



National Traffic Signal Report Card
Executive Summary

2007



The National Transportation Operations Coalition (NTOC) serves as an important foundation for institutionalizing management and operations into the transportation industry. This alliance of national associations, 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.

NTOC is comprised of transportation experts including the Institute of Transportation Engineers (ITE), the American Association of State Highway and Transportation Officials (AASHTO), the American Public Works Association (APWA), the International Municipal Signal Association (IMSA), ITS America, U.S. DOT–Federal Highway Administration (FHWA) and many other organizations.

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TRAFFIC SIGNALS KEEP AMERICA MOVING

Traffic signals have an impact on the everyday lives of the traveling public, whether traveling to and from work, grocery shopping, or simply walking to lunch. Almost everyone encounters a traffic signal in their day-to-day travels. The way traffic signals are operated either can help the journey along or can increase the time spent on daily routines.

It is estimated that improper traffic signal timing accounts for 5 to 10 percent of all traffic delay, or 295 million vehicle-hours of delay, on major roadways alone.¹

Traffic signals affect the traveling public in many ways:

- Drivers pass through a green light at one intersection only to be stopped by a red light at the next intersection. Inconsistent travel on surface streets causes frequent stops and unnecessary delays. *Intersections should be coordinated and traffic signal timing plans updated based on changing travel patterns.*
- Drivers must stop at a red light when there are no vehicles or pedestrians at the cross street. Incorrectly functioning traffic sensors do not serve all vehicles and pedestrians equitably. *The sensor in the roadway may be broken and the agency either hasn't been informed about it or lacks the resources to fix it.*
- Drivers must wait through more than one green signal at an intersection, causing long queues and clogged intersections. *Traffic signal timing should be adjusted to handle traffic diverted from a work zone, crash, or special event.*

In addition to driver impacts, signal-related congestion has broader economic, social and environmental impacts. Congestion not only wastes fuel, time and money, but is also a significant factor in shaping the quality of life for individuals and families. The real impact of congestion is felt in how and where people choose to live, how they commute and how much they pay for things resulting from the additional costs congestion imposes on society.

Congestion causes the average peak-period traveler an extra 38 hours of travel time and an additional 26 gallons of fuel, amounting to a cost of \$710 per traveler per year.²

As the consumers of the transportation system, everyday travelers observe these inefficiencies and know that something more can be done. Improving traffic signal operations must be a priority.

Fact: A February 2007 Harris Interactive Poll found that traffic congestion and its accompanying delays are a fact of life for communities across the United States. ***More than three-quarters of respondents answered that congestion is a moderate to serious problem in their community.*** More than one-third (37 percent) said that traffic congestion is a serious problem in their community; one-quarter said traffic congestion is a serious problem that is not being addressed.³

HOW WELL DOES THE NATION SUPPORT ITS TRAFFIC SIGNAL SYSTEMS?

Findings indicate that, overall, traffic signal operations in the United States score a D, up slightly from a D- in 2005.

There are more than 272,000 traffic signals in the United States.⁴ Traffic signals are owned, operated and maintained by state and local governments. A grade of D means that agency programs to support efficient maintenance and operations of traffic signals are not as effective as they could be.

Some agencies have performed well and some have made incremental improvements to their programs. On the whole, however, the vast majority of traffic signal systems across the United States have the potential for greatly improved performance. Small changes, as discussed in the 2007 National Traffic Signal Report Card Technical Report, can help increase the effectiveness of traffic signal operations and ultimately can reduce delay to travelers. Improved traffic signal operations also can help minimize air pollution by making sure that vehicles are not starting and stopping wastefully and using more fuel than necessary. Because traffic signals are a public investment, jurisdictions have a fiduciary responsibility to maintain and operate them at a high level. Likewise, taxpayers should understand that a modest investment in resources can yield the benefits necessary to improve from a D grade to an A grade.

Studies have shown that the benefits of investments in traffic signal systems outweigh the costs by 40:1 or more.⁵

The 2007 National Traffic Signal Report Card results are based on the 2007 Traffic Signal Operation Self Assessment, administered in 2006 and voluntarily completed by 417 agencies in 47 states, representing approximately 45 percent of all traffic signals in the United States. Of the respondents, 142 agencies responded to both the 2005 and the 2007 Traffic Signal Operation Self Assessments.

2007 National Traffic Signal Report Card Improvements

Several improvements were made to the 2007 National Traffic Signal Report Card. In addition to rewording some of the questions to provide more clarity, the following changes were made:

- Questions were more focused on how traffic signal operations affect performance outcomes.
- Additional information was added to give respondents more specific information on how to score themselves and to promote more consistent scoring across respondents.
- The scoring methodology was provided so that respondents could determine their score and associated letter grade.



SMALL CHANGES MAKE A BIG DIFFERENCE

The 2007 National Traffic Signal Report Card shows that many agencies have used the 2005 assessment to evaluate their traffic signal program and focus on critical areas for improvement. State and local agencies are using the self assessment to improve operations by focusing their efforts in targeted areas, which produces immediate benefits. These localities are also using more effective management techniques and are taking a more thoughtful approach to resource allocation as a direct result of the assessment. In general, these agencies are:

- making targeted asset capital investments in traffic signal infrastructure to reduce maintenance costs;
- placing more emphasis on regular updates for traffic signal timing plans and arterial coordination;
- seeking outside independent peer review of their traffic signal systems program;
- facilitating improved regional coordination of traffic signal systems;
- developing documentation for work processes; and
- initiating new training for engineering and technical staff.

An entire section of the technical report is dedicated to case studies from agencies that have made positive changes since the 2005 report card to improve their overall score. Some highlights of the case studies are below.

City of Austin, TX, USA

Score Improvement: C to A

As a result of the 2005 Traffic Signal Operation Self Assessment, the City of Austin, TX, USA, has emphasized a proactive approach to signal timing maintenance. Instead of spending money responding to problems calls or complaints, the City spends money up front by proactively checking every traffic signal on a regular preventive maintenance schedule. This program was shown to reduce maintenance calls from 5,000 to 2,500 in one year. The City successfully has made improvements to its overall signal operation with no additional funding; instead it focuses on reallocating existing budgets.

City of Naperville, IL, USA

Score Improvement: D TO C

According to Andy Hynes, project engineer, the City of Naperville, IL, USA, had been “contemplating doing some traffic signal studies for some time.” The 2005 report card motivated the City to initiate a signal timing and coordination study. As part of this study, three traffic signal systems were re-optimized during 2005 and 2006 and have produced noteworthy reductions in travel times and emissions:

- Peak directional travel time was reduced by 31.8 percent.
- Annual emissions of carbon monoxide along one corridor were estimated to have been reduced by more than 206 tons per year.

City of Plano, TX, USA

Score Improvement: C TO B

According to Lloyd Neal, transportation engineering manager, “The report card provided a great opportunity for us to improve our own internal management.” Since the first report card, Plano, TX, USA, has restructured staff and changed the way it interacts. The department now has formal meetings among traffic engineers, traffic enforcement and traffic signal maintenance staff that open lines of communication between groups of employees.

The City reported the following savings over a three-year period as a result of changes made in its department:

- Fuel savings: 847,950 gallons
- Stop reduction: 36,085,590 stops
- Delay reduction: 745,490 hours
- Operating cost reduction: \$13,276,556

City of Alpharetta, GA, USA

Score Improvement: **F to C**

"The report card is a great milestone marker," according to Elias Veith, traffic signal engineer. After filling out the second assessment, it was clear how much the City of Alpharetta, GA, USA, had accomplished in the two years since the last assessment. According to Veith, "The City Council has been very supportive of our efforts. This report helped validate their expenditures." After the first year of traffic signal retiming efforts, the City reported the following improvements (averaged over all projects):

- Fuel savings: 8-percent reduction
- Stop reduction: 23-percent reduction
- Delay reduction: 31-percent reduction
- Trip times: 17-percent reduction

Paulding County, GA, USA

Score Improvement: **F to C**

Traffic operations division manager George Jones was new to the Paulding County, GA, USA, Department of Transportation when he completed the 2005 Traffic Signal Operation Self Assessment. As a result of his review of the assessment, he has been able to successfully target areas most in need of attention and improvement. According to Jones, "The assessment was a great tool to help make the case for additional resources." Since the first assessment, Jones has successfully acquired funds for improvements such as the implementation of new equipment, the establishment of a regular signal maintenance program and the addition of a new signal technician.

City of Nashville, TN, USA

Score Improvement: **D to C⁶**

The City of Nashville, TN, USA, has implemented an area-wide program to update signal timing plans, which has resulted in decreased fuel consumption and improved air quality. Results for the first two phases of the traffic signal optimization project include:

- Fuel savings: 9-percent reduction
- Delay reduction: 27-percent reduction
- Benefit-cost ratio: Three-year benefit-cost ratio of 81:1

USING THE REPORT CARD AS A ROAD MAP TO SUCCESS

The 2007 National Traffic Signal Report Card provides a road map to success for traffic engineers. To achieve success, organizations must be provided the resources necessary to go beyond resolving the day-to-day requests for improvements to their traffic signal systems. Organizations must also have the resources required to use proactive, knowledge-based decision-making for their traffic signal systems. Each agency will have different constraints and opportunities to take advantage of tools and resources. Some will progress with change incrementally; others will progress in leaps and bounds.

Following this road map will provide agencies with the ability to respond in a timely and meaningful manner to resolve congestion issues and improve overall traveling conditions. The table below maps the progress from where agencies are now to the goal of excellence in operations of traffic signal systems.

Topic area		Where agencies are	Goal: excellence in operations
Management	D-	A philosophy for how the agency operates signals has not been documented or shared with employees, agency leadership, or the public. Meetings with law enforcement and emergency service providers happen only on an ad-hoc, informal basis. Annual reviews of major roadways are rarely conducted. Agencies are unlikely to have an established business plan for transportation operations with clearly defined performance measures and goals.	Agencies have a documented management approach for traffic signal operations that is shared with employees and reported to agency leadership and the public on a regular basis. Agencies meet routinely with law enforcement and emergency service providers and conduct annual field measurements of major roadways to track performance. Agencies have a business plan for transportation operations that describes performance measures and goals specific to the traffic signal program.
Signal operation at individual intersections	C	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.	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 at least every three years.
Signal operation in coordinated systems	D	Traffic signal timing is rarely reviewed, resulting in outdated timing patterns that do not reflect current traffic and pedestrian needs. Inadequately coordinated signals force motorists to stop at multiple adjacent intersections and result in significant travel delays.	A comprehensive review of area-wide or corridor signal timing is conducted every three years or more often if traffic volumes or land uses change. Routine reviews are conducted for high-priority arterials and locations with high crash rates. Agencies use a comprehensive system for monitoring all reviews.
		As travelers cross jurisdictional boundaries, they experience stops and delays due to lack of coordination between systems.	Traffic signals are coordinated across jurisdictional boundaries. Travelers don't know when they have entered another jurisdiction's signal system.
		Signal technicians are not current on the use of modern software or are prevented from using current software due to resource constraints, resulting in signal timings that are not optimized.	Technicians are knowledgeable and consistent in the use of signal optimization software.
		Timing plans are not in place for emergencies and special events.	Signal timing plans exist for emergencies and special events. Timing plans are implemented quickly and effectively.

Signal timing practices	C-	Intersection operations are infrequently checked in the field to accommodate changing traffic conditions. As a consequence, significant traffic queuing occurs, resulting in blocked lanes and increased congestion.	The overall effectiveness or outcome of traffic signal improvements is measured and assessed to demonstrate practices that produce efficient results. Agencies typically check signal offsets through field observation and adjust as required.
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 broken equipment in the field. 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 allow immediate signal timing adjustments.
Maintenance	C-	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.

STRIVING FOR EXCELLENCE IN TRAFFIC SIGNAL MANAGEMENT

Throughout the development of the report, there has been a recognition that the answer is not simply, “What do we need to do to get an A grade?” Rather, the emphasis has been on what resources are available and how they can be allocated to help agencies strive for performance excellence in traffic signal operations.

To fully realize the benefits of traffic signal systems, investments should be made in five core areas.

Program Management

Program management for traffic signal systems is the foundation of excellence in transportation operations. Successful program management requires clearly defined goals with measurable objectives and specific milestones for achievement. Well established program management is based on the following key criteria:⁷

- Leadership
- Strategic planning
- Customer and market focus
- Measurement, analysis and knowledge management
- Workforce development and training
- Process management
- Outcomes

Application of these principles results in improved operational performance, system reliability, asset duration and resource allocation.

Traffic Monitoring and Data Collection

A robust system of monitoring and collecting data provides necessary information on traffic flow conditions on roadway networks. The data component of infrastructure is often assigned a low priority when considering the funding needs of transportation infrastructure. However, it is a required tool for the active management of these systems and the basis for performance-based decision-making. Having specific, clear knowledge of conditions allows transportation professionals to be creative in their signal timing solutions because it minimizes unknown variability.

Routine Signal Timing Updates

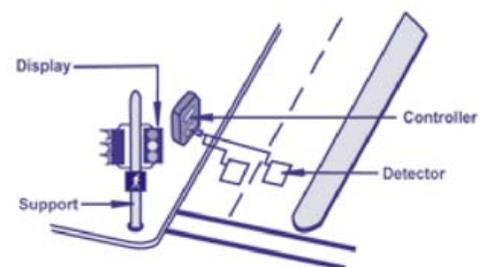
To keep pace with changing travel patterns, traffic signal timing should be actively monitored, reviewed and updated at least every three years and possibly sooner depending upon growth and changes in traffic patterns. Recent estimates show that updating signal timing costs less than \$3,000 per intersection. To support this level of routine signal timing updates nationally, transportation agencies would need to spend an amount equivalent to less than 0.2 percent of the total national expenditure on highway transportation.⁸ The cost of improving signal timing is miniscule compared to annual highway expenditures.

Sound Maintenance Practices

Well-trained traffic signal technicians are needed to properly maintain traffic signals and preserve the investment in hardware and timing updates. With approximately 272,000 signals across the United States, response time requirements, current salaries, benefits, vehicles, parts/supplies and other items necessary to run maintenance programs, the annual maintenance investment would be less than 0.5 percent of the total national expenditure on highway transportation.⁹

Appropriate Traffic Signal Hardware

Traffic signal hardware consists of the signal display that shows the green, yellow and red (and WALK/DON'T WALK) indicators; sensors to detect vehicles and pedestrians; the electric power supply; and the signal controller. The controller is a computer installed at the intersection that controls and adjusts the signal operations for traffic conditions. The controller is similar to a personal computer except that it must function continuously in an outdoor environment through all types of weather conditions. Like a personal computer, signal controller technology becomes outdated over time. To keep from using outdated equipment to operate the signal system, signal controllers should be upgraded at least every 10 years and possibly more frequently in high-growth areas that require more complex control.



BENEFITS OF EXCELLENCE IN TRAFFIC SIGNAL OPERATIONS

Traffic signal operations must be viewed as a continually evolving process with the ultimate goal of improving the level of operations nationwide. If the nation supported its signals at an A grade level, quality of life and protection of the environment would benefit significantly, including:

- Reductions in traffic delay ranging from 15–40 percent; reductions in travel time up to 25 percent; and reductions in stops ranging from 10–40 percent.^{11,12}
 - o For example, a driver who spends two hours in the car commuting to and from work and running errands would save 117.5 hours per year as a benefit of improved signal timing.¹³
- Reductions in fuel consumption of up to 10 percent.
 - o A driver who uses one tank of gas a week would save five full tanks per year per household, or approximately \$240.¹⁴ Nationwide, this would amount to a savings of almost 17 billion gallons of motor fuel per year.¹⁵
- Reductions in harmful emissions (carbon monoxide, nitrogen oxides and volatile organic compounds) up to 22 percent.¹⁶
 - o According to the Surface Transportation Policy Project, motor vehicles are the largest source of urban air pollution.¹⁷ In addition, the U.S. Environmental Protection Agency estimates that vehicles generate 3 billion pounds of air pollutants yearly.¹⁸

Note: Spending less than 1 percent of the total expenditure on highway transportation would lead to a level of excellence in traffic signal operations. This investment strategy would leverage an investment with a 40:1 benefit-cost ratio and would result in benefits of as much as \$45 billion per year. This corresponds to a price of less than \$3 per U.S. household resulting in savings of \$100 per household per year.¹⁰

CONCLUSIONS

The need for good traffic signal operations has never been greater. Today, time spent in traffic congestion is a major livability issue, particularly for people in large cities. Over the 24-year period between 1982 and 2005, less than half (41 percent) of the roadway needed to maintain a constant level of congestion was added to the transportation system.¹⁹ Couple this with the 34-percent growth in the amount of travel nationwide between 1990 and 2001, and the need for solutions with high benefit-cost ratios is clear.²⁰

In urban and many suburban areas, the opportunity to build new streets or widen existing roads is limited or simply impossible. Projects face significant constraints due to lack of available land, environmental issues and the costs associated with building or widening roads. Jurisdictions must make the best use of the existing transportation network to handle the growing traffic demand.

The 2007 National Traffic Signal Report Card shows that improved signal operations can be achieved for lower costs and in shorter time frames than most other capital-intensive transportation improvement options—and with benefits exceeding costs by 40:1 or more.

Agencies are forced into difficult choices about how to spend their limited resources. For many agencies, this simply means addressing the most critical issues on a daily basis. A proactive, integrated program management approach that includes the principles of continuous improvement, asset life-cycle costs and resource allocation for traffic signal operations is seldom seen as an option. Traffic signal operations must be considered a core program with more sustained, stable and consistent resources committed to the professionals who manage, design, operate and maintain traffic signal assets to provide significant reductions in congestion, delay, fuel consumption and emissions.

The agencies managing our traffic signal systems can and want to do better in the daily management of our systems, but this will be accomplished only through the support of local public sector leadership. Proactive traffic signal management, operation and maintenance are critical—our quality of life and the environment depend on it.

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