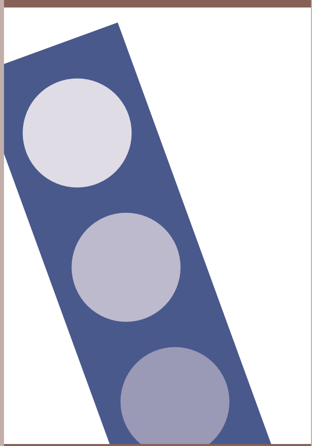
chapter 3



WHAT HAVE WE LEARNED ABOUT ITS? ARTERIAL MANAGEMENT

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EXECUTIVE SUMMARY

This paper presents what has been learned in four principal areas of arterial management: (1) adaptive control strategies (ACS), (2) advanced traveler information systems (ATIS), (3) automated enforcement, and (4) integration. The levels of deployment, benefits, deployment challenges, and future steps are presented for each category.

ACS signifies traffic signal control systems that optimize timing plans in real time, based on current traffic conditions and demand. They have been shown to reduce delay and improve efficiency at intersections. Although the technology has been available for 20 years, ACS is not widely deployed in the United States. The systems are considered expensive and complicated, and U.S. traffic engineers do not seem convinced of the associated benefits. ACS seems to have potential for widespread use in the United States, but deployment has not yet reached that point.

ATIS for arterials provides information on arterial conditions (e.g., travel speeds, travel time, incidents) to motorists through such media as websites, radio, television, or personal devices. While surveys from the Metropolitan Model Deployment Initiative (MMDI) show that the public wants information on arterial conditions, only 67 out of 361 agencies (18 percent) in the largest 78 metropolitan areas reported providing this service. This limited dissemination is in part due to the lack of surveillance on arterial streets. Another challenge is the absence of a commonly understood method of describing conditions on arterial streets. For example, delays caused by traffic signals complicate travel time computations. The advent of new technologies, such as cell phones as probes, increases the likelihood that arterial information will make its way into traveler information systems.

Automated enforcement is a tool that can be used to encourage compliance with traffic laws and promote safety. This type of enforcement uses camera technology to photograph license plates of drivers who break traffic laws. Automated enforcement on arterial streets primarily involves red light running (RLR) and speed enforcement. Legislation has been passed or is being considered in 22 states to allow automated RLR enforcement. Deployment of systems is considered to be moderate. Intersections with RLR enforcement have seen a reduction in violations as high as 50 percent and a reduction in crashes as high as 70 percent. Deployment of automated speed enforcement is not as widespread as RLR enforcement. Privacy and fairness issues associated with automated enforcement make it somewhat controversial. Some automated speed enforcement programs have come under scrutiny by the public and motorist associations because they are perceived as being unfair, and the systems have been discontinued in some communities. However, the future for automated RLR enforcement appears strong as more cities implement this technology.

Integration of arterial management is broken down into three areas: integration across jurisdictions, integration with transit and emergency operations, and integration with freeway management. Integration across jurisdictions occurs in 54 percent of agencies in the largest 78 metropolitan areas. This type of integration consists of coordinating traffic signal timing plans and implementing similar cycle lengths across jurisdictional boundaries. Coordination across boundaries can improve efficiency and reduce delay.

Integration with transit and emergency operations takes the form of traffic signal controls that allow transit vehicle priority and emergency vehicle signal preemption. More than half the agencies in the largest 78 metropolitan areas have traffic signal technologies that allow for preemption by emergency vehicles, while only 12 percent allow some sort of priority for transit vehicles.

An integrated arterial freeway corridor is one that shares arterial travel times, speeds, and conditions with freeway management to adjust variable message signs (VMS), highway advisory radios (HARs), and freeway ramp meters. Freeway travel times, speeds, and conditions are shared with arterial management and used to optimize traffic signal timings. Nearly 20 percent of arterial and freeway management agencies report sharing information on traffic conditions with each other; however, it is unclear how this information is used or passed on to travelers. The number of truly integrated freeway arterial corridors appears to be limited.

Presently, only two arterial management intelligent transportation systems (ITS) technologies meet the deployment level requirements to be called "widespread." They are integration of time-of-day/fixed-time signal control across jurisdictions, and signal preemption for emergency vehicles.

Each of the arterial management ITS technologies discussed in this paper shows the potential for benefits; however, only a few of the technologies have reached widespread deployment.[1] Reasons for the limited deployments vary, but include cost, institutional barriers, uncertainty of benefits, and technological incompatibilities. Table 3-1 summarizes the deployment levels of the ITS technologies presented for arterial management.

Table 3-1. Arterial Management Summary Table

Technology	Deployment Level	Limiting Factors	Comments
Adaptive control strategies	Limited Deployment	Cost, technology, perceived lack of benefits	**Jury is still out**—has shown benefits in some cases, cost still a prohibitive factor, some doubt among practitioners on its effectiveness
Arterial information for ATIS	Moderate Deployment	Limited deployment of appropriate surveillance, difficulty in accurately describing arterial congestion	**Holds promise**—new surveillance technology likely to increase the quality and quantity of arterial information
Automated red light running enforcement	Moderate Deployment*	Controversial, some concerns about privacy, legality	**Successful**—but must be deployed with sensitivity and education
Automated speed enforcement on arterial streets	Limited Deployment*	Controversial, some concerns about privacy, legality	**Jury is still out**—public acceptance lacking, very controversial

[1] The three different deployment levels are defined as follows: Deployed in fewer than 10 percent of the largest 78 metropolitan areas = Limited Deployment; Deployed in between 10 percent and 30 percent of the largest 78 metropolitan areas = Moderate Deployment; Deployed in more than 30 percent of the largest 78 metropolitan areas = Widespread Deployment

Table 3-1. Continued

Technology	Deployment Level	Limiting Factors	Comments
Integration of time-of-day and fixed-time signal control across jurisdictions	Widespread Deployment	Institutional issues still exist in many areas	**Successful**—encouraged by spread of closed-loop signal systems and improved communications
Integration of real-time or adaptive control strategies across jurisdictions (including special events)	Limited Deployment	Limited deployment of Adaptive Control Strategies, numerous institutional barriers	**Holds promise**—technology is becoming more available, institutional barriers falling
Integration with freeway (integrated management)	Limited Deployment	Institutional issues exist, lack of standards between systems preventing integration	**Holds promise**—benefits have been realized from integrated freeway arterial corridors
Integration with emergency (signal preemption)	Widespread Deployment	None	**Successful**
Integration with transit (signal priority)	See Chapter 5, "What Have We Learned About Advanced Public Transportation Systems?"	See Chapter 5, "What Have We Learned About Advanced Public Transportation Systems?"	See Chapter 5, "What Have We Learned About Advanced Public Transportation Systems?"

**Quantitative deployment tracking data not available. Deployment level determined by expert judgment.*

INTRODUCTION

The purpose of this paper is to address what has been learned regarding arterial management, to identify trends in deployment levels of arterial management technologies, and to speculate on the future of arterial management. This paper addresses four principal areas of arterial management: adaptive control strategies, advanced traveler information systems for arterials, automated enforcement, and integration of arterial management.

Deployment levels of the various technologies primarily issue from the U.S. Department of Transportation's (U.S. DOT's) 1999 Metropolitan ITS Deployment Tracking Database (ITS Deployment Tracking Database 1999). Other deployment information was derived from a literature and website search. Opinions on the challenges and future of the technologies were gathered at the Institute of Transportation Engineers (ITE) 2000 International Conference, held in Irvine, California, in April 2000. More than 40 transportation professionals attended an ITE roundtable discussion on arterial management covering each of the four areas delineated in this paper.

ADAPTIVE CONTROL STRATEGIES

What are Adaptive Control Strategies?

Adaptive control strategies use algorithms that perform real-time optimization of traffic signals based on the current traffic conditions, demand, and system capacity. ACS includes software that adjusts a signal's split, offset, phase length, and phase sequence to minimize delay and to reduce the number of stops. The systems require extensive surveillance, usually in the form of pavement loop detectors, and a communications infrastructure that allows for communication with the central and/or local controllers. ACS differs from other more traditional traffic-responsive systems in that new timing plans can be generated for every cycle, based on real-time information. Theoretically, ACS allows an infinite number of timing plans.

The traditional ACS technologies are Australia's SCATS (Sydney Coordinated Adaptive Traffic System) and the United Kingdom's SCOOT (Split, Cycle, Offset Optimization Technique) systems. Los Angeles developed and uses a system called ATSC (Automated Traffic Surveillance and Control) program. New adaptive control algorithms are being developed and tested in the United States under the ACS umbrella. OPAC (Optimized Policies for Adaptive Control) and RHODES (Real-Time Hierarchical Optimized Distributed Effective System) algorithms are deployed in field operational tests sponsored by the Federal Highway Administration (FHWA). Both algorithms are for use on arterial streets, with OPAC designed for over-saturated conditions and RHODES designed for under-saturated conditions. Another new adaptive system, RTACL (Real-Time Traffic Adaptive Control Logic), will be tested on a grid network in Chicago in late 2000. The RTACL algorithm is designed for a network of streets.

The jury is still out on whether ACS works well. Benefits have been demonstrated in several areas where traditional adaptive control technologies (e.g., SCOOT, SCATS) have been deployed. However, some argue that the systems are no better than good fixed-time/time-of-day plans. This observation may be true, especially in areas where traffic is predictable or there is little traffic growth. Other issues with adaptive control include detector maintenance and communications problems. Currently, little information exists on the benefits of newer adaptive control strategies like OPAC, RHODES, and RTACL, and the conclusions about ACS in this paper are taken mostly from experiences with SCOOT and SCATS.

Levels of Deployment

The ITS deployment tracking database currently reports eight ACS deployments in the United States. In addition to these eight, a literature search revealed the existence of two other sites: Broward County, Florida, and Newark/Wilmington, Delaware. One of the first and largest ACS deployments is in Oakland County, Michigan, as part of the FAST-TRAC project. The system became operational in 1992, and more than 350 intersections are now under SCATS control. Also, the ATSC system in Los Angeles includes 1,170 intersections and 4,509 detectors for signal timing optimization as of 1994 (Mitretek Systems 1999). Table 3 shows the deployment cities and levels of utilization. In addition to these deployed systems, there are currently field operation tests of OPAC and RHODES on Route 18 in New Jersey and in Tucson, Arizona, respectively. These two systems are not listed in Table 3-2, as they are field operational tests.

Table 3-2. Locations of Adaptive Control Strategies Deployments

City/County	System	Number of Intersections
Los Angeles, CA	ATSC	1170
Oakland County, MI	SCATS	350+
Hennepin County, MN	SCATS	71
Arlington, VA	SCOOT	65
Minneapolis, MN	SCOOT	60
Anaheim, CA	SCOOT	20
Durham, NC	SCATS	unknown

What are the benefits of ACS?

ACS has several advantages over traditional fixed-time/time-of-day plans. With ACS, timing plans are generated in real time and can more efficiently accommodate fluctuations in traffic demand. Ideally, ACS works best in areas with high levels of nonrecurring congestion, such as incidents and special events, and in areas with fluctuating traffic demand. Although ACS has been shown to provide benefits, it is difficult to give a generalized overview of the benefits for any of the systems, as each technology works differently, and each deployment site is unique and customized to that particular deployment. The extent of benefits depends on several factors, including number and spacing of intersections, size of study area, demand patterns, study base case, and type of adaptive control used.

Three functional areas have shown improvement, or potential for improvement, due to ACS over fixed-time plans. They are delay reduction, safety, and operations and maintenance.

Delay Reduction

In responding to demand variations in real time, ACS adjusts the timing plan to minimize delay and number of stops, a basic goal of an ACS system. Each system performs this optimization in a similar fashion. Delay reductions were reported from five of the deployments. The benefits ranged from 19 to 42 percent. The range in delay may be attributed to differing definitions of delay (e.g., time stopped at an intersection or corridor travel time over a free-flow travel time) and the base case study condition.

The largest delay reduction was experienced in Broward County, Florida, where a SCATS test system was installed at five intersections. A Florida Department of Transportation (DOT) evaluation showed that SCATS reduced delay by up to 42 percent and travel time by up to 20 percent (TransCore 2000). Before-and-after studies of the Oakland County, Michigan, SCATS deployment showed significant delay improvements. Corridor travel time was reduced from 7 percent to 32 percent over optimized fixed-time signal control. The average travel time reduction for traffic during peak periods was 8 percent (average speed increased from 25 mph to 27 mph) (Abdel-Rahim et al. 1998). A preliminary study of the SCOOT installation in 56 intersections in Minneapolis shows a 19 percent reduction in delay during special events. Table 3-3 provides more delay reduction information.

Table 3-3. ACS Travel Time and Delay Benefits Realized in the United States

Location	System	Benefits Realized
Broward County, FL*	SCATS	Delay reduced by up to 42%, travel time reduced by up to 20%
Oakland County, MI	SCATS	Delay reduced by 6.6% to 32%, with an average of 7.8%
Newark, DE area	SCATS	Travel time reduced by up to 25%
Los Angeles, CA	ATSC	Delay reduced by 44%, travel time reduced by 13%
Minneapolis, MN	SCOOT	Delay reduced by up to 19% during special events

**The system in Broward County was installed as a demonstration and has since been turned off due to lack of funds.*

Safety

A reduction in number of stops leads to reduced chance of rear-end collisions. ACS has the ability to reduce the number of stops through a corridor by improving coordination. When compared to fully optimized fixed-time systems, SCATS has been shown to reduce stops by up to 40 percent (TransCore 2000). Following implementation of a SCATS system in Broward County, Florida, the number of stops decreased by 28 percent (TransCore 2000). Floating car studies in Oakland County, Michigan, showed a 33 percent reduction of stops, and the ATSC system in Los Angeles reduced stops by an estimated 41 percent (Mitretek Systems 1999).

Operations and Maintenance

High-growth areas benefit from adaptive control's ability to continually generate timing plans. While there are no guidelines specifying the optimal length of time between traffic signal optimization, the ITS deployment tracking database shows that only 27 percent of agencies in the 78 largest metropolitan areas re-time their signals each year, as shown in Table 3-4. Slightly fewer than a third report re-timing their signals on an as-needed basis. However, practitioners participating in the roundtable discussion held at the ITE 2000 International Conference reported that re-timing most likely occurs when funding and staff resources are available. In fact, ITE estimates that nearly 75 percent of all signals in the United States need to be re-timed (Meyer 1997). In areas of high growth, signal timing plans quickly become out-of-date. The ability of ACS to respond in real time addresses the shortcomings of signal timing in responding to changes in demand.

Table 3-4. Signal Re-Timing Schedule

	As Needed	1 year or less	2 years	3-5 years	5+ years
# of agencies	62	53	21	41	18
% of agencies	31.8%	27.2%	10.8%	21%	9.2%

Source: Metropolitan ITS Deployment Tracking Database, Oak Ridge National Laboratory (1999).

ACS may reduce operational and maintenance costs associated with signal re-timing. The Minnesota DOT reported that technicians were pleased with the ease of operations of the SCOOT system in Minneapolis. Technicians found the system easy to operate, requiring a minimum amount of maintenance once installed (Remer 2000).

What are the deployment challenges to ACS?

ACS has limited deployment in the United States. Several factors have limited its use, including cost, system complexity, and uncertainty in the benefits of adaptive systems.

Current adaptive control system benefits do not appear to be proven to traffic engineers. Several participants in the ITE roundtable discussion mentioned they are not convinced or even aware of ACS benefits. ACS is particularly sensitive to installation. For example, a limited SCOOT installation in Anaheim, California, produced little improvement and, in some cases, actually increased delay. During peak traffic periods, the system experienced delays that were 10 percent greater than baseline conditions. However, during nonpeak periods, the delay was decreased by 5 percent. According to a U.S. Department of Transportation-sponsored evaluation of the system, the reason for sub-optimal performance was most likely in placement of the detectors.

Also, the benefits of ACS depend on the base case condition. In areas characterized by fluctuations in traffic demand and low growth, ACS offers few benefits over well-maintained fixed-time/time-of-day signals. The consensus of engineers in the ITE roundtable discussion was that the benefits of traditional ACS over well-maintained fixed-time plans are unproven (although, as was demonstrated previously, such well-maintained fixed-time plans are the exception, not the rule).

Participants also expressed concern about the complexity of adaptive control systems. Additional training is normally required to operate such systems, which are not considered user-friendly. Different terminology causes problems for U.S. traffic engineers. In the Hennepin County, Minnesota, deployment, system operators found the SCATS system difficult to learn, even though extensive training was provided. Operators had difficulty working with the complex user interface.

In a similar fashion, ACS systems are highly dependent on the communications network, as well as the traffic detectors. If problems arise with communications, the system does not work efficiently, as occurred in Hennepin County, Minnesota, where the communications system was unreliable, and arterial traffic signals experienced ongoing communications failures (Booz-Allen & Hamilton 1999).

Finally, cost appears to be a major obstacle to widespread ACS deployment, even for those who appear convinced of its benefits. This concern extends to both the capital and the operations and maintenance costs of ACS. For example, one of the biggest selling points offered by ACS proponents is that over the long term, the systems are more cost-effective than traditional signal timing approaches. They argue that the operations and maintenance costs associated with ACS are much lower than those associated with signal re-timing. However, as Table 3-5 illustrates, the equation is not that simple, for while signal re-timing costs decrease, other costs such as loop maintenance increase.

Table 3-5. Operations and Maintenance Costs for SCOOT Compared to Standard Traffic Control Devices

Equipment/Task	Costs of SCOOT vs. Standard
Controllers	Same
Detectors	Increases
Loop siting, validation, and fine tuning	No O&M costs (one-time cost)
Signal plans/updates	Decreases
Central equipment and communications	Same as any computer system

Source: Reissnecker, A., "Equipment Requirements for Adaptive Traffic Control," TRB Workshop (January 9, 2000).

Furthermore, even if the operations and maintenance costs were lower, practitioners have expressed concern about the large capital costs associated with ACS. While these costs vary widely depending on the size of deployment, they can (as Table 3-6 indicates) be quite significant. Even some of the practitioners who feel the benefits of ACS justify and outweigh these costs have difficulty in securing the large amounts of capital funding necessary to deploy ACS. Many municipal budgets are not structured to support such large, one-time costs for their arterial network.

Table 3-6. Estimated Costs of ACS Components

System	Central Hardware ($)	Central Software ($)	Local Controllers* ($)	Detectors*
SCATS†	30,000	40, 000 - 70,000	4,000 - 6,000	5,000 - 7,000
SCOOT	30,000	unknown	unknown	5,000 - 7,000
OPAC	20,000 - 50,000	100,000 - 200,000	4,000 - 6,000	unknown
RHODES	50,000	500	unknown	unknown
ATCS	40,000 - 50,000	1,000 + license	8,000 - 10,000	5,000 -10,000

** per intersection*

† requires regional hardware and software

What does the future hold for ACS?

According to the ITS deployment tracking database, only five other sites expect to use an adaptive control system by the year 2005—a rather dismal outlook for ACS. However, most participants in the ITE roundtable discussion believed ACS had the potential to provide significant benefits. These benefits have not yet been convincing or made well-known. Participants agreed that a database of ACS benefits may be helpful in choosing between a traditional traffic signal system and adaptive control.

Furthermore, despite the rather low level of domestic deployment, ACS has enjoyed relatively widespread use outside the United States. For example, SCOOT has been deployed at more than 100 sites worldwide, while SCATS has been deployed in nine countries. While the reasons for this discrepancy are not fully understood, it has been suggested that off-shore development of these systems may be the factor limiting their adoption here. To illustrate, some practitioners have argued that these traditional, foreign-designed systems are insensitive to a number of unique, yet critical, aspects of U.S. signal control, such as pedestrian clearance times.

Finally, this issue may be addressed in part by the adaptive control systems now being developed in the United States. These systems, which are currently being field tested, include RHODES, OPAC, and RTACL, and may show significant benefits and be easier to use than traditional systems. Because cost is one of the main prohibitive factors, the Federal Highway Administration is also considering such solutions as a scaled-down, lower cost ACS that could also be used in small and medium-sized cities and would not require total replacement of current traffic control devices.

ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS) FOR ARTERIALS

What is ATIS for arterials?

ATIS for arterials is used to collect and/or disseminate information on roadway conditions to travelers so they can make more informed decisions.

In addition to traditional radio and television broadcasts, arterial information is disseminated primarily through three ITS media: VMS, websites, and HAR. In addition, U.S. DOT recently announced the creation of a national three-digit traveler information number (511). Both static and dynamic information is provided over these media. Static information includes lane closures and construction, while dynamic information includes real-time travel times and congestion.

Levels of deployment

According to the ITS deployment tracking database, 67 of 361 agencies (nearly 19 percent) report providing some type of arterial information to travelers, with few providing real-time or dynamic information such as travel speeds. This moderate deployment level and lack of real-time data stem from a combination of limited surveillance on arterial roadways and from difficulties in conveying meaningful arterial travel conditions. For example, spot speeds collected through loop detectors are fairly common and useful on freeway facilities. However, even if such detectors were present on an arterial network (which they rarely are), the resulting spot speeds may be misleading, given the confounding influence of traffic signals.

The most widely used ITS method to provide arterial travel information is the Internet, with 28 agencies operating websites. Table 3-7 depicts the deployment levels of other common technologies for providing arterial information. Information provided includes data on arterial speeds, incidents, road closures, and queue lengths.

Table 3-7. Arterial ATIS Deployment Levels

Technology*	1999 Level of Deployment (Number of Sites)
Dedicated cable TV	5.0% (18)
Telephone system	5.8% (21)
Internet websites	7.8% (28)
Pagers/personal data assistants	2.8% (10)
Interactive TV	0.3% (1)
Kiosks	3.0% (11)
E-mail or other direct PC communication	4.4% (16)

Table 3-7. Continued

Technology*	1999 Level of Deployment (Number of Sites)
In-vehicle navigation systems	0.3% (1)
Cell phone/voice	1.1% (4)
Cell phone/data	0.6% (2)
Facsimile	5.0% (18)
Other	1.9% (7)

** Broadcast media is the primary method currently used to disseminate arterial information. Television and radio broadcast arterial information in virtually every major metropolitan area. However, these traditional media are not considered ITS.*

Source: Reissnecker, A., "Equipment Requirements for Adaptive Traffic Control," TRB Workshop (January 9, 2000).

What are the benefits of ATIS for arterials?

ATIS that provides information on arterial roadway conditions offers benefits in customer satisfaction and improved efficiency. In addition to freeway information, travelers seem to want information on arterial roadways so they can make more informed decisions. More than half (57 percent) of respondents in a survey of website users in Seattle suggested adding arterials to traveler information. Similar results were found from surveys in Phoenix and San Antonio during MMDI evaluations. Providing information on arterial conditions may also lead to slight reductions in delay. Results from the Seattle MMDI evaluation show that adding arterial information can bring about a 3.4 percent reduction in delay, up from 1.5 percent, and lead to significant reductions in variability (Jensen et al. 2000).

What are the deployment challenges?

Providing accurate and reliable traveler information continues to be a deployment challenge for ATIS. In most cases, the infrastructure does not exist for arterial data collection. Traveler information systems often have to rely on data collected to serve other needs, such as data from traffic management functions. Agencies are still seeking the best method of surveillance to collect arterial information. ITE roundtable participants agreed that the biggest impediment to providing ATIS with arterial information is providing accurate and reliable travel times.

Another issue concerning arterial ATIS is that currently no common method exists to describe arterial conditions. Users do not always understand the performance metrics used by traffic engineers (e.g., intersection level of service, saturation) for arterial roadways. In addition, as previously mentioned, traditional measures like spot speeds may be misleading on facilities dominated by traffic signal control.

What does the future hold?

Although the current situation does not lend itself to adequate data collection methods, the future does seem hopeful with the emergence of new technologies. As part of the MMDI, San Antonio, Texas, used automated vehicle identification tags and readers to determine travel times/speeds on arterial streets. The system was found to be technically sound; however, the tags never reached a sufficient level of market penetration to consistently measure travel times/speeds throughout all times of the day. Nevertheless, this method can be successful for collecting data on arterials if the appropriate level of market penetration is reached.

In another example, Farmer's Branch, Texas, took advantage of the large number of toll tags in the area (more than 200,000) by putting three toll tag readers along a key arterial in the area to measure travel time. This system detects when incidents occur, measures the effectiveness of attempts to improve travel time, and tracks travel time as a performance measure over months and years. The information is provided to travelers through signs in the roadway median (Davis 2000).

There is also research being conducted on using cell phones in vehicles as traffic probes; however, privacy issues may accompany this new technology. ITE roundtable participants seemed encouraged by the new technologies becoming available to collect arterial information. Although the provision of arterial information is not yet considered a success, it does hold promise because of new surveillance technology.

AUTOMATED ENFORCEMENT

What is automated enforcement?

Automated enforcement uses camera technology to photograph the license plates of traffic law violators. The most prominent form of automated enforcement is red light running enforcement. The purpose of RLR enforcement is to reduce the number of violations and ultimately lead to safer intersections. More than 22 percent of all urban crashes in the United States are caused by noncompliance with intersection controls—which amounts to more than 1.8 million crashes annually (FHWA Web Page). Automated RLR enforcement is a tool that can be used to encourage compliance and prevent crashes.

Levels of deployment

Automated enforcement is not tracked in U.S. DOT's Metropolitan ITS Deployment Tracking Database. Deployment levels were obtained through websites on the subject. Automated RLR enforcement is being used in approximately 40 communities in the United States. Currently, nine states have passed legislation allowing automated RLR enforcement, while 10 additional states are considering such legislation (Insurance Institute for Highway Safety Web Page). There are 14 automated speed enforcement programs (involving either freeways or arterial streets), mostly in the western United States.

One of the reasons for the relatively widespread use of automated enforcement technologies is the active involvement of industry and vendors. The private sector has frequently offered to defray many associated deployment costs in return for receiving a percentage of revenues gained from the ticketing process. While this model has facilitated rapid rise of this technology, it must be employed carefully to ensure that deployments are safety-driven and not motivated by profits.

What are the benefits of automated enforcement?

Automated RLR enforcement can yield benefits in reduced crashes, reduced violations, and increased intersection efficiency. Table 3-8 shows the benefits at several deployment sites. Additionally, revenues from traffic fines may help defray some of the capital and/or operating costs. However, issues of public perception and acceptance dictate that cost savings not be a prime motivator for system deployment. In addition, if the systems perform their function properly, they should ultimately increase compliance and thus lead to decreased ticket revenue.

The benefits of automated speed enforcement are not as well documented and, therefore, red light enforcement benefits alone are presented.

Table 3-8. Benefits of Automated Red Light Enforcement at Various Sites

Site	Impact on Violations and Citations	Impact on Crashes
New York, NY	Violations reduced by 34%	Angle crashes reduced by 60-70% Some increase in rear-end crashes
Howard County, MD (2 sites)	Warnings reduced by 21-25% Citations reduced by 42-50%	Collisions reduced by 40%
Oxnard, CA	Violations reduced by 42% at sites Violations reduced by 22% city wide	Collisions reduced by 24%
San Francisco, CA	Citations reduced by 42%	Injury crashes reduced by 24%
Scottsdale, AZ	Violations reduced by 20%	Collisions reduced by 55%
Minnesota	Citations reduced by 29% for all vehicles Citations reduced by 63% for trucks	unknown
Fairfax, VA (9 sites)	Citations reduced by 44%	unknown

Source: FHWA Web Page.

What are the deployment challenges?

Concerns have been raised that automated enforcement violates a person's privacy. While legal opinions do not support this claim, the perception still exits. Also, as stated above, the public may perceive the systems as revenue generators for the police or for the system vendors. In many cases, the vendor pays for system installation and, in turn, generates revenue from violations. Educating the public about the benefits of the systems may dispel these concerns. Participants in the ITE roundtable agreed that automated enforcement should be encouraged, but that safety aspects need to be demonstrated to the public to gain acceptance.

What does the future hold?

Automated RLR enforcement is moderately deployed at this time; however, it appears to have a strong future. The media have given the systems significant attention, while the number of states considering legislation is increasing rapidly. The Federal role in supporting development of these systems may be limited to public education on the systems and the dangers of red light running.

Automated speed enforcement does not share the same level of public support. Seven out of 10 deployment tests of automated speed enforcement have been discontinued from lack of support (Public Technology, Inc. 1999).

INTEGRATION OF ARTERIAL TRAFFIC MANAGEMENT SYSTEMS (ATMS)

What does the integration of ATMS involve?

There are three types of ATMS integration: (1) integration across jurisdictions, (2) integration with transit and emergency operations, and (3) integration with freeway management. Integration across jurisdictions includes the coordination of traffic signals among different agencies and, in some cases, the sharing of signal control.

Arterial management integration with emergency operations usually takes the form of traffic signal preemption. Preemption provides an automatic green light to emergency vehicles despite traffic conditions and current signal phase. This exception allows the emergency vehicle to move safely and more efficiently through the intersection.

Priority for transit vehicles is similar to preemption, except that the green phase is not automatically implemented. Rather, the green time is either extended or reduced to more efficiently move the transit vehicle.

An integrated arterial freeway corridor is one that shares information and/or control between adjacent freeway and arterial management systems. At a low level, this integration may involve a freeway management agency providing information on freeway incidents to neighboring arterial systems. With more complex systems, arterial travel times, speeds, and conditions may be shared with freeway management to adjust VMS, HAR, and freeway ramp meters. Conversely, freeway travel times, speeds, and conditions may be shared with arterial management and used to optimize traffic signal timings and inform arterial travelers. Such integration may also use incident response timing plans to respond to traffic diverted from the freeway to the arterial.

Where have arterial ATMS been integrated?

Interjurisdictional coordination

Of the 78 largest metropolitan areas, 54 percent report coordinating fixed timing plans across jurisdictions, and 62 percent report planning to do so before 2005.

Integration with transit and emergency operations

More than half the agencies accounted for in the ITS deployment tracking database offer some preemption measures for emergency vehicles (see Table 3-9). Priority for transit is used less frequently than preemption for emergency vehicles, owing largely to concerns over disruption to surrounding traffic. (See Chapter 5, “What Have We Learned About Advanced Public Transportation Systems?” for more detailed information on priority for transit vehicles).

Table 3-9. Extent of Emergency Preemption Deployment

Percent of signals that allow for preemption for emergency vehicles	Number of agencies by type (percentage)		
	State DOT	County Agency	City Agency
100% to 25%	9 (17%)	26 (26%)	53 (29%)
1% to 24%	25 (47%)	38 (36%)	81 (45%)
0%	19 (36%)	41 (38%)	48 (26%)
Total (340 agencies)	53 (100%)	105 (100%)	182 (100%)

Integration with freeway management

According to the ITS deployment tracking database for 1999, 74 (out of 361) arterial management agencies, or 20 percent, provide arterial travel times, speeds, and conditions to freeway management agencies. Conversely, 20 (out of 106) freeway management agencies, or 19 percent, provide information on freeway conditions to arterial management agencies. It is unknown how each agency uses the information. Actual integration of arterial and freeway management—where agencies actively use information from freeway management to better manage arterial roadways—is expected to be much lower than these percentages. For example, fewer than a half dozen integrated freeway/arterial diversion systems use both freeway and arterial incident response plans to incidents, and share real-time incident and travel time conditions with each other and the public.

What are the benefits of integration?

Interjurisdictional coordination

Coordination across jurisdictions can yield delay reductions by providing a seamless travel corridor. Interconnecting previously uncoordinated signals and providing newly optimized timing plans and a central master control system can reduce travel time by 10 to 20 percent (Meyer 1997). For example, the metropolitan planning organization in Denver acted as an organizer in getting area jurisdictions to work together to coordinate signals. Travel time reductions on the Denver arterial corridors ranged from 7 to 22 percent (Meyer 1997).

Integration with transit and emergency operations

Delays at traffic signals usually represent 10 to 20 percent of overall bus trip times (Gordon et al. 1996). Priority for transit vehicles can reduce delay caused by stopping for red lights. (See Chapter 5, "What Have We Learned About Advanced Public Transportation Systems?" for more benefit information). Emergency vehicles experience benefits from traffic signal preemption, with travel time reductions of around 20 percent (Mitretek Systems 1999).

Integration with freeway management

Integrating arterial, freeway, and incident management in San Antonio, Texas, led to travel time reductions of 20 percent during major incidents. The Integrated Corridor Traffic Management (ICTM) project in Hennepin County, Minnesota, experienced benefits from the interjurisdictional relationships formed. Under ICTM, agencies were encouraged to look at the corridor as a whole rather than as separate jurisdictions. For example, before the implementation of ICTM, traffic signals and ramp meters were operated by a variety of nonintegrated systems within separate jurisdictions. ICTM used SCATS to integrate the metered ramps and arterial traffic signals (Booz-Allen & Hamilton 1999).

The Coordinated Highways Action Response Team (CHART) program in Maryland is another example of integration between freeway and arterial management. Surveillance on freeway exit ramps and along the arterial are used to adjust and refine traffic signal timing, especially critical when incidents occur on the freeway and traffic is diverted to the arterial roadways. Adjustments can be made to the traffic signals to accommodate the additional traffic diverted from the freeway (MD DOT undated).

What are some of the challenges of integration?

According to participants of the ITE roundtable discussion, lack of multijurisdictional organization and support continues to be the major impediment to integration. Jurisdictions often may not have the same goals. Furthermore, they may not see the need or opportunity for integrated management. There are also technical issues concerning the compatibility of different systems and technologies.

What does the future hold?

Decision-makers need to become better educated about the benefits of integrated systems and interjurisdictional coordination. This goal may be accomplished by further studying the benefits of integration. ITE roundtable participants called on vendors to help integrate different technologies by opening their architectures and allowing agencies to work together without having to purchase new systems.

CONCLUSION

Each of the technologies discussed in this paper shows the potential for benefits; however, only a few have reached widespread deployment. Reasons for the limited deployments vary, but include cost, institutional barriers, uncertainty of benefits, and technological incompatibilities.

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