## 2012 National Traffic Signal Report Card Technical Report

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## **Table of Contents**

#### 3 Section 1—Description

- 3 Background
- 4 Purpose
- 5 Section 2—The 2011 Traffic Signal Operations Self Assessment Tool Explained
- 5 Development and Update Process
- 5 Traffic Signal Program Management Plan Elements
- 5 Organization

#### 7 Section 3—Self Assessment Response Summary

#### 11 Section 4—Traffic Signal Report Card Results

- 11 National Results
- 12 Noteworthy Findings
- 16 Results by Section
- 17 Management
- 18 Traffic Signal Operations
- 20 Signal Timing Practices
- 23 Traffic Monitoring and Data Collection
- 24 Maintenance

#### 27 Section 5—Recommendations to Improve Traffic Signal Operations

- 27 What Four Key Actions Can An Agency Implement Right Now?
- 27 Resources
- 31 Other Organizations and Training
- 33 Conclusions

## **List of Tables and Figures**

- 7 Table 1: Number of Responses by Signal System Size
- 8 Table 2: Number of Responses by Agency Type
- 8 Table 3: Number of Responses by Jurisdiction Size
- 9 Table 4: Average Number of Staff Performing Traffic Signal Work by System Size
- 9 Table 5: Source of Operating/Maintenance and Capital Funding by System Size and Agency Type
- 10 Table 6: Timeline to Delivery by Signal System Size
- 10 Table 7: Use of 2007 Traffic Signal Operations Self Assessment
- 12 Table 8: Comparison of Report Card Scores and Scoring Mechanisms
- 16 Table 9: Traffic Signal Management Performance Goals by Topic Area
- 11 Figure 1: Comparison of Results of 2005, 2007, and 2011 Traffic Signal Operations Self Assessments
- 14 Figure 2: Results by Signal System Size
- 15 Figure 3: Results by Agency Type

## Description

he 2012 National Traffic Signal Report Card is an effort to bring more attention to the importance of and investment in traffic signal management and operations. The first and second National Traffic Signal Report Cards were released in 2005 and 2007 and assigned national scores of Dand D, respectively. The 2012 National Traffic Signal Report Card score has improved slightly to an overall D+. The improvement in the national score may appear slight, but is meaningful in demonstrating progressive improvement to programs that support management and operations of traffic signals. The number of traffic signals managed by an agency affects the score. In State and metropolitan agencies managing more than 150 signals, the overall score was a C, higher than the national average of D+. In spite of challenging economic conditions this suggests for agencies of all sizes that strategic investments in traffic signal management and operations can make a difference.

This report presents the results of the 2011 Traffic Signal Operations Self Assessment and the findings from the consolidated responses of 241 agencies across the United States and Canada. These results and findings were used to determine the scores for the 2012 National Traffic Signal Report Card. The report discusses these findings in the context of the evolution of practices observed between the 2005, 2007, and 2011 self assessments and a generalized traffic signal program management plan. In addition, this report discusses opportunities and resources available to agencies as well as the future direction of traffic signal systems management and operations.

#### Background

The National Transportation Operations Coalition (NTOC), an informal group of associations<sup>1</sup> interested in advancing transportation system management and operations, conceptualized and developed the report card on traffic signal operations. The report card supports the national initiative to raise awareness with transportation agencies, agencies' policymakers, and the public and bring attention to the benefits of strategic investment in improved management and operations of traffic signals. Some agencies experience strong funding support when elected leaders recognize the value of good traffic signal operations in proactively managing congestion. However, this level of recognition is not widespread.

At the most basic level, traffic signals are infrastructure assets for the control of vehicular and pedestrian traffic. Traffic signals are designed to assign the right of way to the various traffic and pedestrian movements at an intersection. Even the most uninformed traveler recognizes the impact that traffic signals have on travel. Travelers are also surprisingly astute at realizing when signals do not meet their needs for efficient travel.

Traffic signals are owned and operated by State, county, and local transportation and public works agencies. As with all roadway infrastructure, public agencies have a fiduciary responsibility to manage and operate traffic signal systems in a manner that protects the estimated \$82.7 billion public investment in these assets.<sup>2</sup>

Leading transportation professionals have long recognized the value of designing signal timing to meet specific operational objectives, and the value of monitoring performance to meet changing travel demands that can affect efficiency. Appropriately designed, operated, and maintained traffic signals can:

- provide for the smooth flow of traffic along streets and highways at defined speeds, thereby reducing congestion;
- effectively manage the traffic-handling capacity of intersections to improve mobility through the use of appropriate layouts and control measures and regular reviews and updates to the operational parameters; and
- reduce vehicle stops and delays, thereby:
  - lessening the negative impacts to air quality; and
  - reducing fuel consumption.

<sup>&</sup>lt;sup>1</sup> Accessible via www.ntoctalks.com.

<sup>&</sup>lt;sup>2</sup> Example asset value of \$284,459,500 for 1,070 traffic signals from City of Portland, OR, USA, Bureau of Transportation. Asset Status and Condition Report, July 2011, factored up to the 311,000 traffic signals in the United States.

Ensuring that traffic signals are properly timed and maintained should be a key priority at public agencies. However, part of the continuing growth in passenger and freight traffic indicates that a more proactive approach will be necessary to resolve congested conditions and the resulting unreliable service to motorists. An objectives and performance-based plan enables the proactive management, operations, and maintenance of traffic signals as well as supporting the analytical foundation to measure success. This foundation should include the use of applicable performance metrics, targets for performance, appropriate analysis tools to identify, develop, and evaluate solutions to operational problems, an investment plan and a capable workforce necessary to implement the chosen solutions. This proactive approach to traffic signal operations also requires the use of systematic methods to determine the most appropriate strategy to address operational problems.

Improving traffic signal operations can have a significant immediate impact on transportation system efficiency, potentially more than any other operational measure in the traffic engineering toolkit. Delays experienced in highway travel have been steadily increasing during the past 20 years. Delays at traffic signals contribute an estimated 5 to 10 percent of all traffic delay or 295 million vehicle-hours of delay on major roadways alone.<sup>3</sup> Further, the *2011 Urban Mobility Report* notes that in its reporting areas, 61 percent of the street miles in the cities had some level of traffic signal coordination that reduced delay by 21.7 million person hours.<sup>4</sup> There is little doubt that focusing on traffic signal operations has potentially enormous payoffs for the quality of travel experienced by the U.S. traveling public.

The U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office maintains a benefit-cost database that documents traffic signal studies conducted by various agencies. Using this database it has been noted that a program of regular signal timing updates has a benefit/cost ratio between 20:1 and 55:1, with significant estimated annual user savings in the tens of millions of dollars.<sup>5</sup>

#### Purpose

The 2012 National Traffic Signal Report Card is a broad national indicator of how well agencies are supporting activities related

to the planning, management, operations, and maintenance of traffic signals. The purpose of the *2012 National Traffic Signal Report Card* is to:

- highlight opportunities and methods to incorporate best practices in traffic signal management and operations;
- bring attention to the current state of traffic signal systems;
- create awareness of practices enabling good traffic signal management and operations that effectively address congestion;
- present changes since the 2007 National Traffic Signal Report Card; and
- highlight emerging success stories.

The report card score is developed by averaging the individual results submitted by agencies for the *2011 Traffic Signal Operations Self Assessment*. The self assessment is designed to benefit participating agencies on several levels. The purpose of the self assessment is to provide a benchmarking tool for agencies to evaluate their programs and practices in support of achievement of management and operations objectives, compare them to national best practices, and the expectations of system users and decisionmakers, more specifically by:

- giving the traffic professional a guide for defining "good or best practice";
- highlighting strengths and opportunities for improvement in an agency's system or region;
- serving as an objective tool to communicate traffic signal operations needs to management and policy makers;
- presenting results in an easy-to-understand format that supports the need for additional targeted resources and investment in traffic signal operations;
- providing data for the development of the 2012 National Traffic Signal Report Card; and
- providing a general comparison to results from the previous self assessment(s).

One of the most important elements available to public agencies to achieve significant improvement is the proactive, performance, and objectives-based management of their traffic signal operations program.

<sup>&</sup>lt;sup>3</sup> Congestion Reduction Toolbox. U.S. Department of Transportation Federal Highway Administration. Accessible via www.fhwa.dot.gov/congestion/toolbox.

<sup>&</sup>lt;sup>4</sup> 2011 Urban Mobility Report. Methodology-Benefits of Operational Treatments. Texas Transportation Institute, 2011. Accessible via http://mobility.tamu.edu/ files/2011/09/operational-treatments.pdf.

<sup>&</sup>lt;sup>5</sup> ITS Benefits, Costs and Lessons Learned Database. U.S. Department of Transportation (U.S. DOT) Intelligent Transportation Systems Joint Program Office. Accessible via www.benefitcost.its.dot.gov.

## The 2011 Traffic Signal Operations Self Assessment Tool Explained

his section of the report card briefly explains the 2011 Traffic Signal Operations Self Assessment including the development process, key updates, organization, and general elements of the survey.

#### **Development and Update Process**

The 2011 Traffic Signal Operations Self Assessment is a survey created to collect information and assess traffic signal management and operations practices (see Appendix A). A committee of professionals from Federal, State, and local agencies developed the survey. This group represented the following NTOC member organizations in the development process:

- American Association of State Highway and Transportation Officials (AASHTO)
- American Public Works Association (APWA)
- Institute of Transportation Engineers (ITE)
- Intelligent Transportation Society of America (ITS America)
- International Municipal Signal Association (IMSA)
- U.S. DOT—Federal Highway Administration (FHWA)

The 2011 Traffic Signal Operations Self Assessment was updated to reflect comments received following the previous selfassessments and reviewed by the committee to better connect traffic signal management and operations activities to operations objectives. Key changes to the self assessment tool included:

- connecting the questions more to outcomes of objectivesbased traffic signal operations programs and their performance measures rather than outputs;
- consolidating coordinated and isolated operations into one section on traffic signal operations;
- reducing the bias toward centrally managed traffic signal systems;
- removing redundant questions;
- adding information to some of the questions to give respondents more specificity on how to score themselves; to promote more consistent scoring across respondents; and
- modifying and expanding the summary information questions to provide greater depth of information on the characteristics of responding agencies.

The questions were drafted and reviewed by the committee in two rounds of comments before being finalized for distribution. The survey was available to respondents electronically through the Institute of Transportation Engineers Web site and by paper copy.

#### Traffic Signal Program Management Plan Elements

Traffic signal program management plans are a method to create transportation agency processes that include objectives and requirements, responsiveness to citizens, media, policymakers and elected officials as well as maintenance, operations and design strategies to achieve objectives.<sup>6</sup> The self assessment used the following notation with each question:

- [FP] Fundamental Principal: Essential quality or value of an organization.
- [CO] Core Objective: Something that one's actions are intended to accomplish or attain as a result in support of a fundamental principal.
- [KS] Key Strategy: Plan or method for reaching a specific objective or result.
- [SA] Supporting Action: Processes or steps to achieve an objective.

As with the 2007 self assessment, the 2011 self assessment provided the respondents with a detailed description of the scoring methodology. The scoring methodology was designed to allow agencies to benchmark their own performance and derive an individualized score prior to submittal. The results from the 2011 self assessment continue to allow for some comparison to the results of the previous versions so that agencies can gauge changes over time.

#### Organization

The 2011 Traffic Signal Operations Self Assessment consisted of a section on agency summary information and five topic areas identified as necessary for good traffic signal operations. The following summary describes each section:

<sup>6</sup> Improving Traffic Signal Management and Operations: A Basic Service Model. [FHWA-HOP-09-055] Federal Highway Administration, December 2009.

- Section 1: Management—While a traffic signal can eliminate the need for manual control of the right of way, it does not eliminate human involvement, intervention, or intelligence in service delivery—the customer understands this even though he/ she does not know the underlying technologies or engineering involvement. The traffic signal system cannot be effectively maintained and operated without adequate planning and oversight. The issues faced in this section are programmatic management actions that address these important functions.
- Section 2: Traffic Signal Operations—Traffic signal operational strategies support efficiency while maintaining safety and providing signal timing that minimizes and balances congestion while promoting smooth flow. These strategies must address the management of traffic conditions predictably and consistently. Reviewing and updating the timing and operational aspects of signalized intersections on a regular basis is extremely important, especially where changes in traffic volumes and/or adjacent land uses have occurred since the last review. This is important for all signalized intersections, regardless of whether they are isolated or coordinated or whether the coordination is provided by a central system or a smaller, more localized system composed of a few intersections. Traffic signal coordination is one of the more vital aspects of traffic signal control because it ensures that motorists are able to travel through multiple intersections along a corridor with minimal stops and short delays. The issues addressed in this section include review and update of the phasing sequence, detectors, displays, timing parameters (settings), and other related operational aspects of individual signalized intersections, as well as the timing, interconnection, and operation of coordinated systems.
- Section 3: Signal Timing Practices—Some of the questions in the self assessment address issues such as the frequency of signal timing and the number of operational detectors. While these questions are important, it is equally important to consider the outcomes of signal timing activities and whether they have met the intended results of the program objectives; in other words, determining the overall effectiveness of the signal operations that results from all of these activities. This section evaluates the effectiveness of the signal operations through consideration of the degree to which the agency employs signal timing practices that have been shown to produce efficient operations.
- Section 4: Traffic Monitoring and Data Collection—A robust program and supporting systems are needed to determine the condition of traffic flow on roadway networks. These programs and supporting systems collect data connected to agency objectives to:
  - Provide input to traffic signal control operation.
  - Monitor systems in real-time.

- Formulate strategies to effectively manage and control the flow of traffic.
- Monitor flows over long periods of time via data archiving.
- Distribute to others, such as peer agencies, public, universities, and local planning programs.
- Assist in incident response and management.
- Section 5: Maintenance—The maintenance function supports the key strategy of field infrastructure reliability that leads to effective signal operations. A well-timed system must be accompanied by effective maintenance if it is to provide high-quality service to the motoring public. This section can be used to assess the effectiveness of the planning, management, and execution of maintenance activities.

Respondents were asked to rate the extent to which a particular policy or practice had been adopted by their agency (on a scale from 1 to 5) based on their program's progress through the end of 2011. Each question was followed by a short description of outstanding practice (a score of 5). Respondents also were given an option of "not applicable" for questions that did not apply to their agency.

The self assessment results provide an agency with a potential target for improving their own traffic signal operations. **It was not anticipated that any agency would have a perfect score.** Questions scored as "not applicable" did not contribute to the overall score and were not included in the results. The *2011 Traffic Signal Operations Self Assessment* remains available online as a tool for agencies to use on a regular basis.

The self assessment is a subjective and qualitative tool. The quantitative "score" should be viewed as a comparative indicator of an agency's practices relative to a national synthesis of commonly accepted good practice. This provides an agency with a target to improve their own traffic signal operations. Agencies are comparing themselves to an idealized agency representing good practices gathered from across the nation. The self assessment can be used both by local agencies, regional, or statewide programs to identify gaps in practices and target areas for process improvement or investment.

This technical report presents overall results and noteworthy findings from each section of the self assessment as well as summary characteristics of responding agencies. In addition, this report highlights examples of programs and practices that can lead to scoring well in specific sections of the self assessment. Taken together, these results make up the *2012 National Traffic Signal Report Card*.

## Self Assessment Response Summary

total of 241 respondents completed the self assessment. Of the 241 respondents, 49 agencies responded to self assessments in 2005, 2007, and 2011. The respondents represent State, county, and local agencies that operate various-sized traffic signal systems. More state DOTs responded to the self assessment in 2011 although there were fewer total responses from this group because individual submissions from district or regional offices of these agencies were consolidated. Responses were received from 16 Canadian agencies. Because traffic signal operations and their associated funding mechanisms in Canada are similar to those in the United States, the results for the *2012 National Traffic Signal Report Card* include Canadian responses. Inclusion of Canadian responses is consistent with the methodology in previous report cards editions.

There was at least one agency response (State or local) from 43 states. More specifically, responses came from 34 different states for city/municipality agencies, 15 different states for county agencies, and 31 different states for state agencies. The 2012 National Traffic Signal Report Card is an aggregate of the responses to determine the average national score for each section. **Individual results are anonymous.** 

The total number of responses by signal system size and the approximate percentages of overall signals represented by this survey is shown in Table 1. The 2011 version of the self assessment specifically asked agencies how many isolated and/or coordinated traffic signals they operated or maintained. With this information and an updated total of 311,000 signals in the United States in 2011, it is estimated that the survey responses represent approximately 39 percent of all traffic signals in the United States.<sup>7</sup>

Table 1 demonstrates that although agencies operating 50 or fewer traffic signals make up almost a quarter of the total responses, they represent relatively few of the total number of traffic signals captured in the survey. Though no less critical than those in large jurisdictions, this can represent a challenge to coordinate service delivery across many smaller organizations.

Traffic Signals Managed	Number of Responses	Percent of Responses	Number of Coordinated Traffic Signals	Number of Isolated Traffic Signals	Total Number of Traffic Signals Represented	Percent of Total Number of Traffic Signals
Less than 50 <sup>1</sup>	55	23%	768	704	1,472	0.5%
50 to 150 <sup>2</sup>	74	31%	4,177	2,284	6,461	2%
150 to 450 <sup>3</sup>	54	22%	9,281	4,640	13,921	4%
450 to 1,000 <sup>4</sup>	22	9%	9,755	5,106	14,861	5%
More than 1,000 <sup>5</sup>	36	15%	48,156	36,432	84,588	27%
TOTAL	241	100%	72,137	49,166	121,303	39%

#### Table 1: Number of Responses by Signal System Size

#### Notes:

Notes: <sup>1</sup> Includes 1 result from Canada; <sup>2</sup> Includes 3 results from Canada; <sup>3</sup> Includes 5 results from Canada; <sup>4</sup> Includes 4 results from Canada; <sup>5</sup> Includes 3 results from Canada.

<sup>&</sup>lt;sup>7</sup> Unpublished material provided by Phil Tarnoff, 2011.



The number of responses by agency type is shown in Table 2. Table 3 shows the number of responses based on jurisdiction and metropolitan-area size.

#### Table 2: Number of Responses by Agency Type

Jurisdiction	Туре	Number of Responses	Pct. of Responses
City/Municipality <sup>1</sup>		147	61%
County		34	14%
State/Province <sup>2</sup>		57	24%
Other Jurisdiction		3	1%
	TOTAL	241	100%

#### Notes:

Notes: <sup>1</sup>Includes 11 results from Canada; <sup>2</sup>Represents responses from states with various districts or regions that operate their own signal systems. Also includes 5 results from Canada.

#### Table 3: Number of Responses by Jurisdiction Size

Population	Number of Responses	Pct. of Responses
Less than 50,000	52	22%
50,000 to 250,000	86	37%
250,000 to 500,000	19	9%
500,000 to 1,000,000	26	10%
Greater than 1 million	51	22%

Note: Seven agencies did not indicate the size of their jurisdiction

Table 4 presents the average number of full-time equivalent (FTE) staff responsible for traffic signal operations, management, and maintenance in different categories by traffic signal system size. Table 4 is separated into sections for in-house staff in comparison to outsourced positions. Further, the results showed that 135 respondents (58 percent) did not outsource any staff positions, and only 27 outsourced more that 5 FTE positions.

#### Table 4: Average Number of Staff Performing Traffic Signal Work by System Size

Traffic Signals Managed	Non- technical Manager	Engineering Manager	Engineers	Other Professionals	Signal Technicians	Other Technicians	Administrative	Other Staff	Total
In House Staff (FTE	Es)								
Less than 50	0.2	0.4	0.4	0.3	1.0	0.4	0.2	0.1	3.1
50 to 150	0.3	0.7	0.7	0.2	2.3	0.5	0.3	0.1	5.2
150 to 450	0.5	0.9	1.4	0.6	5.5	1.1	0.7	0.6	11.4
450 to 1,000	0.6	1.4	2.8	2.4	13.8	2.7	0.9	0.6	25.2
More than 1,000	2.1	7.7	23.7	4.7	31.6	5.4	2.6	1.8	79.4
AVERAGE	0.9	1.8	5.2	1.8	9.1	2.1	1.1	0.9	22.9
Outsourced Staff (	FTEs)								
Less than 50	0.1	0.1	0.4	0.1	0.7	0.2	0.1	0.0	1.7
50 to 150	0.1	0.1	0.3	0.1	0.4	0.1	0.0	0.1	1.2
150 to 450	0.1	0.1	0.3	0.1	1.3	0.2	0.1	0.0	2.2
450 to 1,000	0.4	0.1	0.1	0.2	1.8	1.1	0.1	0.1	3.9
More than 1,000	0.2	0.2	1.4	0.4	1.9	3.5	0.4	0.5	8.4
AVERAGE	0.2	0.2	0.7	0.3	1.4	1.2	0.2	0.2	4.4

Note: 9 agencies did not respond to this question.

Table 5 shows the average annual source of 1) operating and maintenance and 2) capital funding for traffic signal management operations for different funding categories by traffic signal system size and agency type. Further, the total spending was \$425,587,717 on operating and maintenance programs and \$303,159,558 on capital projects for traffic signal programs by the 219 agencies responding to this question.

#### Table 5: Source of Operating/Maintenance and Capital Funding by System Size and Agency Type

			ance Project/P \$ by System		(Ave	Capital Project/Program erage Funding \$ by System Size)		
	Local	Regional	State	Federal	Local	Regional	State	Federal
Signal System Size								
Less than 50	\$57,493	\$7,000	\$109,715	\$2,909	\$36,482	\$3,636	\$7,691	\$14,345
50 to 150	\$256,340	\$6,284	\$44,780	\$4,311	\$195,277	\$8,041	\$38,784	\$89,797
150 to 450	\$705,492	\$16,652	\$226,215	\$147,315	\$187,173	\$3,041	\$110,166	\$103,148
450 to 1,000	\$763,591	\$456,500	\$461,273	\$431,864	\$427,955	\$300,682	\$135,227	\$294,547
More than 1,000	\$3,061,972	\$187,917	\$4,031,281	\$694,444	\$2,499,583	\$111,111	\$1,572,083	\$2,147,917
Agency Type	1							
City/Municipality	\$1,147,757	\$40,525	\$83,591	\$98,571	\$763,022	\$42,137	\$35,765	\$321,592
County	\$504,605	\$186,029	\$111,647	\$21,206	\$385,005	\$151,029	\$37,340	\$133,529
State/Province	\$23,070	\$4,825	\$2,820,145	\$485,614	\$12,456	\$4,298	\$1,092,719	\$789,386
Average, All Agencies	\$858,981	\$147,279	\$1,202,978	\$349,065	\$711,663	\$98,925	\$521,303	\$756,321

Note: 22 Agencies did not respond to this question.

Table 6 presents a summary of the average amount of time for a project or program that addresses agency objectives in traffic signal management and operations to move from identification through the process to scope, program, budget, and contracting to the start of work. This is shown by signal system size and distinguishes between operating/maintenance programs and capital projects.

#### Table 6: Timeline to Delivery by Signal System Size

Traffic Signals Managed	Operating/ Maintenance Project/Program (Months)	Capital Project/ Program (Months)
Less than 50	7	12
50 to 150	6	15
150 to 450	7	19
450 to 1,000	5	15
More than 1,000	9	18

Table 7 presents how agencies used the results of the 2007 Traffic Signal Operations Self Assessment in their programs. This demonstrates that using the results was a useful exercise to evaluate programs. Forty six percent of agencies used their 2007 results to request additional funding for operating/maintenance programs or capital projects. They were successful slightly more than half of the time.

## Table 7: Use of 2007 Traffic Signal OperationsSelf Assessment

Question	Yes	No	In Process
Define or revise			
operational objectives	34%	51%	15%
and requirements			
Establish performance			
measures and standards	25%	52%	23%
of performance			
Revise existing program	31%	60%	9%
without additional funds	0/10	00 /8	970
Request additional			
funding for operating/	46%	49%	4%
maintenance			
Receive additional			
funding for operating/	24%	71%	4%
maintenance			
Request additional			
funding for capital	46%	49%	5%
projects			
Receive additional			
funding for capital	29%	65%	6%
projects			

**Notes:** Note 1: Only agencies completing the 2007 self assessment. 53 Agencies did not respond to this question.

# Traffic Signal Report Card Results

he national grade is a composite score derived from the 241 responses to the 2011 Traffic Signal Operations Self Assessment for the 2012 report card. The 241 responses were treated equally and were not weighted by system size, agency type, or population. While these criteria are important to characterizing and drawing conclusions about the current state of traffic signal operations, the overall score is presented as an indicator that can be applied on a national scale.

#### National Results: Grade D+

The results indicate that improvement and investment in traffic signal operations remains critical. The *2012 National Traffic Signal Report Card* score is a 69, equivalent to a D+ letter grade. The 2012 score is a modest four point improvement over the 2007 result of a D letter grade (65). Although the overall improvement is small, agencies operating 150 to 450, 450 to 1,000, and more

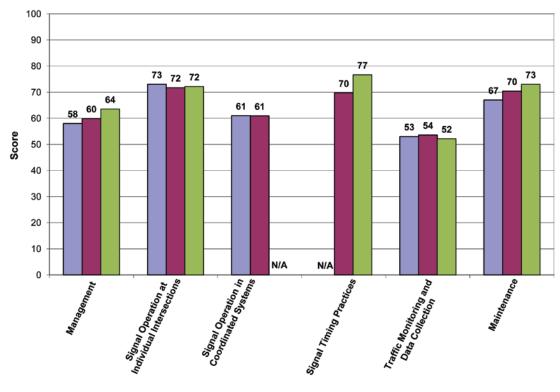
than 1,000 traffic signals each made gains and have an overall letter grade of C in each signal system size category.

The signal assessment was divided into five topic areas identified as necessary for good signal operations:

- Management
- Traffic signal operations
- Signal timing practices
- Traffic monitoring and data collection
- Maintenance

Figure 1 shows the 2012 national results by topic area in comparison to the results by topic area from the 2005 and 2007 report cards.

In addition to Figure 1, Table 8 Shows the distribution of grades and scores for the 2005, 2007, and 2011 results. While not used to calculate the report card score, it is of note that weighting the results by the number of traffic signals operated



#### Figure 1: Comparison of Results of 2005, 2007, and 2011 Traffic Signal Operations Self Assessments

■2005 Results ■2007 Results ■2011 Results

by agencies rather than simply treating all agencies equally suggests that agencies that operate large numbers of traffic signals tend to follow more closely accepted best practices. This is consistent with the results by signal system size as well.

Figure 2 represents the 2012 national results by signal system size—meaning the number of traffic signals managed by a responding agency. Figure 3 represents the 2007 national results by agency type—state, county, and city/municipality.

#### **Noteworthy Findings**

Despite the attention generated in 2007 and the recent emphasis on traffic signal operations through a variety of national, regional, and local programs, *the national score* (69) remains low, with results only slightly improved compared to the 2007 National Traffic Signal Report Card. This is not surprising; given the impact of the recent economic downturn that has affected funding priorities at all levels of government and especially at the local level in some hard hit parts of the country. This will continue to affect funding cycles in most jurisdictions making it difficult to incorporate significant changes from a budgetary perspective. The low score demonstrates the continued need for attention and additional resources for traffic signal management and operations.

Although the overall improvement is small, agencies operating more than 150 signals have an overall letter

**grade of C (73)**. This is an indication of larger staff resources assigned to traffic signal programs as well as a balance of resources compared to the relative complexity and size of the traffic signal system. Even with difficult budgetary choices, the national score improved overall and agencies that operate larger signal systems are performing better than the national average.

This leads to the conclusion that resources for traffic signal operations continue to be prioritized in the allocation of funding in the larger operating agencies.

Scores are remarkably similar across the United States and Canada and across jurisdictions. Although there may be some high performing signal systems, on the whole, the vast majority of systems across the United States and Canada have the potential for greatly improved performance.

Although major improvements were not realized on a national basis, the individual 2011 results highlight that some examples have scored well in specific areas. These agencies were able to correct obvious deficiencies in maintenance or operational practice by making targeted improvements.

The signal timing practices section scored the highest for all signal system sizes except systems with less than 50 signals, where maintenance scored the highest. This is similar to the 2007 and 2005 results for small agencies and is likely to represent situations in which agencies with limited resources and staff are forced to address specific localized problems as they occur.

Interestingly the *maintenance section received the second-highest scores* (73) followed closely by the traffic signal operators section (72), except for those agencies with less than 50 signals. Maintenance has historically been an area that struggles to obtain adequate resources beyond the reactive emergency response-type services, yet in this case there was improvement. Reflecting on the data further, it becomes clear that agencies, especially the larger ones, are stepping up their signal timing practices and maintenance due to their relatively high benefits and low costs when compared with roadway capacity expansion projects.

	2011	2011	2007	2005
Section	Even Weighting	Weighted by System Size	Even Weighting	Even Weighting
Management	D (64)	C (77)	D- (60)	F (58)
Signal Operations	C (72)	C+ (79)	C (72)	C- (72)
			D- (61)	D- (61)
Signal Timing Practices	C (76)	B (81)	C- (70)	N/A
Traffic Monitoring and Data Collection	F (52)	D+ (69)	F (55)	F (53)
Maintenance	C (73)	C+ (79)	C- (70)	D+ (67)
Overall	D+ (69)	C (77)	D (65)	D- (62)

#### Table 8: Comparison of Report Card Scores and Scoring Mechanisms

National Traffic Signal Report Card 2012

Management

**Traffic Signal Operations** 

**Signal Timing Practices** 

Traffic Monitoring and Data Collection

## Maintenance



D

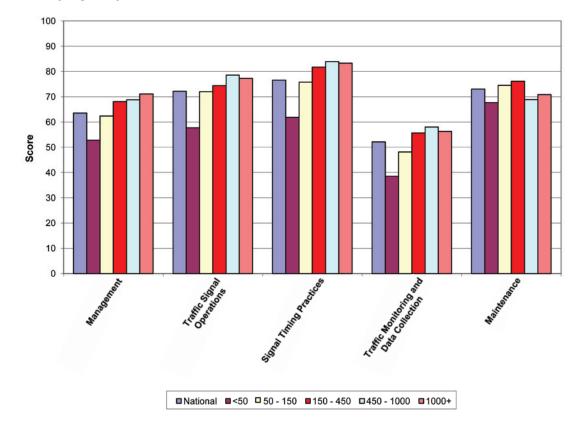
C

C

F

D+

#### Figure 2: Results by Signal System Size

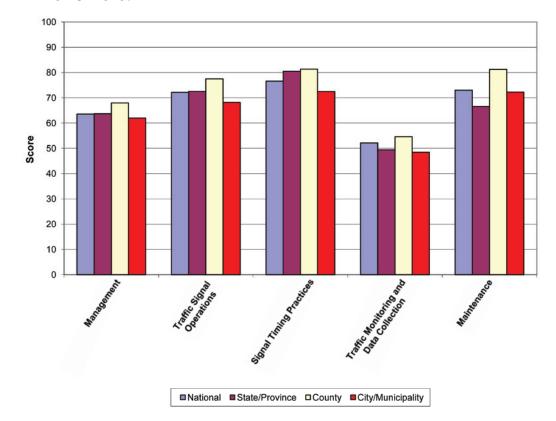


The generally average to low scores indicate that, for the most part, agencies continue to face challenges in their effort to improve traffic signal operations, and, as a consequence, motorists expectations are low. However, well planned traffic signal management, operations, and maintenance practices can save money and provide a high value trade-off compared to other types of infrastructure investment.

The *traffic monitoring and data collection section continues to be the lowest-scoring section* regardless of signal system size or type of agency and significantly lower than all the other topics examined. Without clearly articulated objectives for a traffic signal program requiring performance measurement, it is difficult for agencies to consistently support regular traffic data collection. Traffic monitoring and data collection are essential to uniformly measure progress toward meeting objectives whether they are related to local fluctuations in traffic, overall system performance, or to provide valuable input to the resource allocation process. This further indicates an area where agencies must focus their attention to improve performance. One can infer that agencies are doing more signal timing work, but there is an open question of, "to what end?" if the results are not measured or tied to an objectives driven process. Very small signal systems (less than 50 signals) scored markedly lower (an overall score of 59) than all other system sizes (ranging from 69 to 73) although an improvement from the 2007 result of 51. Small cities and towns tend to operate fewer traffic signals than large metropolitan areas. On the one hand, the small number of signals means that there are fewer signals to manage and, therefore, one would expect them to show better performance; however, many small cities often have no traffic engineering staff. Traffic signals in small systems, in many cases, are the responsibility of a public works department that must spread attention across a wide range of needs including water and sewer systems, roadway maintenance, and responding to everyday service requests. Staff responsible for traffic signals in small jurisdictions are more likely to have broad-based knowledge and experience and are unlikely to have specialized training in traffic signal operations. However, there are likely opportunities for these smaller organizations to apply focused approaches based on key objectives to improve their programs.

Overall, there was little distinction between traffic signal systems with 150 to 450, 450 to 1,000, or more

#### Figure 3: Results by Agency Type



**than 1,000 signals; all scored a composite of (73)**, which may be an indication of increased flexibility in using staff resources, creative process improvements, and a balance of resources compared to the complexity and size of the system. It should be noted that the operations and management of larger signal systems is critical because these systems have the potential to impact—positively or negatively—the travel of significant numbers of people. A score of 73 still leaves much room for improvement.

When the results are assimilated across the entire self assessment, the results are slightly better than the 2007 results. The scarcity of reliable resources for both funding and staffing in the current economic environment necessitates that many agencies, especially smaller ones, do what is needed to provide basic functionality. As a result many agencies continue to lack the capability and resources to proactively manage traffic signal systems. These agencies see this systematic management approach as an additional expenditure of effort and resources even though it can result in overall savings. A programmatic approach to traffic signal management and operations establishes realistic operational objectives and defined, documented, and measured supporting strategies and better enables them to address congestion and fuel consumption and lessen the negative impacts to air quality to improve the quality of life within our communities. Agencies that perform well on this report card have demonstrated that they employ recognized objectivesbased best practices in their use of traffic signals to manage and operate the roadway network.

This does appear to be gradually changing as shown in the modest improvement in the signal timing practices and maintenance sections. However, there still appears to be a disconnect between established, stated, measureable objectives and performing signal operations tasks and timing practices. The traveling public pays the price in terms of congestion, air quality, and fuel consumption. However, as stated previously, some agencies can be viewed as leaders in terms of managing their signal operations. They should be recognized and emulated. Noting these positive outcomes and progressive approaches is very helpful because this highlights real-world practices that agencies can use to improve, even within a short time period. The report provides information on selected examples of practice as well as detailed results in the next section.

#### **Results by Section**

The following pages describe results for each of the five sections included in the self assessment tool. For each section, a general description, characteristics for high scores and noteworthy findings are described. In addition, this section provides a summary of the good practices that support achievement of excellence in each self assessment section. The text for each question can be found in Appendix A. Appendix B includes figures showing the results for each question by signal system size and agency type.

The 2012 National Traffic Signal Report Card provides a road map to success for traffic engineers. To achieve success in today's economic environment, organizations must define their



Topic area		Where agencies are	Goal: excellence in operations
Management	D	An objectives-based program for how the agency operates signals is seldom documented or shared with employees, agency leadership, or the public. Outreach to the public, policymakers, and emergency service providers happens only on an ad-hoc, informal basis. Measurement of system or organizations' performance is rarely conducted. Agencies are unlikely to have an established business plan for transportation operations with clearly defined performance measures and goals.	Agencies have established a documented objectives-based management approach for traffic signal management and operations that is measured and shared with employees and reported to agency leadership and the public on a regular basis. Agencies meet routinely with the public, policymakers and emergency service providers and conduct a comprehensive performance management measurement of progress related to objectives. Agencies have a business plan for transportation operations that describes performance measures and goals specific to the traffic signal program and the overall operations program.
Traffic Signal Operations	С	Information on signals and timing inventories is generally collected and maintained in a central location; however, field changes to reflect changes in traffic or land use patterns are made infrequently. Traffic signal timing performance is not regularly measured in connection to objectives, resulting in outdated timing patterns that do not reflect current traffic and pedestrian needs. Coordinated signals may force motorists to stop at multiple adjacent intersections and result in travel delays when settings are not updated. Signal technicians generally current on the use of modern software but may not be able to use current software due to resource constraints, resulting in signal timings that are not optimized. Timing plans are not in place for emergencies and special events.	Agencies maintain a comprehensive system for monitoring high-priority arterials and locations with high crash rates as well as an inventory of all traffic signals and their timing settings. Signal timing is reviewed for all signals in accordance with operational objectives at least every three years. Agencies use a comprehensive system for monitoring all reviews. Traffic signals are coordinated across jurisdictional boundaries. Engineers and Technicians are knowledgeable and consistent in the use of signal optimization software. Signal timing plans exist for emergencies and special events. Timing plans are implemented quickly and effectively.
Signal Timing Practices	С	Signal timing policies and practices tend not to be documented. The design of signal timing does not consider all available signal control features such as volume density and traffic responsive modes of operation. A limited number of signal timing parameters are evaluated during signal retiming projects. The number of signal timing plans developed may not meet traffic demands during all periods of weekdays and weekends, holidays, special events, and incident conditions.	Signal timing policies and practices are documented. The design of signal timing is oriented around objectives and impacts to performance measures are considered both for the network and across all intersection approaches. All available signal timing features are considered and the number of timing plans designed and implemented is consistent with traffic demand during weekday and weekend periods.
Traffic Monitoring and Data Collection	F	Real-time traffic data are seldom available to the traveling public for information and route planning. There are few, if any, quality checks for traffic monitoring and collection systems. This leads to inaccurate data for signal operations and the potential for malfunctioning field equipment. As a result, signals may not operate based on actual traffic conditions, resulting in delays.	Established programs for checking the quality of data gathered by roadway detectors are utilized to check against historical data, field observations, or physical checks to make sure they are operating correctly. Real-time traffic monitoring systems are in place to evaluate traffic flow and performance, enabling immediate signal timing adjustments and evaluation of system effectiveness.
Maintenance	С	Agencies lack adequate staff and training resources and, therefore, are forced to address only the most critical issues rather than proactively maintain the signal system.	Maintenance offices are adequately staffed to ensure the continued sound operation of traffic signals.

program goals and objectives as well as measure their progress to justify the resources necessary to go beyond resolving the day-to-day requests for improvements to their traffic signal systems. Organizations must refocus their resources to use proactive, knowledge-based decision-making for their traffic signal systems that will enable them to identify areas for improvement. Each agency will have different constraints and opportunities to take advantage of tools and resources. Some may progress with change incrementally; others may progress in leaps and bounds. Following this road map will provide agencies with the ability to lead the actions to resolve congestion issues and improve overall traveling conditions in a timely and meaningful manner.

The previous table maps the progress from where agencies are now to the goal of excellence in operations of traffic signal systems.

Agencies scoring well on specific sections of the self assessment likely adhere to one or more of the Fundamental Principles [FP], Core Objectives [CO], Key Strategies [KS], or Supporting Actions [SA] that are associated with the survey questions in each section. A concise description of excellence in each section has been developed based on the relationship between these characteristics and a generalized signal program management plan. Although the self assessment questions cover many of these characteristics explicitly, some need to be defined by an agency in its program plan. Based on the individual responses in each section, agencies have been asked to share good practices that may contribute to excellence in any of the five sections. In addition to highlighting the practice, agencies have been asked to share relevant documentation that is publicly available by uploading or providing a link to the information on the NTOC Traffic Signal Library and User Forum .

What follows is a generalized description of each section with the program management plan characteristics and examples of good practice.

#### Management: Grade D

Traffic signal operations is one of the transportation industry's most visible services to the traveling public. Therefore, it is appropriate that executive management, policymakers, and the public be aware of the outcomes of good traffic signal operations. Excellence in management suggests that the agency has developed a written plan that shares its management approach for traffic signal operations with agency leadership,

employees, and the public. The plan describes policies, objectives, and performance measures specific to the traffic signal program and is considerate of the needs of regional partners, other transportation modes, facilities, and system users including pedestrians. The plan should be written in the context of agency resources and capabilities and include mechanisms for workforce development. Following are elements of good practice for a well-managed traffic signal system:

#### **Fundamental Principles [FP]**

- Document clear operations objectives. (Q12)
- Measure and report outcomes in terms of operations objectives. (Q13)
- Outreach program to communicate proactively with policymakers and the public. (Q14)
- Closely coordinate design, operations, and maintenance resources and limitations. (Q12)
- Signal timing policies and strategies are linked to objectives, guide design, and operations activities and are supported by maintenance capability. (Q17)
- Develop and maintain a proficient workforce. (Q18)

#### Core Objective [CO]

• Pursue achievable objectives that are appropriate for the level of traffic demand, land use, and network configuration.

#### **Regional Traffic Signal Operations Programs**

In Regional Traffic Signal Operations Programs (RTSOPs) state, county, and city departments of transportation work cooperatively and collaboratively to address a region's mobility issues on arterial street networks. RTSOPs provide partner agencies a formal framework to discuss issues, plan for improvements, and share experiences. By working across traditional jurisdictional boundaries, agencies provide higher levels of customer service through more objectiveoriented actions that consider the regional impacts of local activities. The most successful programs have an active set of leaders who emphasize the importance of regional collaboration and sustainable funding sources for strategic investments that provide continuing improvements, use performance measures to quantify benefits and progress toward program goals, and engage in outreach to the public and elected officials to foster champions in the policymaking arena.

#### **Engaging Policymakers and the Public**

Program management plans for traffic signal management and operations should include an outreach and awareness strategy that identifies the process for reporting progress of the program to agency management, policymakers, elected officials, and the public. Customer service requests should be documented, tracked, and responded to within defined time frames by type of service. The strategy must support meaningful timely response to requests from top management and elected officials. The process must establish a connection from the complaint to the person responsible for resolving the issue. The small details does matter because it affects general public support for agency goals.

The process should allow for both ad hoc and systematic reports based on operational objectives. Reports should be short, descriptive, rigorously factual, well presented, and closely related to the interests of the public and, in turn, elected leaders and policymakers. Policymakers and elected officials will be looking at issues in the context of how they affect the whole community and often receive valuable information from outside the transportation engineering profession. While they will want results, they also do not want to be surprised. Ultimately, the best engineering decision in a particular instance may not be the best solution for the community.

One should be aware that policymakers and elected officials need to accomplish something during their appointment or term of office and often are looking forward to their next role. Remember that transportation and traffic signals may not be the first concern in many communities and in some, it is ranked below public safety, employment, education, and other issues. It is important to make transportation relevant as an issue with a higher level of concern.

The outreach strategy should clearly define whether the traffic signal management and operations staff should communicate with the media, as well as when, and a media representative should be designated.

- Evaluate the impact of operational strategies on safety.
- Regionally coordinated traffic signal operations. (Q15)
- Coordinate traffic signal operations with other relevant facilities such as freeway, transit, emergency vehicle, bicycle and pedestrian. (Q16)

#### Key Strategy [KS]

- Field infrastructure reliability.
- Accommodation of planned and unplanned events, incidents, roadway construction, weather.(Q20)
- Projects are developed systematically and linked to objectives. (Q22)
- Develop a process to align signal timing that is appropriate to current traffic demand.

#### Support Activity [SA]

- Performance monitoring. (Q19)
- Training programs and linkages to professional organizations such as NTOC, ITE, IMSA, AMPO, APWA.
- Utilization of guidance, training and research available through organizations such as TRB and FHWA.
- Collaborate with regional partners to address regional needs such as regional coordination for routine operations, planned and unplanned events, closures, and emergency preparedness. (Q20, Q21)

#### Noteworthy Findings

The average national numerical score for the management section is 64. The overall poor performance in the management section is the most noteworthy finding.

- One-third of respondents reported having minimal or no program defined for traffic signal operations.
- 40 percent do not have operations plans that consider traffic monitoring and management.
- Almost half (43 percent) do not actively monitor or manage traffic on a regularly scheduled basis.

Encouragingly 36 percent of reporting organizations have traffic signal timing parameters connected to a policy objective and 25 percent report a high level of professional training of staff.

#### **Traffic Signal Operations: Grade C**

Excellence in traffic signal operations results in the implementation of strategies and activities that achieve the agencies' stated operations objectives. The strategies and activities that are implemented are supported by documented signal timing practices and policies and consider current and future resources and capability. This approach is applicable, regardless of whether an individual signalized intersection is coordinated with other nearby signals or operates independently. Reviewing and updating the intersection-specific timing, operational, and coordination aspects of signalized intersections based on stated objectives is extremely important, especially where changes in traffic volumes and/or adjacent land uses occur. The issues addressed in this section include review and updating of the phasing sequence, detector operation, displays, timing parameters, and other related operational issues. In addition, this section addresses the timing, interconnection, and operation of coordinated signals. Key elements include:

#### Fundamental Principles [FP]

- Documented operations objectives inform the selection of signal timing strategies and guide design and operations activity. (Q12)
- Operations and maintenance capability and resources inform planning, design, and operations activities. (Q12)

#### Core Objective [CO]

- Safe operation
- Avoid stops
- Minimize delay
- Provide access to land use

#### Key Strategy [KS]

- Select mode of operation and pursue strategies that are consistent with traffic demands and objectives.
- Utilize a systematic process to implement advanced operational strategies. (Q34)
- Use signal timing review to direct data collection requirements. (Q25)

#### Support Activity [SA]

- Documented process to manage approved signal timing settings, trigger reviews, updates, and to evaluate performance. (Q23, Q24)
- Documented process to select, evaluate, respond to, and report performance measures.

#### Pima Association of Governments—Regional Traffic Signal Operations Program

Pima Association of Governments (PAG), the Tucson, Arizona-area metropolitan planning organization, worked closely with the Regional Transportation Authority and member jurisdictions to make traffic signal timing improvements across the metropolitan area.

The program completed a coordinated review of more than 600 traffic signals throughout the Tucson region, resulting in 133 intersections receiving extensive timing modifications, which resulted in smoother traffic flow without negatively impacting pedestrian mobility. The retiming program led to more than 9 percent in reduced vehicle delay and 3 percent in fuel consumption reduction. Reductions in various vehicle emissions from the updated signal timing plans range from 2 percent to 16 percent less output. Adjustments to another 500 signals improved pedestrian safety to avoid unnecessary conflicts with vehicles at signalized intersections. Specific adjustments were made to the WALK signal times to accommodate the slower pedestrian walk speed recommended in the 2009 Manual of Uniform Traffic Control Devices (MUTCD). The program has supported the interconnection of traffic signals into the regional network, funded traffic signal equipment upgrades, enabled regular evaluation and adjustments of the region's traffic signal operations, and helped fund the establishment of a municipally owned telecommunications network to support regional traffic signal operations.

The regionally-led program was selected as a national best practice by the National Cooperative Highway Research Program (NCHRP) as part of a nationwide research project to document and share information about various sized multiagency regional traffic signal programs. "The regional traffic signal program aims to deliver 'seamless' traffic signal operations across jurisdictional boundaries through the establishment and support of a centrally coordinated regional traffic signal network," said Paul Casertano, Transportation Operations and Safety Lead at PAG.

SOURCE: Pima Association of Governments

• Documented criteria and policies to guide the application of signal timing strategies (i.e. time-of-day, traffic responsive, adaptive) and mode of operation i.e. coordinated or isolated. (Q26 to Q33)

#### Noteworthy Findings

The average national score for traffic signal operations is 72.

- The management of signal operations has maintained an average level, but still leaves room for improvement. Seventy percent of agencies reported having some documented process that triggers review of signal timings at signalized intersections. (Q24)
- On a positive note, after new timings are developed, signal timing parameters are updated, plans are documented, and timings are implemented quickly. Seventy percent of agencies reported having strong or outstanding procedures for updating signal timing parameters when performing a timing update. (Q26)

- Sixty-eight percent reported having strong or outstanding documentation and managed inventory of approved signal phasing and timing settings for each intersection. (Q23)
- Although fifty percent reported that a traffic signal is updated in the field in less than two weeks, (Q29) larger system sizes (all systems larger than 450 signals) and state agencies reported much higher percentages of 85 percent and 90 percent, respectively.
- A significant indicator of strong-traffic signal operations is the systematic and performance-related review of traffic signal timing. Fewer than one-third (28 percent) of agencies reported minimal activity or not conducting a comprehensive review of signal timings at least every three years. (Q24)

#### Signal Timing Practices: Grade C

The overall effectiveness of traffic signal operations is an outcome of the agencies practices, policies, and activities. These

#### Metropolitan Transportation Commission Program for Arterial System Synchronization

The Metropolitan Transportation Commission (MTC) established the Program for Arterial System Synchronization (PASS), July 1, 2010, to provide financial and traffic engineering assistance to local Bay Area transportation agencies in retiming traffic signals for morning, midday, and afternoon peak periods. The MTC partners with Caltrans and is the MPO for the nine county Bay Area and is charged with working with more than 100 cities in the region on the successful implementation of the PASS. In support of the goal of safe and efficient operations of the transportation system, the program includes additional services such as creation of school area timing plans, transit signal priority timing plans, traffic responsive timing plans, incident management flush plans, and timing for weekend peaks. PASS focuses on arterial traffic signal systems that cross multiple jurisdictions; have established regional significance; provide priority for transit vehicles; and connect to the freeway system.

Further, the program implements checks in relation to current traffic signal timing practices such as the recently adopted California MUTCD; modifying the pedestrian walking speed lower to 3.5 feet per second from 4.0 feet per second to provide additional clearance time for pedestrians; reviewing the minimum green time and increasing the parameter at intersections to enhance safety for bicyclists; and reviewing and updating the yellow-time and all-red intervals at intersections to provide additional time for the vehicular traffic to clear or stop safely.

The outcomes for the first funding cycle ending June 30, 2011 show that for the first 13 projects involving 339 traffic signal places the total value of the mobility and emissions improvements is more than \$101 million over a five year time horizon, at a benefit/cost ratio of 80:1. Specifically:

- auto fuel consumption savings was 14 percent or more than 9.87 million gallons;
- auto CO emissions reduction was 519.42 tons;
- reduction in oxides of nitrogen (NOx) emissions was 94.19 tons;
- reduction in particulate matter (PM 10) emissions was 9.97 tons;
- travel time savings for transit was 7 percent or approximately 48,000 hours;
- transit speed increased by 9 percent; and
- travel time savings for autos was 18 percent, or more than 3.8 million hours.

SOURCE: http://www.mtc.ca.gov/services/arterial\_ operations/downloads/PASS/Summary\_with\_all\_Project\_ Fact\_Sheets.pdf

http://www.mtc.ca.gov/services/arterial\_operations/pass.htm

should be aligned with objectives and strategies and based on documentation, standards, accepted practice, and engineering judgment. This section addresses the effectiveness of traffic signal operations through consideration of the degree to which agencies employ traffic signal timing practices that have been shown to produce efficient operations. Key components of excellent traffic signal timing practices include:

#### Fundamental Principles [FP]

• Signal timing practices and policies are based on defensible standards, guidance, and engineering judgment.

#### Key Strategy [KS]

• The mode of operation (coordinated, isolated) and operations strategy (free, time-of-day, traffic responsive, adaptive) and signal timing parameters (cycle, split, offset, and phase settings) are developed and implemented in consideration of measured or predicted traffic demand and operations objectives. (Q39, Q40)

#### Support Activity [SA]

• Signal timing parameters (cycle, split, offset, and phase settings) are developed and implemented in accordance with traffic engineering principles and assessed to ensure effectiveness and compliance with operations objectives. (Q35, Q36)

#### **Utah Department of Transportation**

commissioned a Quality Improvement Team to evaluate its practices against national best practices. The agency has a vision that focuses on UDOT providing "World Class Traffic Signal Maintenance and Operations." The Quality Improvement Team identified obstacles and formulated strategies to achieve the agency vision for traffic signal management and operations. While significant improvements have been realized since the 2007 National Traffic Signal Report Card, room for challenges and opportunities still existed and UDOT chose to take action to transition from its current practices to its future vision of world class services. Up until 2007, UDOT budgeted about \$1 million per year (\$1,000 per signal) for signal maintenance. After the 2007 report card, this was increased to \$3.325 million per year (\$2,950 per signal).

SOURCE: Utah Department of Transportation

#### Traffic Signal System Audits and Road Safety Audits

The use of Road Safety Audits (RSAs) has become an effective tool for proactively improving the future safety performance of road projects during the planning and design stages, and for identifying safety issues in existing transportation facilities (safety.fhwa.dot.gov/ rsa). Analogous to RSAs are traffic signal system audits (TSSAs) (www.ite.org/reportcard/traffic\_audit\_FINAL. pdf), which assess an agency's traffic signal system design, management, operations, maintenance, and/or safety practices relative to generally recognized best practices and to recommend actions that might be taken by the agency to incorporate these practices into its existing operation. The primary difference is that a road safety audit typically focuses on a particular project or location and the traffic signal system audit expands into areas of overall program management of a traffic signals system.

The audit process for both is similar:

- 1. Identity project, scope, objectives, and budget for the audit.
- 2. Select the audit team.
- 3. Conduct a start-up meeting.
- 4. Perform field and office reviews.
- 5. Conduct analysis and prepare a report of observations and recommendations.
- 6. Present observations and recommendations to owner.
- 7. Prepare formal response including comments on the draft.
- 8. Respond to owner's comments and revise recommendations as appropriate.
- 9. Implement findings.

As an example, the City of Cincinnati RSA for the Spring Grove Avenue corridor between Winton Road and Clifton Avenue incorporates key elements of a TSSA. The project was to improve a commuter arterial street, including bridge widening, geometric design changes, and traffic signal modifications (http://safety.fhwa. dot.gov/rsa/case\_studies/fhwasa06017/page12.cfm), to address a high number of crashes and traffic volumes increases. The audit process reviewed several different upgrade options and resulted in a set of key findings and suggestions regarding safety and operational issues with traffic signal infrastructure, turn movement operation and geometry, driveway location, and pedestrian crossing treatments.

SOURCE: Federal Highway Administration

- Tools such as time-space diagrams and signal timing optimization software are selected to align the tool's functional objective with the operational objective being pursued. (Q37)
- Evaluation of settings such as phase sequence, leading and lagging left-turns, overlaps is assessed to evaluate the impact on performance as part of design and review activities.
- The development and implementation of signal timing settings includes an evaluation of the potential impact of those settings on safety and efficiency.
- Signal timing development includes consideration of pedestrians and other facilities such as freeways and transit and complies with the MUTCD and Americans with Disabilities Act and other relevant standards, requirements, and guidelines.
- Considering factors such as volume/density; turn lane blockages and queue spill-back into adjacent intersections; vehicle delay;

and vehicle extension times when timing actuated controllers as well as reviewing signal timing in the field and adjusting the timing to account for actual field operating conditions. (Q40)

• Applying signal operational strategies that minimize delays during periods of light traffic flow or at night. (Q39)

#### **Noteworthy Findings**

The average national numerical score for signal timing practices is 77.

- Two-thirds of agencies perform a comparative analysis of cycle lengths, offsets, phase sequence, and other timing parameters as part of the evaluation and implementation of signal timings. (Q36)
- Seventy-one percent reported having strong or outstanding procedures for considering different signal phase sequences to minimize interruption of traffic progression during the evaluation of timing for a coordinated system. (Q37)

#### Los Angeles Department of Transportation—Automated Traffic Surveillance and Control System

The City of Los Angeles Department of Transportation (LADOT) began to implement the first area of the Automated Traffic Surveillance and Control (ATSAC) System in advance of the 1984 Olympics and now 72 percent of the city's 4,300 traffic signals are part of the system. ATSAC monitors traffic conditions and system performance, provides information to the public on congestion (trafficinfo.lacity.org), selects appropriate signal timing strategies, and performs equipment diagnostics and alert functions. Detectors provide real-time information on the number of vehicles, vehicle speed, and the level of congestion. The information is analyzed to determine if better traffic flow can be achieved by changing the signal timing and then implementing the change.

The Adaptive Traffic Control System (ATCS) is the latest enhancement to ATSAC and uses a software program which provides fully adaptive signal control based on real-time traffic conditions to automatically adjust traffic signal timing in response to current traffic demands by allowing ATCS to simultaneously control all three critical components of traffic signal timing, namely cycle length, phase split, and offset. Another important benefit of the ATSAC System is the ability to dynamically add new and innovative traffic control features through software, when necessary, without building new systems or adding the significant cost of new hardware. LADOT implemented their program for signal priority timing for the management of transit vehicles (LRT and buses) on major commuter corridors within the city in this manner.

ATSAC provides the capability to continually measure traffic volumes and congestion levels for analysis of trends and other transportation planning purposes. ATSAC also dynamically adjusts crossing times for pedestrians at school dismissal and after special events as well as operating without requiring a button-push in predominantly Jewish neighborhoods between sundown on Friday and sundown on Saturday to address Sabbath rules. Additionally, since 2010 LADOT has implemented detectors in bike lanes to actuate traffic signals.

The ATSAC system's ability to effectively manage dynamic traffic flow has shown in evaluation studies that travel times (decreased by 15 percent), traffic signal delay, vehicular stops (decreased by 20–30 percent), air emissions and fuel use are significantly reduced. These are significant improvements for the cost of approximately \$150,000 per intersection.

- Agencies also reported using actuation and off-peak timing practices to improve flow during periods of light traffic.
   Seventy-three percent of agencies reported having strong or outstanding procedures for timing actuated controllers. (Q38)
- Seventy-three percent reported having strong or outstanding procedures for using operational strategies that promote smooth and efficient traffic movement along an arterial during periods of light traffic flow or at night. (Q39)

#### Traffic Monitoring and Data Collection: Grade F

Determining the outcome of operations strategies and activities is enabled by traffic monitoring and data collection. An effective traffic monitoring and data collection program identifies and selects measures of effectiveness (MOEs) that are traceable to agency objectives and allow the agency to manage the performance of the system and articulate results to agency

#### Georgia State Route 9 in Alpharetta, Roswell, and Sandy Springs

The Georgia Department of Transportation (GDOT) identified State Route 9 (SR9) as a regionally significant corridor in its Regional Traffic Operations Program (RTOP). The overall mission of the RTOP program is to increase travel throughput by minimizing congestion and reducing delays along regional commuter corridors through improved traffic signal operations. The program focuses on traffic signal maintenance and repair, and the active management of crossjurisdictional corridors for mainline priority. The program uses CMAQ money as a starting point.

The \$3.5 million SR9 project will update traffic signals along an 18-mile corridor that has traffic ranging from 21,000 to 45,000 vehicles per day. The project is being coordinated by the City of Sandy Springs under the administration of a Federally-funded RTOP grant from GDOT and local funding. The goal of the project is to reduce travel times and provide a more reliable trip between the cities. Some of the existing traffic signals in the corridor are already interconnected and actively managed. This project will address gaps between systems, upgrade the traffic signal system to adaptive control technology, add fiber optic communications, detection systems, driver information systems and CCTV cameras, as well as upgrade traffic control center equipment.

SOURCE: Georgia Department of Transportation

professionals, leadership, and customers in the context of resources and capabilities. Critical components of traffic monitoring are data collection, assessing the quality of the data and having procedures for archiving the information. In the absence of resources to implement technology-based monitoring agencies should seek other low-cost means to evaluate the performance of the system on an ongoing basis. Key components of an excellent traffic monitoring and data collection system include:

#### **Fundamental Principles [FP]**

• Performance Measures are traceable to agency objectives. (Q41)

#### Core Objective [CO]

- Monitoring and data collection activities support the prioritization of operations and maintenance activity. (Q41)
- Monitoring and data collection activity to provide information to evaluate the achievement of operations objectives.

#### **Indiana Department of Transportation**

Between 2006 and 2009, Indiana Department of Transportation's (INDOT) gas tax revenue declined by 9 percent. Faced with budget and staffing shortfalls, the agency developed a plan to live within its financial constraints. The agency developed performance measures that support operational decisions by evaluating challenges from a geographic, organizational, and performance perspective. The agency reorganized how engineers were assigned to districts to eliminate borders that did not align with field infrastructure, operational, and customer needs. The benefits have been enormous and have come with no additional cost to the agency. The use of performance measures allowed the agency to prioritize and reallocate resources to work better, faster, and smarter. Commissioner Michael B. Cline states, "Performance measures are a fundamental component of INDOT's vision for active traffic management. They enable us to collect and analyze data, prioritize investment, and implement and assess the most promising solutions."

INDOT uses highly trained and specialized staff provided with the appropriate technology and tools to evaluate complex problems and deliver solutions.

#### Key Strategy [KS]

- A documented process is in place to provide information about the systems performance relative to operations objectives.
- Traffic monitoring and data collection needs are considered during the planning, design and operations of traffic signal facilities.

#### Support Activity [SA]

- A data quality program is in place to ensure monitoring is reliable and that the data is credible. (Q42)
- Data is archived and shared with regional partners in support of regional objectives. (Q43, Q44)

#### Noteworthy Findings

The average national numerical score for traffic monitoring and data collection is 52. This section has the greatest potential for improvement because the scores are the lowest.

- Almost half of agencies (49 percent) reported having little to no regular, ongoing program for performance monitoring system to assess operational objectives. (Q41)
- Half of agencies do not assess the quality of data collected.
  (Q42) As a result, agencies may be using faulty data to analyze and time their traffic signals.
- A third of agencies have some process to archive traffic data. (Q43)

#### Maintenance: Grade C

This section is intended to assess the effectiveness of the planning, management, and execution of maintenance activities supporting field infrastructure reliability. A well-timed traffic signal system must be accompanied by an effective maintenance program if it is to provide continued high-quality service to the traveling public. A very basic level of maintenance is an absolute requirement; non-functional traffic signals are highly visible and are unsafe to the traveling public. The maintenance program should inform planning, design, and operations decisions to alignment of these programs with maintenance resources and capabilities. High quality and reliable operations cannot be sustained without field infrastructure reliability. Key components of an excellent maintenance program include the following:

#### **Fundamental Principles [FP]**

- Traffic signal infrastructure reliability objectives provide timely response to critical malfunctions. (Q45)
- The design of traffic signal infrastructure and selection of control devices considers maintenance resources and capabilities. (Q47)

#### Core Objective [CO]

Maintain the reliability of field infrastructure in support of operations objectives.

#### Town of Castle Rock, Colorado, Traffic Signal Operations and Maintenance—A Basic Service Plan

The Town of Castle Rock, Colorado developed a program management plan for managing their traffic signal network to maintain a consistent level of service for the traveling public. The program plan uses a comprehensive approach by establishing objectives for initial planning and design of traffic signals, public relations protocols, and operations and maintenance activities. The program plan establishes two core objectives that thematically affect strategies and actions in the plan:

1. During weekday peak hours, we will do our best to ensure the smooth flow of traffic on the main streets to and from I-25. We will strive to minimize stops, but when stops must occur, we will make them brief, within the context of safe operation. 2. During off-peak hours, we will do our best to equitably serve land uses such that queues and cycle failures are minimized.

The program plan was cited as being directly transferable and adaptable as a model document to other communities with a traffic signal infrastructure. In addition, the approach offers benchmarking opportunities for agencies that adopt the same approach. This program won the American Public Works Association Colorado Chapter 2011 Public Works Administration Award for medium-sized communities.

SOURCE: Town of Castle Rock, Colorado

#### Key Strategy [KS]

- Develop and utilize contingency plans and implement maintenance strategies to minimize disruptions to traffic signal operations in the context of resources and capability. (Q46)
- Maintain an inventory of maintenance records, schematics, documentation for all traffic signal control equipment. (Q50)
- Develop and utilize a process to evaluate equipment reliability and schedule maintenance activity.
- Conduct preventive maintenance activities on a routine basis for relevant traffic signal control equipment. (Q49)
- Prioritize maintenance activities to ensure the integrity and readiness of critical infrastructure.

#### Support Activity [SA]

- Provide training resources for traffic signal maintenance personnel. (Q48)
- Support, require, and reward maintenance personnel for attaining maintenance certifications from professional organizations. (Q48)
- Continuous malfunction monitoring notification of critical components that provide reports to maintenance personnel within a defined timeframe of detecting a failure. (Q51)
- Plan to support traffic signal operations during power failures. (Q53)
- Operational availability and functionality of a detection system at a 95 percent level. (Q54)

#### Noteworthy Findings

The average national numerical score for maintenance is 73.

- To maintain a well-functioning traffic signal system, it is critical to have adequate maintenance resources either on staff or through contractors. The results showed that 80 percent of agencies have policies and processes to provide a technician at an intersection where a critical malfunction is reported within four hours during business hours and within eight hours outside of regular business hours. (Q45)
- Most agencies reported having personnel and procedures in place to make sure the equipment is functioning. Seventy percent reported having regular preventive maintenance and operational reviews to assess the condition of the traffic control system. (Q49)
- Most agencies, eighty seven percent, have some sort of maintenance management system even if it is only paper recordkeeping or electronic spreadsheets. (Q52)





## **Recommendations To Improve** Traffic Signal Operations

he overall results reported in the previous section reveal that there are many opportunities for transportation professionals to move their agency's performance forward. There are on-going and innovative programs available through peer networks, research, professional capacity building, and resources available from the Federal Highway Administration as well as professional associations.

The 2011 Traffic Signal Operations Self Assessment itself and an agency's own report card score can be used as the basis for an agency outreach strategy to engage policymakers, elected officials, the media, and the general public on the importance of traffic signal management and operations.

#### What Four Key Actions Can An Agency Implement Right Now?

- Take a rigorous and systematic look at all the components of traffic signal operations in the organization and develop an objectives-driven program management plan that addresses any shortcomings and encourages coordination with neighboring jurisdictions and interaction with the public.
- 2. Engage in workforce development and succession planning for all traffic signal operations staff using available resources from government agencies, universities, professional associations, and content available through the Internet from credible sources.
- 3. As a mechanism to evaluate achievement of objectives, establish or expand a traffic monitoring and data collection program to provide the basis for signal timing updates and feedback to the traffic signal management program management plan.
- 4. Develop an outreach strategy for policymakers and the public for the traffic signal program management plan

#### **Resources**

There are a wide variety of resources available for agencies to improve traffic signal management and operations. Following is a brief list of resources:

#### National Transportation Operations Coalition

The National Transportation Operations Coalition (NTOC) serves as an important foundation for institutionalizing management and operations into the transportation industry. This alliance of national organizations, practitioners, and private sector groups represent the collective interests of stakeholders at state, local, and regional levels who have a wide range of experience in operations, planning and public safety. The organization hosts the following resources:

- Online Community: NTOC Forums and Traffic Signal Library. https://ntoctsl.groupsite.com This site is a public meeting place that provides members and the public with resource documents, peer-to-peer discussion forums, member profiles, and file storage to share transportation management and operations information, with emphasis on topic areas such as traffic signals, safety, and maintenance. The site is an important first resource for traffic signal management and operations knowledge. The site includes:
  - Library Clearinghouse: Traffic signal documents and reports available in PDF format can be found under the Share tab in the File Cabinet. For documents, reports, textbooks, and publications that are published by transportation associations and other groups, visit the Resource tab for pages by association. The goal is to provide a one-stop resource for locating publications relating to traffic signals.
  - **Discussion Forums:** You have traffic signal questions? The members have answers! Register with a user profile and join the discussion board today under the Communicate tab. Share a lesson learned or seek help for a traffic signal challenge.
  - **Network:** Create your profile under the Network tab and find other professionals working on the same challenges and objectives.

**Recently AASHTO released the Systems Operations** and Management Guidance website (www. aashtosomguidance.org). At the core of the guidance is the application of the capability maturity model (CMM) to identify key program, process and institutional preconditions in transportation organizations. The concept underlying CMM is continuous improvement through improving capability. Because agencies around the country are in different places in their abilities, the practical method is to develop strategies that can be implemented on an incremental basis from different starting points. CMM combines into one framework the key features of quality management, organizational development, and business process reengineering concepts that have long been used as strategic management tools to support organization leaders. CMM is applicable to outcomeoriented product and service development, especially in areas impacted by changing technology like traffic signal management and operations.

Six critical dimensions of capability are closely associated with the more effective program activities including:

- Business processes including formal scoping, planning, programming, and budgeting.
- Systems and technology including use of systems engineering, systems architecture standards, interoperability, and standardization.

- Performance measurement including measures definition, data acquisition, and utilization.
- Culture, including technical understanding, leadership, outreach, and program legal authority.
- Organization and workforce including programmatic status, organizational structure, staff development, and recruitment and retention.
- Collaboration including relationships with public safety agencies, local governments, MPOs, and the private sector.

Each of the six dimensions is divided into sub-dimensions to support more specific targeting of the guidance.

The CMM approach evaluates the current strengths and weaknesses of an agency's current capability level in the key dimensions shown to be critical to improving effectiveness on a continuous basis. There are four distinct progressive levels in the guidance structure for each of the six dimensions representing levels of increased capability achieved by development of processes and organizational structure characterized by increasing integration, structure, formality, and collaboration. The importance of the guidance release is that it provides agencies with a tool that provides definition of issues that have long been tacitly understood as challenges (often informally discussed) related to transportation agency culture, organization, processes, workforce, etc.

- News: This site contains daily news feeds from transportation Web sites, databases, and newsletters to keep you up to date on the latest traffic signal management and operations, safety, and maintenance news. Bookmarking our site and visiting it daily saves you time searching for news.
- <u>Web site and Newsletter:</u> http://www.ntoctalks.com.
- <u>Training</u>: Talking Operations web casts: http://www.ntoctalks. com/web\_casts.php.

In addition, the NTOC member organizations listed in the NTOC Forums and Traffic Signal Library offer resources in their own right as noted below.

#### Federal Highway Administration

Office of Operations

The FHWA Office of Operations provides national leadership for the management and operations of the surface transportation system. Among the office's responsibilities are the areas of congestion management, intelligent transportation systems (ITS) deployment, traffic operations, emergency management, and freight management and operations. Specific resources for traffic signal management and operations are available through:

• Arterial Management Program (ops.fhwa.dot.gov/ arterial\_mgmt/index.htm). The objective of the Arterial Management Program is to advance management practices and operations strategies that promote the safe and efficient use of arterial roadway capacity to reduce congestion. The program has three focus areas: Traffic Signal System Management, Regional Traffic Signal Operations Programs and Traffic Signal Timing and Operations Strategies. For each of the focus areas, resources such as guidance, training and technical assistance are available. Regional Traffic Signal Programs are a growth area that have demonstrated the capacity to accelerate and sustain improvements through collaboration.

- Resource Center Operations Team provides the latest information on operations practices and ITS technology along with key FHWA initiatives and key points of contact. (www. fhwa.dot.gov/resourcecenter/teams/operations/index.cfm)
- Peer-to-Peer Program offers free short-term technical assistance to agencies seeking to improve transportation operations. The effectiveness of the program stems from the knowledge and experience of who participate as peers to provide. The program is responsive to satisfy time constraints identified by the requesting agency. The program is confidential for the requesting agencies, allowing them to make strategic decisions quietly without prematurely engaging the consultant community. This assistance is provided free on request to enable agencies with limited resources to participate.
- Every Day Counts, Adaptive Signal Control Technology initiative, The U.S. DOT Everyday Counts program is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment. The Adaptive Signal Control Technology (ASCT) initiative focuses on utilizing systems engineering to align agency objectives and needs with technology solutions by developing traceable requirements to guide the selection and testing process. ASCT is an operations strategy that responds to variability in demand that is difficult to address with traditional methods. The main benefits of ASCT over conventional signal systems are that it can:
  - Continuously distribute green light time equitably for all traffic movements.
  - Improve travel time reliability by progressively moving vehicles through green lights.
  - Reduce congestion by creating smoother flow.
  - Prolong the effectiveness of traffic signal timing.

Visit http://www.fhwa.dot.gov/everydaycounts/ to learn more.

 Office of Safety Intersection Program Intersection Safety Program (http://safety.fhwa.dot.gov/intersection/)
 The FHWA Intersection Safety Program provides a number of resources focused on improving the safety of intersections. Intersection safety is a national, State, and local priority. Intersections represent a disproportionate share of the safety problem. As a result, organizations such as the FHWA, NHTSA, the Institute of Transportation Engineers (ITE), the American Association of State Highway and Transportation Officials (AASHTO), the American Automobile Association (AAA), and other private and public organizations are devoting resources to help reduce the problem.

#### American Association of State Highway and Transportation Officials (www.transportation.org)

AASHTO represents transportation professionals from all 50 states, the District of Columbia, and Puerto Rico. AASHTO serves as a liaison between state departments of transportation and the Federal government. AASHTO sets technical standards for design, construction of highways and bridges, materials, and many other areas. Two key committees provide support in the area of traffic signal management and operations:

- <u>Subcommittee on System Operations and Management</u> focuses on 1) advancing State DOTs in their organizational structure and focus on operations; 2) enhanced use of performance monitoring and measurement to operate systems on a real time basis; 3) enhanced development and deployment of technology, standards, and best practices; and 4) improved coordination and partnerships with other stakeholders, interests, and associations.
- <u>Subcommittee on Traffic Engineering</u> focuses on 1) effectiveness of traffic control practices and devices in terms of public safety, traffic operations, convenience, and cost; 2) federal regulatory mandates; 3) advancements in methods and equipment, which reduce costs, lower energy consumption, improve motorist guidance, and lessen accident experience; and 4) recommended improvements in standards and guidelines contained in the *Manual on Uniform Traffic Control Devices* (MUTCD).

## American Public Works Association (www.apwa.net)

APWA provides resources and tools as well as professional committees to individuals, agencies, or corporations with an interest in public works and infrastructure issues including public works directors; city engineers; transportation managers; and

## Applying Systems Engineering to Design and Implementation of Operations Strategies.

Systems Engineering (SE) is a process by which the risks associated with technology deployment are addressed early in the project development cycle by defining customer needs and required functionality upfront to inform design and implementation decisions and to test adherence to those decisions. The process engages stakeholders to consider both their business and technical needs to ensure the delivery of a quality product.

Systems engineering is often associated with software projects; however it has demonstrated substantial benefits in terms of cost, schedule, and effectiveness when applied to intelligent transportation systems (ITS). In an effort to mainstream the use of Adaptive Signal Control Technology (ASCT) as part the FHWA Every Day Counts Program, FHWA developed Model Systems Engineering Documentation for ASCT implementation. The Model SE Documents for ASCT significantly reduce the level of effort to apply SE to ASCT projects and has also proven to increase the consistency of how ASCT projects are carried out from jurisdiction to jurisdiction.

The Model Systems Engineering Documents for ASCT provide the means by which an agency practitioner who is already knowledgeable about traffic signal operations can develop systems engineering documents in compliance with federal regulations. The model documents significantly reduce the level of effort to produce a system engineering analysis compared with traditional processes. In so doing, the risks of implementing systems inconsistent with an agency's objectives and capabilities are greatly reduced.

representatives from engineering and other consulting firms. APWA's Transportation Committee focuses on transportation issues that affect public works departments.

## Institute of Transportation Engineers (www.ite.org)

The Institute of Transportation Engineers facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development and management for any mode of ground transportation. Through its products and services, ITE promotes professional development of its members, supports and encourages education, stimulates research, develops public awareness programs and serves as a conduit for the exchange of professional information. Specific groups within the organization that work on traffic signal management issues are:

- <u>Management and Operations/ITS Council</u> promotes dialogue and innovation in deployment of transportation solutions that maximize the use of existing infrastructure to benefit society so that it is viewed as equal in importance with project design and construction.
- <u>Traffic Engineering Council</u> creates and delivers products relating to the design, operation, and maintenance of

roadway networks and the relationship of these facilities with the other modes of transportation. The council has a large portfolio of projects to develop recommended practices, informational reports, and other resources of practical use.

• <u>Public Agency Council</u> identifies, develops, and delivers relevant products on management, leadership, organizational, institutional and related issues affecting employment in or interaction with the public sector.

#### ITS America (www.itsa.org)

ITS America provides the transportation community with knowledge on best practices and industry advancements for technologies that improve the safety, security and efficiency of the nation's surface transportation system. ITS America offers:

• Forums as member-driven committees that serve as the focal point for dialogue and networking on the challenges and opportunities surrounding research and deployment of ITS. Each Forum consists of committees—smaller ad hoc or standing groups that concentrate on specific ITS challenges, needs, or opportunities. The Transportation Management Forum addresses the issues of traffic signal management and operations in the context of ITS technology.

- <u>Knowledge Center 2.0</u>, which houses every technical and scientific paper presented at every ITS America Annual Meeting and World Congress event hosted in North America since 2000.
- <u>Sessions dedicated to traffic and transportation management</u> <u>at ITS America Annual Meetings</u> including sessions on Utilizing Performance Measures for Traffic Signal Systems and ITS for Intersection Safety.

## International Municipal Signal Association (www.imsasafety.org)

IMSA is an organization with the objectives to improve the efficiency, installation, construction, and maintenance of public safety equipment and systems by increasing the knowledge of its members on traffic controls, fire alarms, radio communications, roadway lighting, work zone traffic control, emergency medical services and other related systems. IMSA is best known in the traffic engineering profession through its certification programs for traffic signal technology and traffic signal inspection which many agencies incorporate into the requirements for engineering and technical position descriptions.

#### Transportation Research Board (www.trb.org)

The Transportation Research Board engages transportation practitioners, researchers, public officials, and other professionals in a range of interdisciplinary, multimodal activities to lay the foundation for innovative transportation solutions. Specific groups and programs related to traffic signal management operations are:

- Traffic Signal Systems Committee, AHB25 (http:// trbsignalsystems.org) This committee is concerned with provision of the safe and efficient movement of people and goods on surface streets through the use of traffic management systems. The scope includes system design, implementation, operations, and maintenance; development of traffic operations centers; development of traffic management strategies; integration and operational evaluation of surface street systems with freeway, traveler information, and transit systems; and incorporation of surface street systems into Intelligent Transportation Systems (ITS).
- Regional Transportation System Management and Operations Committee, AHB10 (http://sites.google.com/ site/trbrtsmocommittee) This committee is concerned with regional transportation systems management to maximize transportation system performance in metropolitan areas, including coordinated and integrated decision-making approaches to operations and the harmonization of

operations with planning, construction, preservation, and maintenance of transportation facilities.

- National Cooperative Highway Research Program conducts research in problem areas that affect highway planning, design, construction, operation, and maintenance nationwide and has developed many useful reports in the traffic signal management subject area including those at the end of this section.
- The second Strategic Highway Research Program (SHRP 2) (http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/ Blank2.aspx) addresses research needs related to the nation's highway system among them congestion stemming both from inadequate physical capacity and from events that reduce the effective capacity of a highway facility. These needs define the four research focus areas in SHRP 2:

#### **Other Organizations and Training**

## Consortium for ITS Training and Education (www.citeconsortium.org/)

The Consortium for ITS Training and Education (CITE) provides integrated advanced transportation training and education program on ITS subject matter. The program, based on a consortium of universities, is open to anyone pursuing a career in advanced transportation. Instruction offered through CITE may include graduate and undergraduate level courses, as well as skillbased training and technology transfer. CITE coordinates, creates, and maintains advanced transportation courseware based on the needs of government and industry using distance learning tools.

#### University of Idaho MOST (http://www.webs1.uidaho.edu/most )

MOST training approach to traffic signal timing uses a simulation environment to provide direct observation of how the selected signal timing parameters affect the quality of traffic operations at a signalized intersection. The MOST course includes seven separate laboratories, with nearly forty individual experiments. Each experiment has one or more specific learning objectives that will guide the work during that experiment. Five of the laboratories cover isolated actuated intersection operations, while two cover coordinated signal systems.

Unlike many courses that emphasize an instructor-focus (with lectures presented to students). The important distinction of the MOST course is its emphasis and focus on the students where they will learn by doing the experiment, analyzing

#### **Useful Reports and Other References**

NCHRP Report 693: Attracting, Recruiting, and Retaining Skilled Staff for Transportation System Operations and Management. Transportation Research Board, 2012.

System Operations and Management Guidance. AASHTO, 2012. Accessible via http://www.aashtosomguidance.org/.

Institutional Architectures to Improve Systems Operations and Management. [SHRP 2 Report S2-L06-RR-1 Transportation Research Board, 2012. Accessible via http:// onlinepubs.trb.org/onlinepubs/shrp2/SHRP2\_S2-L06-RR-1.pdf.

Model Systems Engineering Documents for Adaptive Signal Control Technology (ASCT) Systems. [FHWA-HOP-11-027] Federal Highway Administration, Draft August 2011.

2011 Traffic Signal Operations Self Assessment. Washington DC: National Transportation Operations Coalition, 2011. Accessible via www.ite.org/selfassessment.

Bullock, Darcy M., Day, Christopher, M. et. al. "Architecture for Active Management of Geographically Distributed Signal Systems." ITE Journal. May 2011.

NCHRP Synthesis 403: Adaptive Traffic Control Systems: Domestic and Foreign State of Practice. Transportation Research Board, 2010.

NCHRP Synthesis 409: Traffic Signal Retiming Practices in the United States. Transportation Research Board, 2010.

NCHRP Synthesis 420: Operational and Institutional Agreements That Facilitate Regional Traffic Signal Operations. Transportation Research Board, 2010. *Traffic Signal Operations and Maintenance Staffing Guidelines.* [FHWA-HOP-09-006] Federal Highway Administration, March 2009.

*Improving Traffic Signal Management and Operations: A Basic Service Model.* [FHWA-HOP-09-055] Federal Highway Administration, December 2009.

Wasson, Jason S., Sturdevant, James R., and Bullock, Darcy M., "Real-Time Travel Time Estimates Using Media Access Control Address Matching." ITE Journal. June 2008.

"Traffic Signal Timing: Moving State-of-the-Practice Closer to State-of-the-Art." Intelligent Transportation Systems for Traffic Control. U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office, January 2007. Accessible via http://ntl.bts.gov/lib/jpodocs/ brochure/14321\_files/a1019-tsc\_digital\_n3.pdf.

*Traffic Signal Audit Guide*. Washington, DC, USA: National Transportation Operations Coalition, 2007. This guide, accessible at www.ite.org/reportcard, provides general audit processes and audit items that are key to evaluating the effectiveness of the program management of traffic signal and associated systems.

*Benefits of Retiming Traffic Signals: An ITE Informational Report.* Washington, DC, USA: Institute of Transportation Engineers (ITE), 2005.

Tarnoff, Philip J. and Javier Ordonez. *Signal Timing Practices and Procedures: State of the Practice.* Washington, DC: ITE, 2004.

data collected, and drawing conclusions about what makes good signal timing practice.

#### National Highway Institute (www.nhi.fhwa.dot.gov)

The National Highway Institute (NHI), a division of the Federal Highway Administration (FHWA), works to improve the performance of the transportation industry through training.

Recent available course offerings related to traffic signal management and operations include:

FHWA-NHI-133028 Traffic Signal Design and Operation. This course addresses the application of the *Manual on Uniform Traffic Control Devices* (MUTCD) to intersection displays, as well as signal timing, computerized traffic signal systems, control strategies, integrated systems, traffic control simulation, and optimization software. The course is divided into two primary parts: Traffic Signal Timing and Design and Traffic Signal Systems.

Focus of the course is on understanding of effective traffic signal timing and optimization to better manage congestion and delays.

#### Conclusions

Our country faces the continuing expense of congestion in time and money that affects both personal and business decisions, as has been well documented in the *2011 Urban Mobility Report.*<sup>8</sup> Poor signal timing contributes 5 percent to overall total sources of congestion<sup>9</sup> and a much higher percentage to arterial and local roadway congestion. The influence of these costs has a real effect on choice of home and business location, commute mode, and retail costs.

Throughout the development of this report, there has been the recognition that agencies' response to the self assessment should not be, "How do we get an A grade?" Rather, the approach to traffic signal program management should start with the expectations of the motorists to whom the service is being provided. To meet those expectations, agencies are beginning to reorganize, working smarter to focus resources on operations and maintenance, and collaborating regionally to take advantage of distributed expertise and to compete for resources to improve their capabilities more effectively based on the value offered to the community. Management, operations and maintenance practices that consider agency objectives, capabilities and resource constraints are now recognized to have great potential to improve the performance of the transportation system. Success is a strongly correlated combination of effective leadership, commitment to operations and outcomes on the street.

The need for good traffic signal management and operations continues to be great. Time spent commuting and traffic congestion are major livability issues, particularly for cities and suburbs. Traffic signal management and operations have been historically underfunded as a core agency service. However, more recently there has been allocated funding toward traffic signal programs even during the economic downturn. Investment in traffic signal operations is one of the most cost effective means to improve transportation system efficiency and achieve agency and community objectives related to mobility.

The self assessment measures how agency programs support traffic signal management and operations and helps agencies understand opportunities for improving their own policies and practices. Each of the agencies that participated can benefit by using their individual results to identify strengths in their signal systems and opportunities for improvement—some already have.

The self assessment included notation that indicates the relationship of the questions to a generalized traffic signal program management plan incorporating forward leaning practices. **The key element to improving traffic signal operations is developing effective leaders and giving them the tools they need to work within their resource constraints.** There is a strong correlation between effective leadership, commitment to operations and outcomes on the street. The written plans and well stated objectives and measures are a byproduct of effective leadership. The application of strong effort that this approach takes to traffic signal programs makes the achievement of performance-based objectives more likely for the agency, policy makers and pubic.

The nation's traffic engineering professionals have already taken steps to improve traffic signal operations in their locales and are ready, willing and able to do the job necessary to improve traffic signal performance given appropriate management, workforce development and fiscal resources. However what remains is to make the best use of the existing transportation network to handle the growing traffic demand. That includes ensuring that traffic signals provide the best operation possible. The environment benefits from reduced fuel consumption and better air quality. Improvements can be made quickly and for the benefit of all.

The agencies managing traffic signal systems can and want to do better in the daily management and operations of traffic signals, but this will be accomplished only through the support of local public sector leadership. Proactive traffic signal management based on objectives-based measurable traffic signal program management plans are critical—our nation's quality of life and the environment depend on it.

<sup>&</sup>lt;sup>8</sup> 2011 Urban Mobility Report. Texas Transportation Institute, 2011. Accessible via http://mobility.tamu.edu/ums/

<sup>&</sup>lt;sup>9</sup> SOURCE: http://www.ops.fhwa.dot.gov/congestion\_report/executive\_summary.htm



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