort must be ongoing and consistent to be effective.
- Providing secure funding is the mechanism to institutionalizing an RTSOP. Several agencies reported using legislation (e.g., dedication of sales tax monies) as a means of institutionalizing programs.
- Signal retiming and infrastructure upgrades should be included in the construction process for arterials. Agencies need to include ITS projects/signal timing improvements as a component of other projects (including construction and transit projects). This should be part of agencies' normal plan development process.
- Local MPOs should include the assessment of regional traffic signal operations as part of their Unified Planning Work Program. At the MPO level, MPOs need to be staffed with individuals who understand operational issues to allow operations to be considered in plan development. FHWA should review the traffic signal timing assessment as part of the MPO's recertification process.
- Equipment base-level functionality and performance standards should be established for the region. Use the performance standards to define the minimum acceptable level of operations and hold individuals and agencies accountable to these standards.
- Leverage media outlets, including social media, to illustrate program successes. Agency and staff should be responsive and accountable to media outlets.

CHAPTER 11

Planned Implementation Activities

The scan team identified several implementation activities to promote the findings and advance the recommendations from the scan.

- **Conduct at least two webinars on best practices.** The scan team will organize and conduct a minimum of two webinars during 2013 to promote the scan's findings and recommendations.
- **Present findings at technical meetings and conferences.** The scan team identified a number of upcoming technical meetings and conferences at which the workshop results could be presented, including:
  - TRB's annual and summer meetings of its Regional Transportation System Operations and Management, Small- to Medium-Sized Metropolitan Planning Organizations, Operations, and Traffic Signal Systems Committees
  - The annual and local section meetings of the Institute of Transportation Engineers
  - The annual meeting of the Association of Metropolitan Planning Organizations
  - The annual meeting of the National Association of Regional Councils
  - The annual meeting of the AASHTO Subcommittee on Systems Operations and Management
- **Promote peer-to-peer exchange on regional traffic signal operations through professional organization discussion boards and websites.** Peer-to-peer exchange between system operators is extremely valuable in developing, promoting, and sustaining regional traffic signal operations. The scan team plans to use existing professional organization discussion boards (e.g., the NTOC and Institute of Transportation Engineers Community of Practice sites to promote discussion on regional traffic signal operations.
- **Work with FHWA to develop a Case Studies Report on RTSOPs.** The scan team will work with FHWA to identify and develop case studies of RTSOPs. The case studies report should provide agencies with examples of model RTSOPs, documenting how these programs were developed and the lessons learned in developing and sustaining these programs over time.

- **Develop and submit research program statements for potential funding through NCHRP.** The scan team identified two candidate topics for future research:
  - Project- and program-level performance measures for RTSOPs
  - Methodologies for assessing the benefits and costs associated with RTSOPs

  Scan team members will develop these research topic areas further and submit them for funding to their appropriate AASHTO representatives.

- **Coordinate with the Operations Committee of the Association of Metropolitan Planning Organizations (AMPO)**. Scan team members will work with and coordinate with AMPO's Operations Committee to share ideas and best practices related to RTSOPs. (Natalie Bettger is with the North Central Texas Council of Governments, and one of the workshop participants chairs this committee). At a minimum, the scan team plans to send copies of the final report to the committee.

- **Develop a video that shows the benefits of regional traffic signal operations**. This would be a five- to 10-minute video that provides basic information about regional transportation signal operations. The video will be geared toward policy makers and will discuss how to start an RTSOP and the potential benefits that can be derived through such programs.

- **Sponsor short articles to FHWA's *Public Roads***. The scan team will prepare an article suitable for publication that highlights the scan's results and findings.

APPENDIX A: SCAN TEAM CONTACT INFORMATION

APPENDIX A:

Scan Team Contact Information

Brent Jennings – AASHTO Chair
State Highway Operations and Safety Engineer
Idaho Transportation Department
Office of Highway Safety
3311 W. State Street
Boise, ID 83707-1129
Phone: (208) 334-8557
Fax: (208) 334-4430
E-mail: brent.jennings@itd.idaho.gov

Kevin N. Balke, PhD, PE – Subject Matter Expert
Center Director
TransLink Research Center
Texas Transportation Institute
Texas A&M University System
College Station, TX 77844-3135
Phone: (979) 845-9899
Fax: (979) 845-9873
E-mail: k-balke@tamu.edu

Gene (Yancy) Bachmann
Assistant State Traffic Engineer, Field Operations
Georgia Department of Transportation
Office of Traffic Operations
935 East Confederate Avenue, Building 5
Atlanta, GA 30316
Phone: (404) 635-8129
Fax: (404) 624-7116
E-mail: ybachmann@dot.ga.gov

Eddie Curtis
Traffic Management Specialist
FHWA Resource Center
61 Forsyth Street, SW, Suite 17T26
Atlanta, GA 30303
Phone: (404) 562-3920
Fax: (404) 562-3700
E-mail: eddie.curtis@fhwa.dot.gov

Steve Misgen
Traffic Engineer
Metro District
Minnesota Department of Transportation
1500 West Country Road B2
Roseville, MN 55113
Phone: (651) 234-7835
E-mail: steve.misgen@dot.state.mn.us

Vanloan Nguyen, PE
Assistant State Traffic Engineer
Traffic Engineering Division
Virginia Department of Transportation
1401 East Broad Street
Richmond, VA 23219
Phone: (804) 786-2918
Fax: (804) 225-4978
E-mail: vanloan.nguyen@vdot.virginia.gov

Jacob B. Renick, PE
Traffic Signal Engineer
Mississippi Department of Transportation
2567 N. West Street
Jackson, MS 39216
Phone: (601) 359-1654
E-mail: jrenick@mdot.state.ms.us

APPENDIX B:

Scan Team Biographical Sketches

BRENT JENNINGS (AASHTO Chair) is the State Highway Operations and Safety Engineer for the Idaho Transportation Department, where he manages the Office of Highway Operations and Safety. This office is responsible for traffic, maintenance, and highway safety operations. He is a member of several AASHTO committees, including the Subcommittee on Traffic Engineering, Subcommittee on Maintenance, and the Standing Committee on Traffic Engineering Safety. He also is a member of the National Committee on Uniform Traffic Control Devices. In his current capacity, Jennings serves as both the State Traffic and State Maintenance Engineer and is responsible for statewide traffic and maintenance programs and policies. Prior to this, he has served in various capacities in both the district and headquarter offices as a Project Construction Engineer, District Materials Engineer, Associate Construction Engineer, State Construction Claims Engineer, Assistant State Construction Engineer, and Assistant District Engineer. Jennings earned his bachelor's degree in civil engineering from California State Polytechnic University in 1982 and is a registered professional engineer in Idaho.

GENE (YANCY) BACHMANN is the Assistant State Traffic Engineer for the Georgia DOT. In this role, he oversees programs that include vehicle crash analysis and reporting, the Safe Routes to School Program, the Safety Improvement Program, the Operational Improvement Program, the Traffic Signal Upgrade Program, traffic studies, traffic engineering, general operations, and access management. He also manages the intelligent transportation systems (ITS) maintenance, ITS construction support, the signal timing unit, signal installations, and the warehouse. Bachmann has been with the Georgia DOT for 25 years, is a member of the Georgia Section of the Institute of Transportation Engineers and is a graduate of Southern Technical Institute (now Southern Polytechnic State University) with a BCET (Broadcast Engineering Technology) degree.

KEVIN N. BALKE (Subject Matter Expert) is a Research Engineer with the TransLink Research Program of the Texas Transportation Institute in College Station, TX. Balke has more than 20 years of experience conducting research in traffic operations and traffic management systems. His research efforts have been concentrated in the areas of traffic signal systems, freeway management, operational effects of geometric design, and motorist information systems. He has also developed and taught numerous professional development courses on traffic signal operations. Prior to joining the Texas Transportation Institute, Kevin worked for the City of Austin, Texas, as a traffic and signal engineer. Balke holds bachelor's, master's, and doctoral degrees in civil engineering from Texas A&M University. He is a registered professional engineer in Texas and is a member of the TRB Traffic Signal System Committee.

EDDIE CURTIS is a Traffic Management Specialist with the FHWA Resource Center and Headquarters Office of Operations. He manages the Arterial Management Program, which is responsible for supporting research and developing guidance, training, and outreach to advance traffic signal management and operations. He has 18 years of experience in traffic signal operations and held positions with the City of Los Angeles and PB Farradyne before joining FHWA in 2006. Curtis has had significant roles in the development of the 2007 and 2012 National Traffic Signal Report Card and several publications, including the Traffic Signal Timing Manual, Improving Traffic Signal

Management and Operations: A Basic Service Concept, and Regional Traffic Signal Management and Operations Programs. He served as the team leader for the Every Day Counts Adaptive Signal Control Technology Initiative. Curtis is a received a bachelor's degree in civil engineering from California State University of Los Angeles and is currently working on a MSCE/PhD at the Georgia Institute of Technology. He is a registered professional engineer in California and is a member of the TRB Traffic Signal Systems and Regional Transportation Systems Management and Operations Committee.

STEVE MISGEN has been the Traffic Engineer for the Minnesota DOT Metro District for six years. His primary duties include the design, construction, maintenance, and operation of signing, lighting and traffic signal systems. He has been with Minnesota DOT for 23 years, with most of that time involved with signal operations. Misgen is a graduate of the University of Minnesota, Twin Cities, with a bachelor's degree in civil engineering. He is a certified professional traffic operations engineer and a licensed professional engineer in Minnesota.

VANLOAN Q. NGUYEN is serving as Assistant State Traffic Engineer for the Traffic Engineering Division of the Virginia DOT. She provides leadership and direction to multiple statewide programs, including traffic control devices, the statewide signal systems framework, the regulatory and directional signing programs, traffic engineering asset management and strategic planning, short- and long-term planning of statewide budgets, contract procurement, and oversight of 20 staff members and multiple consultant engineers. Nguyen is currently directing several key initiatives, such as the redevelopment of the Virginia Supplement to the Manual on Uniform Traffic Control Devices and a pilot program implementing an innovative adaptive traffic control system at approximately 100 intersections across the commonwealth. Prior to her current position, Nguyen served as City Traffic Engineer/Division Director for Transportation Engineering in the City of Richmond, Virginia. Prior to this, she served in various roles at private engineering consultant firms. She has been a voting member of the Richmond Metropolitan Planning Organization since 2005. Nguyen is a registered professional engineer and professional traffic operations engineer and received her bachelor's degree in civil engineering from Virginia Tech.

JACOB RENICK is an area traffic signal engineer for the Mississippi DOT in Jackson. In this role, he is responsible for overseeing the design, maintenance, and operation of traffic signal control systems throughout the southern third of the state. He has served as a delegate on Mississippi DOT's behalf at the AASHTO Subcommittee on Traffic Engineering annual convention, the National Committee on Uniform Traffic Control Devices annual convention, and at several National Transportation Research Board conferences. He is a licensed professional engineer in Mississippi and a member of the Institute of Transportation Engineers. Renick is a graduate of Mississippi State University with a bachelor's degree in civil engineering and a master's degree in business administration.

Appendix C: Participating Agency Key Contacts

Arizona

Sarath Joshua
ITS & Safety Program Manager
Maricopa Association of Governments (MAG)
302 North 1st Avenue, Suite 300
Phoenix, AZ 85003
Phone: (602) 254-6300
E-mail: sjoshua@azmag.gov

Paul Casertano
Transportation Safety and Operations Lead
Pima Association of Governments (PAG)
177 N. Church Avenue, Suite 450
Tucson, AZ 85701
Phone: (520) 792-1093, Ext. 511
E-mail: pcasertano@pagnet.org

California

Jane White, PE
Senior Civil Engineer
Los Angeles County Department of Public Works
900 South Fremont Avenue
Alhambra, CA 91803
Phone: (626) 300-2020
E-mail: jwhite@dpw.lacounty.gov

Marty Amundson, PE
Senior Civil Engineer
Los Angeles County Department of Public Works
900 South Fremont Avenue
Alhambra, CA 91803
Phone: (626) 300-4774
E-mail: mamund@dpw.lacounty.gov

Steve Gota
Project Manager
Los Angeles County Metropolitan Transportation Authority (LACMTA)
One Gateway Plaza, MS 99-22-4
Los Angeles, CA 90012-2932
Phone: (213) 922-6000
E-mail: gotas@metro.net

Danielle Stanislaus
Senior Planner & Program Manager
Freeway Performance Initiative & Arterial Operations Program
Metropolitan Transportation Commission (MTC)
101 Eighth Street
Oakland, CA 94607-4700
Phone: (510) 817-5737
Fax: (510) 817-5848
E-mail: dstanislaus@mtc.ca.gov

Vamsi Tabjulu
Arterial Operations Program Manager
Metropolitan Transportation Commission (MTC)
101 Eighth Street
Oakland, CA 94607-4700
Phone: (510) 817-5936
Fax: (510) 817-5848
E-mail: vtabjulu@mtc.ca.gov

Ronald Keith, PE
Principal Traffic Engineer
Orange County Transportation Authority (OCTA)
550 S. Main Street
Orange, CA 92863-1584
Phone: (714) 560-5990
Fax: (714) 560-5794
E-mail: rkeith@octa.net

Anup Kulkarni
Section Manager
Orange County Transportation Authority (OCTA)
550 S. Main Street
Orange, CA 92863-1584
Phone: (714) 560-5867
E-mail: akulkarni@octa.net

Colorado

Greg MacKinnon, PE
Transportation Operations Program Manager
Denver Regional Council of Governments (DRCOG)
1290 Broadway, Suite 700
Denver, CO 80203
Phone: (303) 480-5633
E-mail: gmackinnon@drcog.org

Georgia

Grant Waldrop, PE
Atlanta Regional Traffic Operations Program Manager
Georgia Department of Transportation
Wayne Shackelford Building
935 East Confederate Avenue, SE, Building 24
Atlanta, GA 30316-2531
Phone: (404) 635-8558
Fax: (404) 635-8004
E-mail: gwaldrop@dot.ga.gov

Shahram Malek
Associate Vice President
ARCADIS US. Inc.
2410 Paces Ferry Road
Atlanta, GA, 30339
Phone: (770) 431-8666
Fax: 770.435.2666
E-mail: shahram.malek@arcadis-us.com

Michigan

Danielle Deneau, PE
Signal Systems Engineer
Road Commission for Oakland County
1200 N. Telegraph, West 49
Pontiac, MI 48341
Phone: (248) 858-7250, Ext. 4730
E-mail: ddeneau@rcoc.org

Thomas Bruff
Manager, Transportation Programs
Southeast Michigan Council of Governments (SEMCOG)
535 Griswold, Suite 300
Detroit, MI 48226
Phone: (313) 961-4266
Fax: (313) 961-4869
E-mail: bruff@semcog.org

Missouri

Ray Webb, PE
Manager of Traffic Operations, Operation Green Light
Mid-America Regional Council
600 Broadway, Suite 200
Kansas City, MO 64105
Phone: (816) 474-4240
E-mail: rwebb@marc.org

Nevada

Brian Hoeft, PE
Assistant Director
Regional Transportation Commission of Southern Nevada (RTC-FAST)
4615 West Sunset Road
Las Vegas, NV 89118
Phone: (702) 432-5311
E-mail: hoeftb@rtcsnv.com

North Dakota

Wade Kline
Executive Director
Fargo-Moorhead Metro Council of Government
Case Plaza, Suite 232
One Second Street North
Fargo, ND 58102-4807
Phone: (701) 232-3242
E-mail: kline@fmmetrocog.org

Pennsylvania

Domenic D'Andrea, PE
Transportation Planner, Coordinator, Regional Traffic Signal Projects
Southwestern Pennsylvania Commission (SWPC)
425 Sixth Avenue, Suite 2500
Pittsburgh, PA 15219-1852
Phone: (412) 391-5590, Ext. 341
E-mail: ddandrea@spcregion.org

Utah

Mark Taylor, PE
Signal Systems Engineer
Utah Department of Transportation
Traffic Operations Center
2060 South 2760 West
Salt Lake City, UT 84104
Phone: (801) 887-3714
E-mail: marktaylor@utah.gov

Texas

Natalie Bettger, PE
Senior Program Manager
North Central Texas Council of Governments (NCTCOG)
616 Six Flags Drive
PO Box 5888
Arlington, TX 76005-5888
Phone: (817) 695-9280
E-mail: nbettger@nctcog.org

Washington State

Stephanie Rossi
Principal Planner
Puget Sound Regional Council (PSRC)
1011 Western Ave, Suite 500
Seattle, WA 98104
Phone: (206) 971-3054
Fax: (206) 587-4825
E-mail: srossi@psrc.org

Appendix D: Amplifying Questions

Regional Goals and Objectives

1. What were your agency's motivating factors for organizing the Regional Traffic Signal Operations Program (RTSOP) in your area? What issues and needs were you trying to address? What were the processes/steps that your region went through to establish the program?

2. What are the goals and objectives of your program? How are program objectives and benefits linked to overall regional mobility goals and objectives? Does a link exist between the Congestion Management Process, the Long-Range Transportation Plan and the RTSOP?

3. How have program goals and objectives evolved over time? What were the forces that created a need for change over time?

4. How does your program accommodate the needs for multimodal integration (e.g., transit signal priority, preemption, bicycles, and pedestrians)?

5. Is there a documented management approach used to develop your program? Does a Regional Concept of Operations exist? If so, has it been beneficial to management and operations within the region? What type of documents/processes were used (e.g., Regional Assessment Plans or Implementation Plan)? Could you please provide copies of these documents?

6. How have you kept all the parties interested in your program? What kinds of "incentives" are used to keep agencies participating in the program?

Structure and Governance

1. What functions does your program perform? What is your program's organizational structure? What entities in the region are involved? What is the role and responsibility of the each partner? Which agency was selected to be the lead agency and why?

2. How are policy-level decisions made in your program (e.g., how much money to spend on the program and what activities/functions will the program perform)? How are operational-level decisions made in the program? What authority does each entity have in the program? At what level within each entity can decisions be made?

3. In establishing your program, did you consider consolidating individual agency functions/staff (including planning, design, operations, and maintenance) into a single regional entity? Why/why not? From a lessons learned perspective, what are the advantages and disadvantages of consolidating functions between agencies?

4. Does everyone in your region agree with the concept that has been deployed? How are disagreements between entities handled?

Agreements

1. What types of institutional agreements and arrangements were involved in establishing your program? What are types of things are included in your agreements? What in your agreements has proved beneficial and what has proved to be a hindrance to your region achieving its goals and objectives? What should and should not be included in organizational agreements?

2. How does an entity "leave" the program? How are agreement terminated? (Please provide a copy of the agreement.)

3. How is liability assigned? To what degree does that influence your decision in operating the intersection?

Operations and Maintenance

1. What type of operations (e.g., adaptive control, traffic responsive, and time-of-day) is used in your programs? Is everyone required to use the same equipment (e.g., controllers, cameras, detection, and communications)? Is there a minimum level of performance at which the signals have to operate? How are the upgrades addressed (determined and paid for) across the system? Is the a minimum level of equipment (e.g., age of controller, controller functions, and communications.)? Are agencies required to upgrade equipment to a certain level in order to participate? Is there a maximum level of functionality that the system can support, and what happens if agency wants to exceed basic equipment requirements?

2. How does your program develop and implement regional traffic signal timing plans? Which agency is responsible for developing the timings? Which agency is responsible for implementing the timings? How are individual agency signal timing philosophies, policies, and practices integrated into your system? How are conflicting operational policies between agencies resolved?

3. How do you manage operational changes in your program? If an agency wants to make an operational change, what processes and procedures are in place to ensure that these changes are consistent with regional goals and objectives? What types of procedures and processes are used to ensure that changes are documented and communicated to other regional partners?

4. Are there regional policies for standard signal timing standards? How were they established? What is the progress for making changes to coordinated signal timing plans? What levels of approvals are needed? What process is used when operational changes are needed? (Can you provide this documentation?)

5. Does your program perform real-time monitoring of traffic signal operations? If so, how? Do you have a regional operations center that supports real-time monitoring? If so, what functions does the center perform? What are its hour of operation? How are operational costs shared between participating entities? What is the limit of its operational authority (e.g., what can operators do to affect changes in signal timing)?

6. How is your regional traffic signal program staffed? What are these individuals tasked to do? Is there a minimum staffing level (numbers and qualifications) that your require? How are these levels established? For what agency to these individuals work? Does your program require any types of certification for your operations personnel (e.g., professional engineer, professional traffic operations engineer, or IMSA)? Do you have a region-wide training program that is used to develop consistent core competencies in staff across agencies? If so, can you please describe the types of training that are performed and by whom?

7. Are any of your program functions outsourced? If so, which ones and why?

System and Hardware Maintenance

1. How are maintenance functions performed in your program? Who is responsible for performing maintenance to the traffic signal control field equipment, the communications equipment, and the central management system (if used)? Which agencies are responsible for performing basic maintenance functions, preventive maintenance functions, and emergency repair functions? Is there a defined standard to which all entities are required to maintain their equipment? What happens if an agency doesn't conform to this standard?

2. Is there a hierarchy or priority given to maintenance issues and repairs? If so, what is that priority? Who makes that decision?

3. How are equipment upgrades performed? Do you purchase equipment or use resources available under another agency's contract?

4. What types of tools are used in your program to support maintenance functions? Do the agencies use (or are they required to use) the same maintenance management software program? Does your program maintain a signal timing database?

5. How is maintenance budgeted? Do you share after-hours responsibilities with other agencies? Are maintenance resources from multiple agencies pooled? If a pooled maintenance budget is used, how is it managed (i.e., how does the accounting work)? What levels of qualifications/certifications are required for your maintenance personnel?

Performance Measures

1. What types of benefits (e.g., performance, safety and others) have your program generated? How do you measure them? Do all agencies agree to them? How were they developed and agreed upon?

2. What specific measures of performance do you use to measure your program's effectiveness? Do you have a formal evaluation program to measure effective operations? Do you have separate regional performance measures and local performance measures? How are the program benefits reported? How often are the benefits reported?

3. How are performance measures used to make operational and planning level decisions for the program? What measures do you use to determine when a corridor should be retimed? Is maintenance performance a performance measure?

Funding

1. What type of funding was used to establish your program? How are the projects programmed in respective planning documents (e.g., Transportation Improvement Plans)?

2. What type of funding is used to keep the program operating? How are funding splits determined between the agencies? Are agencies allowed to "soft" match with their own staff time instead of "hard" match?

3. How are future expenses predicted and budgeted into the program? What is the budgeting planning horizon? Is there a joint business plan for the program to plan for the future?

4. How do you sustain the program over time? What are the critical steps/actions/activities that need to be performed to successfully sustain a program? How do you keep agencies engaged in the process?

5. To what extent do you use federal funds? What types of federal-aid program funding have you used? To what extent have you developed an alternative funding source? What are the keys to developing alternate sources of funding?


PROTECTED
LEFT ON
GREEN ARROW