The Active Transportation and Demand Management Program (ATDM): Lessons Learned

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7. Author(s) Beverly Kuhn (TTI), Deepak Gopalakrishna (Battelle), and Eric Schreffler (ESTC)	8. Performing Organization Report No.
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16. Abstract
Active transportation and demand management (ATDM) is the proactive and dynamic management, control, and influence of travel demand, traffic demand, and traffic flow of transportation facilities. Using available tools and assets, traffic flow is managed and traveler behavior is influenced in real time to achieve operational objectives, such as preventing or delaying breakdown conditions, improving safety, promoting sustainable travel modes, reducing emissions, or maximizing system efficiency. Under an ATDM approach, the transportation system is continuously monitored. This report documents the lessons learned and critical issues related to the deployment of ATDM across the United States to date. Common themes that resonate with transportation professionals regarding ATDM include agency approaches to incorporating ATDM in the planning process, regulatory and institutional obstacles that may need to be overcome prior to implementation, the importance of developing strong partnerships with stakeholders, the importance of outreach, addressing design exceptions created by ATDM applications, appropriate signage to adequately convey operational strategies to travelers, and operations and maintenance approaches and responsibilities.

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Executive Summary

In response to the growing pressure for agencies to do more with less and address congestion challenges from all aspects of the network, the Federal Highway Administration (FHWA) is working to promote a dynamic approach to manage the transportation network. The approach seeks to optimize performance and increase efficiency throughout the entire trip chain as seen from the traveler's perspective. Termed Active Transportation and Demand Management (ATDM), the program advances the ability to manage, control, and influence travel demand, traffic demand, and traffic flow of transportation facilities.

The program builds off the existing investments that state and local agencies have made in transportation systems management and operations. Investments on our transportation facilities are wide-ranging and include monitoring systems (detectors), communication backbones, advisory systems (message signs, highway advisory radios), field personnel and vehicles (safety service patrols), centers (traffic management centers), public information portals (websites, 511), control systems (traffic signal systems, ramp meters, road/lane closure systems), and operational information exchanges (Computer Aided Dispatch [CAD] integration, data warehousing). Leveraging these investments to realize a greater degree of real-time, dynamic management and operational capability is the primary goal of the program.

Figure ES-1 illustrates the continuous dynamic nature of ATDM when applied to system management and operations. Under an ATDM approach, the transportation system performance is continuously assessed; dynamic actions using existing tools and assets are constantly evaluated and implemented in real time to achieve performance objectives, such as preventing or delaying breakdown conditions, improving safety, promoting sustainable travel modes, reducing emissions, or maximizing system efficiency. Implemented actions are continuously monitored as they start to affect system performance. This cyclical approach can be carried out at various operational time-scales, ranging from longer-term strategic approaches to the short-term tactical decisions.

As agencies move toward more active management, new and emerging implementation approaches allow for more dynamic operations by agencies leading to more fluid traveler behavior choices to positively affect the system. Broadly, these approaches can be classified into three categories:

- Active Traffic Management: A suite of strategies that actively manage traffic on a facility. Examples include variable speed limits, dynamic shoulder use, queue warning and lane control strategies.

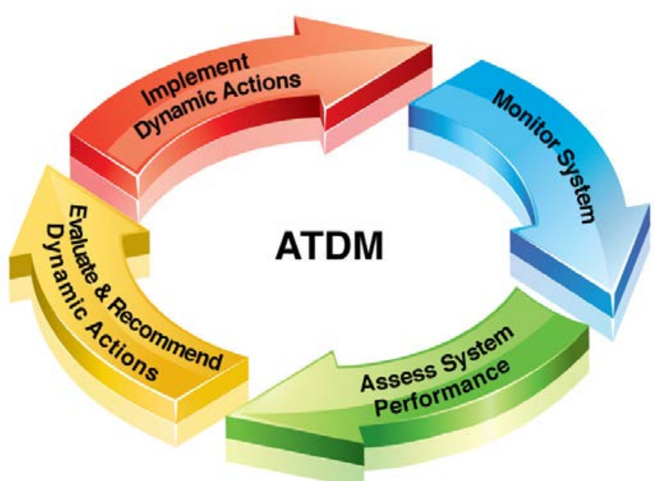

Figure ES-1. The Active Management Cycle.

- Active Demand Management: A suite of strategies intended to reduce or redistribute travel demand to alternate modes or routes. Examples include comparative multi-modal travel times, dynamic ride-sharing, pricing and incentive approaches.
- Active Parking Management: A suite of strategies designed to affect the demand, distribution, availability, and management of parking. Examples include dynamic parking pricing, real-time parking availability and reservation systems

All agencies and entities operating transportation systems can advance toward a more active management philosophy by making changes that move operations along the active management continuum. This progression on the continuum represents a natural evolution in an agency's ability to provide and the public's acceptance of active management as shown in Figure ES-2.

Sources for figures: left – Battelle, middle – Washington DOT, right – UK Highways Agency

Figure ES-2. Moving towards active management in the area of speed control.

Through a series of outreach workshops across the country, transportation professionals have learned about the concept of ATDM and had the opportunity to question early implementers of various approaches about specific issues and discuss the lessons they learned along the way to implementation. Peers across the country consistently challenged implementing agencies to answer questions regarding ATDM and their approach to implementation. These questions spanned the breadth of planning, design, and operations issues facing agencies and point to the recurring challenges agencies face when considering new approaches to managing congestion in their jurisdictions. Common themes that resonate with transportation professionals include agency approaches to incorporating ATDM in the planning process, regulatory and institutional obstacles that may need to be overcome prior to implementation, the importance of developing strong partnerships with stakeholders, the importance of outreach, addressing design exceptions created by ATDM applications, appropriate signage to adequately convey operational strategies to travelers, and operations and maintenance approaches and responsibilities.

In general, ATDM requires that agencies increase their emphasis on customers, who will want to know how they can directly benefit from ATDM. Agencies need to understand that customers are more than highway users and that they need to be seen as an ally and advocate for ATDM. Providing real-time, accurate communications can help gain them as allies. It is also important to identify and demonstrate successful institutional arrangements for ATDM. Another key approach is to show customers what they gain from ATDM rather than focusing on how the agency benefits. The use of polls and focus groups can help agencies understand the public's perspectives and help them to develop messages.

Technological capability is core to ATDM but it is also important for agencies to recognize that technology is not the end-all for managing the transportation system. They do not need to be on the cutting edge to manage their system efficiently. The fact that technologies change so rapidly could result in the public sector chasing technologies instead of maximizing what they have. The goal of agencies needs to be to maintain and/or operate their equipment to its fullest potential. Technology can enhance management and operations, but it is not a panacea or the necessary end- result.

Policies and regulations can present challenges to the deployment of ATDM approaches, which push the boundaries of operations, partnerships, and opportunities. Ensuring that laws are flexible enough to accommodate them and the myriad ways they are planned, developed, financed, and implemented helps move the state of the practice forward.

Effective communications is also essential to implementing ATDM on a broad basis. If an agency cannot convince the public that innovative approaches can help solve their problems, then it cannot hope to gain the attention of policymakers and decision makers. Members of the public can be critical partners, advocates, and champions. Consistent messages from all levels of the organization help sell the concept, especially when they resonate with the greater population and target issues that are of global concern, such as health and safety. How a message is crafted can make or break a project and a program.

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1.0 Introduction

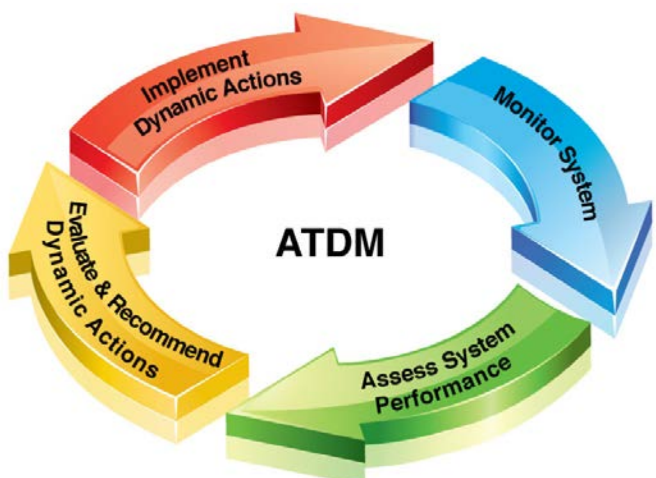
In response to the growing pressure for agencies to do more with less and address congestion challenges from all aspects of the network, the Federal Highway Administration (FHWA) is working to promote a dynamic approach to manage the transportation network. The approach seeks to optimize performance and increase efficiency throughout the entire trip chain as seen from the traveler's perspective. Termed Active Transportation and Demand Management (ATDM), the program advances the ability to manage, control, and influence travel demand, traffic demand, and traffic flow of transportation facilities.

The program builds off the existing investments that state and local agencies have made in transportation systems management and operations. Investments on our transportation facilities are wide-ranging and include monitoring systems (detectors), communication backbones, advisory systems (message signs, highway advisory radios), field personnel and vehicles (safety service patrols), centers (traffic management centers), public information portals (websites, 511), control systems (traffic signal systems, ramp meters, road/lane closure systems), and operational information exchanges (Computer Aided Dispatch [CAD] integration, data warehousing). Leveraging these investments to realize a greater degree of real-time, dynamic management and operational capability is the primary goal of the program.

As the popularity of ATDM approaches rises across the nation, it is important that agencies understand the impacts and the lessons learned so that they can begin utilizing similar approaches to help create smart transportation infrastructure and programs that are effective in their region for proactively and dynamically managing demand and operations. This document provides insight into lessons learned by early adopters of ATDM in the United States to help provide guidance for agencies considering ATDM for their region.

1.1 The ATDM Operational Concept

ATDM is the proactive and dynamic management, control, and influence of travel demand, traffic demand, and traffic flow of transportation facilities. Under an ATDM approach, the transportation system performance is continuously assessed; dynamic actions using existing tools and assets are constantly evaluated and implemented in real time to achieve performance objectives, such as preventing or delaying breakdown conditions, improving safety, promoting sustainable travel modes, reducing emissions, or maximizing system efficiency. Implemented actions are continuously monitored as they start to affect system performance. This cyclical approach can be carried out at various operational time-scales, ranging from longer-term strategic approaches to the short-term tactical decisions. The general phases of the ATDM approach are illustrated in Figure 1. (1)



Source: FHWA

Figure 1. The ATDM approach.

As agencies move toward more active management, new and emerging implementation approaches allow for more dynamic operations by agencies leading to more fluid traveler behavior choices to positively affect the system. Broadly, these approaches can be classified into three categories:

- Active Traffic Management: A suite of strategies that actively manage traffic on a facility. Examples include variable speed limits, dynamic shoulder use, queue warning and lane control strategies.
- Active Demand Management: A suite of strategies intended to reduce or redistribute travel demand to alternate modes or routes. Examples include comparative multi-modal travel times, dynamic ride-sharing, pricing and incentive approaches.
- Active Parking Management: A suite of strategies designed to affect the demand, distribution, availability, and management of parking. Examples include dynamic parking pricing, real-time parking availability and reservation systems

An agency can deploy a single ATDM approach in order to capitalize on a specific benefit or can deploy multiple active strategies to gain additional benefits across the entire transportation system. All agencies and entities operating transportation systems can advance toward a more active management philosophy by making changes that move operations along the active management continuum. This progression on the continuum represents a natural evolution in an agency's ability to provide and the public's acceptance of active management as shows in Figure 2.

Figure 2. Moving towards active management in the area of speed control.

ATDM builds upon existing capabilities, assets, and programs and enables agencies to leverage existing investments—creating a more efficient and effective system and extending the service life of existing capital investments. While active management can be applied to any part of our transportation system (such as implementing dynamic pricing on a facility to manage congestion or informing travelers of specific or compatible transit operations for their trip), it is most beneficial when the relationships and synergies to other parts of the system are considered.

1.2 The International Influence

The origins and the evolution of active management concepts in Europe have considerably influenced the evolving ATDM program in the United States. The antecedents of the ATDM program in the United States emerged from international experience with active traffic management on key highways as well as observing how travel demand management and traffic management are more closely integrated in some other countries. For example, in 1995, the UK Highways Agency in England began to actively manage traffic via variable speed limits. In 2002, full active traffic management (ATM) was installed on the M42 near Birmingham. This project has become the most widely cited example of ATM. The focus of ATM is to reduce bottlenecks and traffic perturbations by utilizing hard shoulder running during peak flows, ramp metering, variable speed limits, and dynamic lane control; detecting and clearing incidents quickly; and improving real-time traffic information.

ATM planners in Europe and elsewhere now use a diverse and flexible set of tools to manage their facilities. Commonly used strategies now include variable speed limits, hard shoulder running, dynamic merge control, adaptive ramp metering, and queue warning and dynamic traveler information. The benefits of these ATM strategies, especially variable speed limits, have been reported to include compliant driver behavior, improved vehicle throughput, travel time reliability, improved safety (especially during inclement weather), and reduced emissions. A 3-year safety review of M-42 highlighted a reduction in the number and severity of personal injury crashes when the ATM operational regimes were in effect. (2)

As ATM tools continue to be applied in Europe, both the Dutch Ministry for Transport and the UK Department of Transport recognized that ATM addresses only part of the congestion problem and that there is a parallel and complementary need to manage the demand on the transportation system. The Dutch model of travel demand and traffic management involves a three-stage process that recognizes the difference between travel demand management and traffic management and places these concepts into a larger framework of travel choices and congestion-reduction techniques. As shown in Figure 3, the process begins with the consideration of overall travel demand (the need to travel) and moves through traffic demand (the demand on the transportation system) and network demand (the demand on the individual facilities). Through both traffic and travel demand management strategies, the framework shows how travelers can be provided choices across mode, destination, route, and time.

The ATDM program in the United States emerged from international experience with active traffic management on key highways and how travel demand management and traffic management are more closely integrated in some other countries.

These international experiences have provided the impetus for the development of an ATDM program in the U.S., drawing from the three technical exchanges between U.S. and European transportation professionals in 2005, 2006, and 2011. The ATDM program has been adapted to meet the needs of the stakeholders in the U.S. Table 1 highlights the key influences from Europe and how they shape the ATDM program in the U.S.

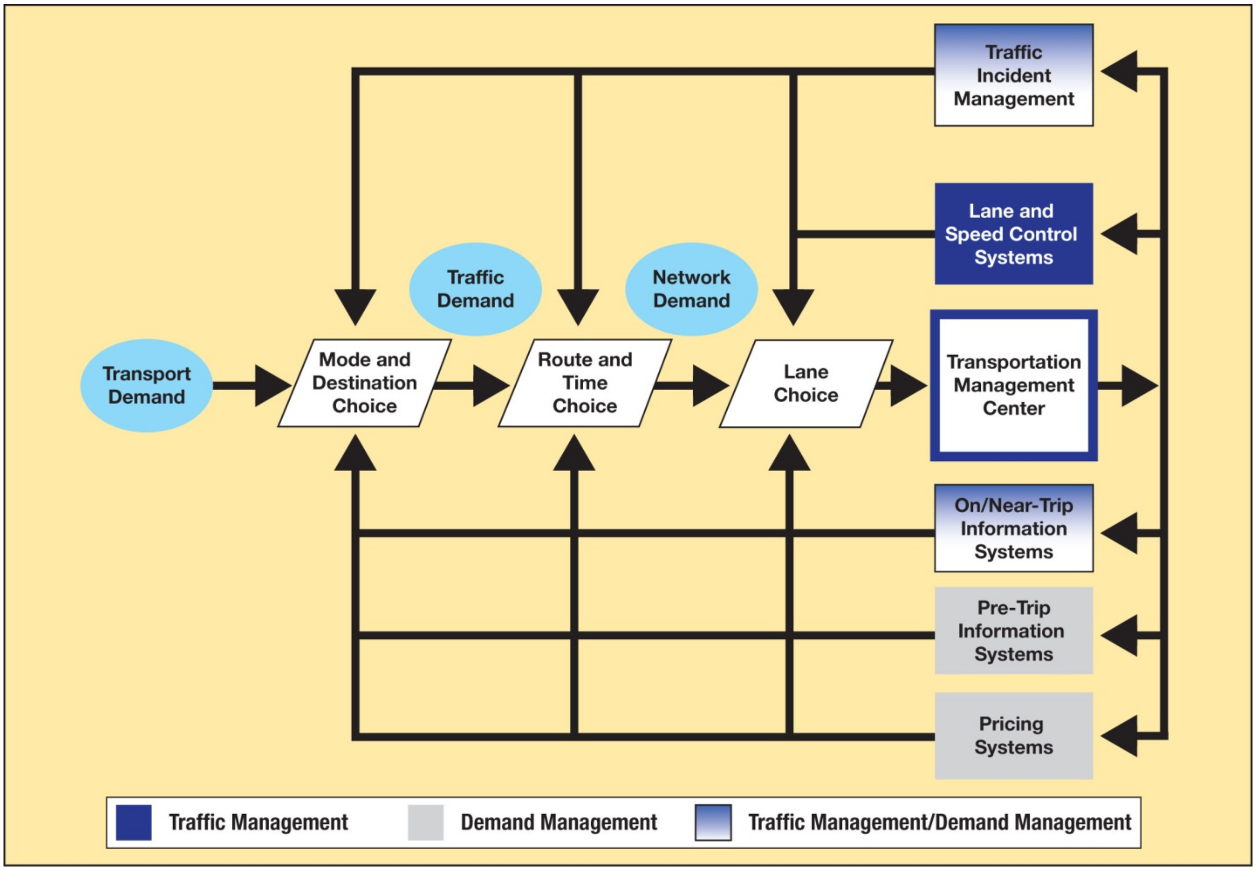


Figure 3. Modified Dutch model of travel demand and traffic management. (3)

Table 1. International Influence on the ATDM program.

Influences from Europe	Adaptation to the U.S. Environment	Key Thrusts of the ATDM Program
Active management as a tactical philosophy	Through the international scans, the value of being more proactive and dynamic in overall operations was noted. Current operations in the U.S. can benefit from such a shift.	Focus on increasing U.S. operating agency's capability to actively manage their facilities, maximizing the use of data, performance assessment and continuous improvement.
Use of ATM strategies to manage motorways	Many of the ATM strategies are of interest in the U.S. Several have been tried in isolation or as part of pilots here.	Continue to promote adoption of ATM strategies, elaborating on how they can be used in the U.S. environment. Focus on a wide range of tools and a wide range of application settings ranging from spot-specific deployments to synergistic large-scale ATM.
Moving toward a performance- or risk-based approach to design for ATM	ATM strategies need to be adapted to the U.S. environment focusing on the unique challenges faced by agencies in design, operations, maintenance and enforcement.	Specific focus is on how the ATM strategies used in Europe can be adapted to U.S. facilities including appropriate design, operations and maintenance, safety, and institutional considerations. A key aspect of the ATDM program involves the sharing of best practices and the development of guidance and technical support to help agencies evaluate and implement ATM in their regions.
Consideration of TDM strategies as part of traffic operations	Traditional TDM is well established in the U.S. In fact, some areas such as carpooling have a long and storied history in the U.S., more so than in Europe. However, traditional TDM approaches have focused on long-term behavior changes. Examples from Europe point to a more operational use of TDM to influence day-to-day travel behavior via incentives, partnerships and traveler information for a wider variety of applications.	The ATDM program in the U.S. supports the development and adoption of active or dynamic approaches to manage demand, especially for short-term travel behavior modifications. While traditional TDM will continue to play an important role, the ATDM program is focused on strategies that involve influencing travel choices in an active manner.

1.3 Implementation Approaches

As noted before, the tactics for ATDM can be classified into implementation categories like active demand management, active traffic management or active parking management. Typically, these represent the implementation bundles being considered by agencies as part of the ATDM framework. Several of these approaches have been successfully demonstrated in the United States.

1.3.1 *Active Demand Management*

Active demand management (ADM) works to influence travel behavior in real time and goes beyond traditional travel demand management (TDM) to use information and technology to dynamically manage demand including redistributing travel to less congested times of day or routes, or reducing overall vehicle trips by influencing a mode choice.

> ***Active demand management works to influence travel behavior in real time, going beyond traditional demand management to use information and technology to dynamically manage demand to different routes, modes, and/or times of day.***

ADM seeks to influence more fluid travel choices by users on a day to day or even hour to hour basis. Contrasting with traditional TDM, which seeks long-term behavior changes, ADM supports dynamic trip making behavior enabled by technology and connectivity of the modern age. It is supportive of other active measures by redistributing or reducing overall traffic levels during congested conditions, thus becoming an integral part of an overall management philosophy to actively manage a facility or system. (4)

ADM builds upon the success of traditional TDM programs by using new technologies to inform and influence travel choices, which are not limited to mode choice decisions. As with many TDM efforts, financial levers are important to ADM, either as incentives or disincentives (such as higher tolls for single-occupancy vehicle or peak period travel). Incentives can take various forms:

- Travel time savings (high-occupancy vehicle [HOV]/high-occupancy toll [HOT] lanes)
- Direct financial incentives for avoiding peak hour travel
- Gift certificates through points accumulated by offering rides with dynamic ridesharing vendors
- Shopping information or discounts to encourage changes in departure times during peak periods.

Information technology, especially with the connectivity and the social networking possibilities enabled by smartphones, is now being used to dynamically match en-route travelers with others needing a ride or providing comparative travel times for traffic and transit to induce an en-route mode or route shift after a trip as begun. Based on the results of early dynamic ridesharing pilot projects, program managers identified five critical success factors, which could be applied to many ADM strategies:

1. A critical mass of travelers within a defined area
2. An appropriate incentive program
3. Minimal complexity for the user
4. Demonstrated security and privacy
5. Stakeholder engagements involving highway operators, transit, employers, and businesses to help ensure that the different needs of these groups are addressed by the ADM applications.

The key to successful ADM projects is an integrated approach to offering a technically sound, user-friendly service, with incentives to make a different travel choice, as well as buy-in by key public and private stakeholders. The overall utilization and effectiveness of many of these approaches are still being tested. (4)

1.3.2 Active Traffic Management

Active traffic management (ATM) is the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions.

Active traffic management approaches seek to increase throughput and safety using integrated systems with new technology, including the automation of dynamic deployment to optimize performance quickly.

Focusing on trip reliability, it maximizes the effectiveness and efficiency of the facility. ATM approaches seek to increase throughput and safety using integrated systems with new technology, including the automation of dynamic deployment to optimize performance quickly and immediately when operators must deploy operational strategies manually. ATM includes dynamic routing, dynamic junction control, adaptive signal control, and transit signal priority. These approaches can be described as follows:

- **Adaptive ramp metering:** The deployment of traffic signal(s) on ramps to dynamically control the rate at which vehicles enter a freeway facility. This in essence smooths the flow of traffic onto the mainline, allowing efficient use of existing freeway capacity. Adaptive ramp metering utilizes traffic responsive or adaptive algorithms (as opposed to pre-timed or fixed time rates) that can optimize either local or system-wide conditions. Adaptive ramp metering can also utilize advanced metering technologies such as dynamic bottleneck identification, automated incident detection, and integration with adjacent arterial traffic signal operations. In an ATDM approach, real-time and anticipated traffic volumes on the freeway facility will be used to control the rate of vehicles entering the freeway facility. Based on the conditions, the ramp meter rates will be adjusted dynamically.

- **Adaptive traffic signal control:** The continuous monitoring of arterial traffic conditions and the queuing at intersections as well as the dynamic adjustment of the signal timing to optimize one or more operational objectives (such as minimize overall delays). Adaptive traffic signal control approaches typically monitor traffic flows upstream of signalized locations or segments with traffic signals, anticipating volumes and flow rates in advance of reaching the first signal, and then continuously adjusting timing parameters (e.g., phase length, offset, and cycle length) during each cycle to optimize operational objectives.
- **Dynamic junction control:** The dynamic allocation of lane access on mainline and ramp lanes in interchange areas where high traffic volumes are present and the relative demand on the mainline and ramps change throughout the day. For off-ramp locations, this may consist of assigning lanes dynamically either for through movements, shared through-exit movements, or exit-only movements. For on-ramp locations, this may involve a dynamic lane reduction on the mainline upstream of a high-volume entrance ramp, or might involve extended use of a shoulder lane as an acceleration lane for a two-lane entrance ramp that culminates in a lane drop. In an ATDM approach, the volumes on the mainline lanes and ramps are continuously monitored, and lane access is dynamically changed based on the real-time and anticipated conditions.
- **Dynamic lane reversal or contraflow lane reversal:** The reversal of lanes in order to dynamically allocate the capacity of congested roads, thereby allowing capacity to better match traffic demand throughout the day. In an ATDM approach, based on the real-time traffic conditions, the lane directionality is updated quickly and automatically in response to or in advance of anticipated traffic conditions.
- **Dynamic lane use control:** The dynamic closing or opening of individual traffic lanes as warranted and the providing of advance warning of the closure(s) (typically through dynamic lane control signs) in order to safely merge traffic into adjoining lanes. In an ATDM approach, as the network is continuously monitored, real-time incident and congestion data are used to control the lane use ahead of the lane closure(s) and dynamically manage the location to reduce rear-end and other secondary crashes.
- **Dynamic merge control:** Also known as dynamic late merge or dynamic early merge, this strategy consists of dynamically managing the entry of vehicles into merge areas with a series of advisory messages (e.g., displayed on a dynamic message sign [DMS] or lane control sign) approaching the merge point that prepare motorists for an upcoming merge and encouraging or directing a consistent merging behavior. Applied conditionally during congested (or near-congested) conditions, dynamic merge control can help create or maintain safe merging gaps and reduce shockwaves upstream of merge points. In an ATDM approach, conditions on the mainline lanes and ramps approaching merge areas are continuously monitored, and the dynamic merge system is activated dynamically based on real-time and anticipated congestion conditions.
- **Dynamic shoulder lanes:** The use of the shoulder as one or more travel lanes, known as hard shoulder running or temporary shoulder use, based on congestion levels during peak periods and in response to incidents or other conditions as warranted during non-peak periods. In contrast to a static time-of-day schedule for using a shoulder lane, an ATDM approach continuously monitors conditions and uses real-time and anticipated congestion

levels to determine the need for using a shoulder lane as a regular or special purpose travel lane (e.g., transit only).

- **Dynamic speed limits:** The adjustment of speed limits based on real-time traffic, roadway, and/or weather conditions. Dynamic speed limits can be either enforceable (regulatory) speed limits or recommended speed advisories, and they can be applied to an entire roadway segment or individual lanes. In an ATDM approach, real-time and anticipated traffic conditions are used to adjust the speed limits dynamically to meet an agency's goals/objectives for safety, mobility, or environmental impacts.
- **Queue warning:** The real-time display of warning messages (typically on DMS and possibly coupled with flashing lights) along a roadway to alert motorists that queues or significant slowdowns are ahead, thus reducing rear-end crashes and improving safety. In an ATDM approach, as the traffic conditions are monitored continuously, the warning messages are dynamic based on the location and severity of the queues and slowdowns.
- **Transit signal priority:** The management of traffic signals by using sensors or probe vehicle technology to detect when a bus nears a signal controlled intersection, turning the traffic signals to green sooner or extending the green phase, thereby allowing the bus to pass through more quickly. In an ATDM approach, current and predicted traffic congestion, multiagency bus schedule adherence information, and number of passengers affected may all be considered to determine conditionally if, where, and when transit signal priority may be applied.

The two fundamental concepts of ATM are active management of the capacity and direct interaction with drivers to encourage them to make tactical driving decisions (e.g., stopping, slowing down, and changing lanes). The idea is not to simply react to changing conditions but to anticipate them and actively manage the system prior to their occurrence. All agencies and entities operating transportation systems can advance toward a more active management philosophy by making changes that move operations along the active management continuum. This progression on the continuum represents a natural evolution in an agency's ability to provide and the public's acceptance of active management.

Agencies can realize numerous benefits with ATM. General operational benefits include:

- A decrease in primary incidents by alerting drivers to congested conditions and promoting more uniform speeds
- A decrease in secondary incidents by alerting drivers to the presence of queues or incidents and proactively managing traffic in and around incidents
- Increased throughput by reducing the delay associated with the number of primary and secondary incidents, reducing speed differential in traffic flow, and reducing the shockwave effects of excessive braking
- Increased overall capacity by adding shoulder use during congested periods when it is needed most

- Overall improvement in speed uniformity during congested periods
- Increased trip reliability by increasing capacity and throughput, reducing incident delay, and improving vehicle throughput

1.3.3 Active Parking Management

Active parking management is the dynamic management of parking facilities in a region to optimize performance and utilization of those facilities while influencing travel behavior at various stages along the trip-making process, i.e., from origin to destination. Dynamically managing parking can affect travel demand by influencing trip timing choices, mode choice, and parking facility choice at the end of the trip. This ATDM approach can also have a positive impact on localized traffic flow by providing real-time parking information to users and ensuring the availability of spaces to reduce circling around parking facilities. The overall goal is to help maximize the nation's transportation infrastructure investments, reduce congestion, and improve safety. (5)

> ***Active parking management is the dynamic management of regional parking facilities to optimize performance and utilization while influencing travel behavior at various stages along the trip-making process.***

A fundamental component of active parking management is information. With clear, detailed, relevant, and real-time parking information, travelers can make informed decisions regarding their trip. The information a user needs to make parking-related decisions can be conveyed in numerous ways and in various formats. These include, but are not limited to, traditional static road signs, dynamic message signs, the Internet, cell phones, smartphones and similar mobile devices, and navigation systems. Agencies can harness the power of an enhanced technology infrastructure (wireless and wired communications, embedded sensors, etc.), combine it with the breadth of currently available technologies to convey information as well as to accept reservations and parking payments, monitor use, and conduct enforcement. These technologies can be applied to both on-street and off-street parking spaces to optimize use of all facilities in a region. (5)

Parking system operators also realize numerous benefits with active parking management. Agencies can reduce costs, improve efficiency, and increase parking utilization rates. By increasing the availability of limited parking spaces and optimizing the use of facilities at all times of the day, agencies can help reduce congestion in and around parking facilities, improve enforcement efficiency, foster public trust, and accommodate alternative payment methods. Active parking management also benefits a region as a whole by reducing pollution, encouraging the use of alternative modes, relieving congestion around commercial businesses, and helping improve access for emergency responders. In some cases, agencies can actually increase parking capacity within a limited footprint with innovative parking facility designs that stack vehicles and/or automate parking.

1.4 The Impact of Strategies on the Trip Chain

ATDM is intended to influence travel behavior throughout the entire trip chain, as shown in Figure 4. The process begins with the consideration of overall travel demand and moves through traffic demand and network demand. Through both traffic and travel demand management strategies, travelers can be provided choices across mode, destination, route, and time. By using the various ATDM approaches at each stage of the trip, agencies can work to influence behavior and the resulting demand on the system to optimize performance.

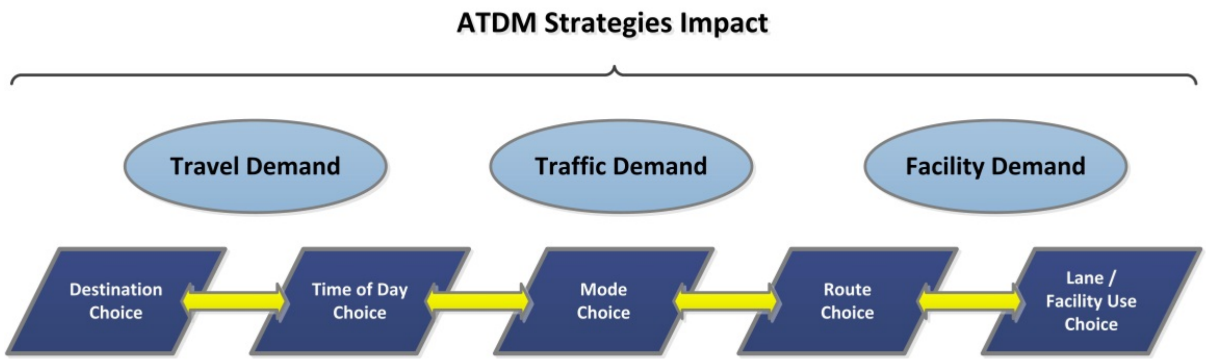


Figure 4. ATDM impact on the trip chain.

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2.0 ATDM Knowledge and Tech Transfer Workshop Highlights

Since its introduction into the United States, ATDM has garnered attention in many sectors of the transportation industry. To help promote the concept and develop programmatic direction, FHWA hosted several workshops across the country in 2011 and 2012. The following sections provide a summary of the primary questions generated by workshop attendees and lessons learned that were offered by those agencies that have implemented some aspect of ATDM. They also highlight the proceedings of those workshops, which were instrumental in the development of key tenets of the FHWA ATDM program.

2.1 Primary Questions and Lessons Learned

Through a series of outreach workshops across the country, transportation professionals learned about the concept of ATDM, had the opportunity to question early implementers about specific issues of concern, and discussed the lessons they learned along the way to implementation. The subsequent subsections highlight the themes from the following workshops:

- Active Transportation and Demand Management and Hard Shoulder Running Workshop, hosted by Delaware Valley Regional Planning Commission, May 2012
- Public Relations and Variable Speed Limit Workshop, hosted by Oregon Department of Transportation, May 2012
- Active Transportation and Demand Management Workshop, hosted by Intelligent Transportation System (ITS) Texas Chapter at the Houston Galveston Area Council, June 2012
- Active Transportation and Demand Management Workshop, hosted by ITS Nevada Chapter at the Freeway and Arterial System of Transportation (FAST) Building, June 2012
- Great Lakes Regional Transportation Operations Coalition Active Transportation and Demand Management Summit, hosted by Illinois Tollway Authority in coordination with Wisconsin Traffic Operations and Safety Lab, September 2012
- Active Transportation and Demand Management Workshop, hosted by California Department of Transportation (Caltrans) District 12 Transportation Management Center, November 2012.

2.1.1 Key Peer Questions Regarding ATDM

Peers across the country consistently challenged implementing agencies to answer questions regarding ATDM and their approach to implementation. These questions spanned the breadth of issues facing agencies and pointed to the recurring challenges agencies face when considering new approaches to managing congestion in their jurisdictions. Table 2 provides a summary of questions that emerged during the various outreach workshops. The planning questions addressed broader ATDM where some of the design and operations questions were focused on the traffic management side of ATDM. The questions are not presented in any particular order but are organized by primary topic.

Table 2. Key peer questions regarding ATDM.

Topic Area	Key Question
Planning	What approach is an implementing agency taking to include ATDM and the various strategies in the regional planning process?
	What regulatory obstacles did the agency face when trying to implement ATDM?
	Did temporary shoulder use require any reevaluation of sound laws/mitigation measures?
	How did the agency address any air quality issues regarding temporary shoulder use?
	Did the agency conduct any modeling prior to implementation?
	What performance measures is the agency using to determine success when implementing ATDM?
	What type of public outreach and education did the agency undertake with the implementation of ATDM?
Design of ATM systems	How did the agency select specific signage for the implementation for ATM?
	How did the agency handle striping of the shoulder lane?
	How did the agency design the facility to accommodate dynamic lane use control?
	How far apart did the agency space overhead signs for the installation? Has the agency experienced issues with visibility of those signs?
	Have there been any concerns with the presence of too many signs providing too much information in the corridor?
	Did temporary shoulder use present design issues with entrance and exit ramps?
Operations of ATM Systems	What agency is responsible for operations and maintenance?
	Did the agency have to hire additional staff to support operations?
	How is the implementing agency collecting data, what data are being collected, and for what purpose is that data being used?
	What is the benefit to deploying temporary shoulder use over having a permanent lane and using ATM to control usage?
	Is there a benefit to using the right vs. the left shoulder for temporary shoulder use?
	How is enforcement handled? What, if any, fines are associated with violations?
	What is the regional experience with compliance with the regulatory strategies, particularly during off-peak periods?
	How did the implementation of ATDM impact motorist service patrols in the corridor?
	What has been the experience with incident management when dynamic lane use control is operational?
	How did the agency procure the software to operate the system, and what does that software entail?

2.1.2 Key Lessons Learned

In response to the litany of questions, peer institutions with experience in implementing ATDM provided insight into lessons learned throughout the entire project development process. Table 3, Table 4, and Table 5 provide a concise inventory of lessons learned that can be beneficial to other agencies considering ATDM approaches for their region. The lessons are organized by topic (planning, design, and operations) and responding agency. Planning lessons learned are broader and pertain to all aspects of ATDM. Since a majority of the deployments that were discussed in the workshops pertained to ATM, design and operations lessons pertain more towards ATM systems. The deployments discussed in the various workshops included:

- Deployment of temporary shoulder lane use in the Boston, MA region
- Use of buses on shoulders in Chicago, IL
- Use of priced dynamic shoulder lanes on I-35W in Minneapolis, MN
- Use of variable speed limits in Missouri
- Deployment of variable speed limits in Oregon
- Evolution of shoulder use on I-66 in Virginia
- Use of ATM in Seattle, WA.

Table 3. Key ATDM planning lessons learned.

Agency	Planning Lesson(s) Learned
FHWA	**ATDM is about how technology is used in operations in a dynamic manner. Existing investments in ITS provide the foundation for active management.** It is important to conduct an inventory of existing assets, resources, and capabilities so an agency knows the state of its assets, what resources can be leveraged, and what capabilities can be expanded to implement ATDM. ATDM strategies need stakeholder buy-in, which should include identifying the need and vision to be accomplished by the strategy, developing a communication plan with a consistent and overarching message, identifying the location of stakeholders that interact with the transportation system, looking for opportunities to integrate systems with partners and the public, and conducting early and continual outreach to partners and the public.
Illinois	**Involve multiple stakeholders for ATDM.** The bus on shoulder project was a cooperative effort between Pace Transit, the Illinois Department of Transportation, the Regional Transportation Authority, and the Illinois State Police.
Massachusetts	**Consider evolutionary approaches starting with the easy options.** For example, no separate speed limits for shoulder use have been implemented, as it would require legislation to allow for variable speed limits, and some believe it would confuse drivers. Outreach consisted of a media campaign and working with the regional planning agencies to promote the temporary use of the shoulder as having the potential to save time and lives.
Minnesota	**It is important to be consistent with terminology and messaging and to determine that messaging early in the project.** Obtaining buy-in from decision-makers makes these projects easier to move forward. Stakeholder support from lawmakers is important to ensure success.
Missouri	Missouri Department of Transportation (MoDOT) found success by **focusing outreach on three key areas: expectations, enforcement, and media relations.**
Oregon	**It is important to take the time to educate law enforcement and other emergency responders, bring them into the conversation early, and have them accompany agency staff when meeting with the media.**
Virginia	For implementing variable speed limits on the Woodrow Wilson Bridge reconstruction effort, Virginia Department of Transportation (VDOT) **conducted targeted outreach to courts and judicial offices to obtain buy-in and enforcement support, though some judges were not comfortable enforcing some citations.** **Creating a good website with solid information, along with television, is effective to reach a wide audience**. **Ensuring a consistent and clear message is essential to gain support from elected officials.**
Washington	**It is essential to educate elected officials, the media, and the public on the project.** This education should be early, often, and consistent in its message. This outreach can help advocate specific projects and lay the groundwork for future projects and concepts. **When planning a project, plan ahead for software design and software/hardware test procedures throughout the life of the project.** Tweaks and continual adjustments will most likely be needed. **Carefully consider standard operating procedures.** Spend time thinking beyond normal situations to identify appropriate procedures before they are necessary in the field. **Take advantage of emerging opportunities due to reconstruction or other programs which can support active management.**

Table 4. Key design lessons learned for ATM Systems

Agency	Design Lesson(s) Learned
FHWA	**Currently, agencies interested in proceeding with dynamic lane use control will need to get a design exception to use the shoulder as a travel lane, which can be coordinated through the FHWA Division Office.** A request for experimental treatments is required if signing will be used that is not currently in the *Manual on Uniform Traffic Control Devices* (MUTCD). The decision to deploy dynamic lane use control on the right or left side of the facility is case dependent and requires specific analysis. At entrance and exit ramps, an agency can either make the shoulder lane an exit-only lane or allow vehicles to travel through the interchange on the shoulder. Drainage issues need to be assessed when considering dynamic lane use control involving the shoulder.
Minnesota	**The sign structures that support the intelligent lane control signals (ILCSs) were designed with maintenance of the system in mind. The structures are a catwalk design allowing crews access to the equipment mounted over the roadway, including the hinged ILCS.** Design considerations for emergency pull-offs included a goal to locate them every half mile and make them 14 ft wide and a minimum of 200 ft long.
Oregon	Oregon Department of Transportation (ODOT) **utilizes a battery backup to help offset power and telecommunications issues in a rural location.**
Virginia	The spacing of emergency refuge areas is not necessarily consistent, but the agency installed them wherever feasible. **A different color pavement is used to differentiate the shoulder from the general purpose lanes.**
Washington	**The agency has tried to limit the usage of static signs and is keeping to MUTCD guidance for DMS spacing where possible.** Washington State Department of Transportation (WSDOT) uses a three-gantry rule whereby successive speed changes are not more than 15 mph. Gantry spacing is half a mile. Initially, speeds were held constant across all lanes, but now the system allows for speed differentials to allow higher speeds in the adjacent HOV lane, up to a 15 mph speed differential. **Camera coverage is essential to successful operations.**

Table 5. Key operations lessons learned for ATM Systems

Agency	Operations Lesson(s) Learned
FHWA	**The benefits of dynamic lane use control may not be equal for both directions and both peak periods. It is recommended to review performance and modify the hours of operation as necessary to maximize the benefit for all directions and times.** There is a need to have at least two layers of performance measures, one for the agency's operational purposes and the other for the public to convey benefits.
Illinois	The bus on shoulder project has increased on-time performance from 68 percent to 92 percent and has increased ridership on impacted routes. **Initial safety concerns of both Illinois Department of Transportation and Illinois State Police have been diminished, as there have been no incidents with buses using the shoulder lanes.**
Massachusetts	A series of crash reviews found that approximately 20 percent of crashes occurred in or were a direct result of the temporary shoulder use, which was deemed acceptable. Without the strategy, congestion would be much more severe. **By allowing shoulder use, the agency has seen a reduction in incidents and an improvement in traffic flow, which helps offset the loss of the shoulder for emergency response.** Incident management plans were updated to reflect shoulder usage and new protocols. Response and lane control are coordinated. Extensive snow removal is deployed after significant snow events. For long-lasting storms, the temporary shoulder use is closed to accommodate snow storage.
Minnesota	**The availability of emergency pull-off areas beyond the shoulder can help facilitate incident management when dynamic lane use control is operational.** State police and freeway service patrol coordinate to ensure rapid incident response, and traffic management center (TMC) operators have the ability to close the shoulder if necessary. Deploying temporary shoulder use impacts snow storage and increases the amount of roadway an agency has to plow during snow events. Operations and maintenance are conducted in-house, and MnPASS (electronic toll collection) revenue does help offset some of the related costs. These operations involve full-time staff dedicated to the system. Off-peak violations are high, so the shoulder was kept open during the day but closed in the evening. **By allowing shoulder use, the agency has seen a reduction in incidents and an improvement in traffic flow, which helps offset the loss of the shoulder for emergency response.** Early results from the variable speed limits (advisory) show improvements in mobility, including throughput and minimum speed during congestion, as well as improvements in safety regarding speed differentials approaching congestion and reduced shockwave. Initially, the project included pavement lighting to mark when the priced dynamic shoulder lane (PDSL) was open or closed. After 2 years, the system failed as a result of the harsh climate, but early results showed no distinguishable difference in violation rates of the PDSL with or without the in-pavement lighting. It will not be replaced. Minnesota Department of Transportation (MnDOT) has full camera coverage of the shoulder lanes, so the agency is able to quickly spot debris and use the motorist

Table 5. Key operations lessons learned (Continued)

Agency	Operations Lesson(s) Learned
	safety patrol to clear any obstructions.
Missouri	**MoDOT initially deployed variable speed limits and then went to variable advisory speeds. When speeds are below 40 mi/h, the signs are blank since they cannot post anything lower on an interstate**. To determine if the system is operational, MoDOT's system has a built-in alarm system to alert operators if the system is not functioning properly.
Virginia	**Law enforcement has grown to accept the intermittent use of shoulders as a way to help ease congestion on the roadways. Local county courts are receptive to the enforcement efforts of law enforcement with respect to the illegal use of shoulders**. A quick clearance program for disabled or wrecked vehicles has helped reduce response time of wrecker service to incidents. Ensuring that emergency responders have the correct information to best select a route to the scene is critical. A safety impact study found no significant difference in crashes between when the shoulder lane is open and when it is closed.
Washington	When the system was initially activated, the data were unstable at lower speeds, resulting in frequent changes in posted speeds under stop-and-go conditions. This condition was not desirable and led to the use of 40 mi/h as the lowest speed, which was later lowered to 35 mi/h with a possible manual override of 30 mi/h. WSDOT was able to identify the cause of the instability and develop a solution, thereby bringing the posted speed limit closer in line with what motorists are experiencing. WSDOT believes that activating additional signs in advance of congestion, rather than leaving them blank, will give additional warning to travelers of upcoming conditions and begin the process of reducing speeds earlier. This change will result in the initial gantries posting 60 mi/h and warning of congestion ahead. Subsequent gantries will step the speed limit down to 30 or 35 mi/h, depending on conditions. WSDOT uses DMS signs that are located on the side of ATM gantries to post travel times. DMSs post both a distance to downtown and a travel time. One possible message could read as follows: "Downtown Seattle 9 miles; Downtown Seattle 20 minutes." This message can help drivers better understand the extent of the congestion in which they are driving and help them make informed decisions regarding route choice. Initially, the side-mount signs posted the message "Reduced Speed Zone." Changing this message to indicate travel time provides additional usable information that would change to reflect upcoming conditions while reinforcing the understanding that the system recognizes that drivers are in stop-and-go conditions. Data collection includes the use of loop detection for detector occupancy and an algorithm to convert the occupancy to speed. WSDOT originally looked at Bluetooth technology but did not find that it would provide sufficient coverage to serve this purpose. Compliance has been acceptable. Because of the gantry spacing, when drivers see one speed limit and then another reading the same speed within half a minute downstream, they seem to trust the system's display. **Think about maintenance procedures and staff and how staff will gain access to equipment, how much time they will need to be out in the field (reliability), and what preventive maintenance can be done.**

2.2 ATDM Peer Exchange Workshop Themes

FHWA hosted a peer exchange workshop in Seattle in June 2011 to gather information and direction from key thought leaders from around the United States based on their collective experience with innovative transportation solutions and ATDM in particular. The key message that emerged from this peer exchange was that transportation system management, operations, and partnerships can save money and time, provide quicker mobility solutions to their customers and constituents, expand travel options and choice, provide a better return on investment, and provide overall stability and reliability to the transportation system.

Transportation system management, operations, and partnerships can save money and time, provide quicker mobility solutions to customer and constituent problems, expand travel options and choice, provide a better return on investment, and provide overall stability and reliability to the transportation system.

2.2.1 Requirements

Thought leaders agreed that there is a vital need to optimize the existing system. Transportation departments in particular need to shift their institutional and organizational culture from one that focuses on construction and deployment of the transportation system to one that focuses on managing and operating it. This shift will require leadership of executive management, leadership of and collaboration with all transportation system partners, and significant outreach to customers. Furthermore, transportation departments will need to shift from an engineering focus to an operations and management focus when addressing their congestion challenges.

The urban setting is critical. The majority of mobility problems and challenges are in the cities and urban suburbs. The challenge lies in the fact that transportation departments and FHWA do not have responsibility for much of the urban infrastructure. Therefore, States need to foster partnerships with their cities, metropolitan planning organizations (MPOs), regional planning authorities, transit agencies, and other stakeholders as equal partners. Furthermore, they need to reach out to a broader and less traditional audience of partners that can be strong advocates for ATDM. These potential audiences might be elected community leaders; associations representing transit agencies, tolling agencies, and MPOs; the communications industry; high-tech firms; and other similar stakeholder groups.

ATDM requires that agencies increase their emphasis on the customer, who can directly benefit from ATDM.

2.2.2 A Customer Emphasis

ATDM requires that agencies increase their emphasis on customers, who will want to know how they can directly benefit from ATDM. Agencies need to understand that customers are more than highway users and that they need to be seen as allies and advocates for ATDM. Providing real-time, accurate communications can help gain allies. It is also important to demonstrate where an altered institutional approach regarding ATDM has worked and emphasize the success achieved. Another key approach is to show customers what they gain from ATDM rather than focus on how the agency benefits. The use of polls and focus groups can help agencies understand the public's perspectives and develop messages.

2.2.3 Technology's Role

> ***Technology is not a substitute for building or managing the transportation system. An agency does not need to be on the cutting edge to manage its system efficiently.***

It is important for agencies to recognize that technology is not a substitute for building or managing the transportation system. They need not be on the cutting edge to manage their system efficiently. The fact that technologies change so rapidly could result in the public sector chasing technologies instead of maximizing what they have. The goal of agencies needs to be to maintain and/or operate their equipment or capital assets to its fullest extent. Technology can enhance management and operations, but it is not a panacea or the end result.

2.2.4 The Federal Role Change

Thought leaders encouraged FHWA to lead the ATDM charge by example. The agency has established a modally integrated team composed of individuals in the United States Department of Transportation (USDOT) and in the regions who focus more on management and operations than on engineering. The intent would be to learn from transportation operators, the public, and the private sector on how to optimize the existing infrastructure. Other needs include rethinking laws that may be obstacles to ATDM, particularly regulations that are current barriers to managing and operating a transportation system. Other efforts that can help facilitate ATDM include providing incentives to encourage transportation departments, MPOs, and transit agencies to move from a project-focused State transportation improvement plan (STIP) and transportation improvement plan (TIP) to a STIP and TIP committed to managing and operating a transportation system beyond specific project investments. Agencies can also benefit from FHWA serving as a source of undisputed data quality.

2.3 ATDM Executive Session

FHWA hosted an executive peer exchange on ATDM in 2012 to further the discussion of ATDM at the executive level of transportation agencies. The purpose of the workshop was to provide FHWA with guidance and insight regarding how best to advance and adjust institutional culture and organizational strategies to include a more proactive approach to traffic management programs and identify the necessary organizational and cultural strategies within State, local, and regional transportation agencies to sustain these programs. The following sections highlight the themes that emerged from this executive peer exchange.

2.3.1 The Operations Story

Perhaps the most significant issue facing the transportation profession is that its future is very different from what was envisioned 50 years ago. Today, the focus is on making the system better and more efficient rather than building new infrastructure. This major organizational change is a result of numerous external pressures, particularly the emphasis on doing more with less. FHWA is putting a primary focus on improving operations to improve efficiency, manage resources, improve sustainability, and enhance cost-effectiveness, as well as on promoting a proactive approach. Proactive transportation system operations require data collection, monitoring, analytics, technology, integration, and planning/managing all of these factors.

FHWA is putting a primary focus on improving operations to improve efficiency, manage resources, improve sustainability, and enhance cost-effectiveness, as well as on promoting a proactive approach.

A need exists for government to make the shift from construction to operations, from being builders to becoming maintainers and operators. The challenge is that the transportation profession is primarily driven by civil engineering, whereas a primary avenue to successful and efficient operations is technology. It is difficult to keep pace with the rapid advancements in technology as well as identify a way to develop lifecycle costs for technologies. Technology requires changing institutional structures, developing new skills and capabilities for the workforce, and changing how the procurement process works.

Another challenge is looking at the transportation network from a holistic perspective. No longer can agencies focus only on the freeways. They must work cooperatively with other agencies to identify the best approach to managing the entire network, from the freeways to the surface street system to the other modes that share the network, and provide mobility solutions to travelers. Capitalizing on public and private partnerships and identifying champions can help build an environment that sees opportunities to meet the needs of the public with innovative solutions.

Agencies must work cooperatively to identify the best approach to managing the entire network and provide mobility solutions to travelers.

Policies and regulations also present challenges to the deployment of ATDM approaches. ATDM approaches push the boundaries of operations, partnerships, and opportunities. Ensuring that laws are flexible enough to accommodate them and the myriad ways they are planned, developed, financed, and implemented helps move the state of the practice forward.

Effective communications is also essential to implementing ATDM on a broad basis. If agencies cannot convince the public that innovative approaches can help solve their problems, then they cannot hope to gain the attention of policymakers and decision makers. Members of the public can be vital partners, advocates, and champions. Consistent messages from all levels of the organization help sell the concept, especially when they resonate with the greater population and target issues that are of global concern, such as health and safety. How a message is crafted can make or break a project and a program.

2.3.2 Advancing ATDM Strategies

In the past, State and Federal highway programs were traditionally centered on roadway and bridge infrastructure expansion and preservation. Today, programs are increasingly broad, including system reliability, safety, and performance. Current financial constraints require transportation departments to look for alternative delivery, operation, and management approaches, and ATDM can help agencies work within these constraints to meet the needs of the traveling public. While ATDM is a work in progress, many successes support the institutional shift to management and operations.

ATDM can help address safety and congestion, but it relies on performance and proactive management of demand: doing more with existing assets and technologies. ATDM relies on real-time information, technology, pricing, and policy to support the broad categories of ADM, ATM, and APM. For ATDM to be a success, agencies need to build upon current technology to ensure deployment-ready applications.

ATDM can help address safety and congestion, but it relies on performance and proactive management of demand: doing more with existing assets and technologies.

Numerous barriers impede full implementation of ATDM. Given that, agencies need to address the challenges of transferability, guidance, data, modeling, institutional barriers, and limited communications. For example, institutional barriers such as data acquisition and accuracy hamper the transfer of predictive travel times. Another example is that the general public may not see the value in variable speed limits since they may not reflect existing conditions. These issues emphasize the fact that messaging and perception may be the most difficult challenges to overcome. To that end, agencies need to be diligent in communicating the concept to the public so that they understand and buy into the approaches being implemented.

Knowledge and technology transfer (KTT) tools are valuable in helping emphasize transferability and encourage and foster the implementation of ATDM concepts. KTT can take many forms, including outreach, workshops, traveling road shows, lessons learned, best practices, and target messages for a variety of audiences. It is also important to utilize the best communication mediums to get the message out to the right audience.

2.3.3 Developing an Agency's Capability and Level of Maturity to Proactively Manage Its Transportation Systems

There is a need to institutionalize continuous improvement, which requires business processes, standardization, metrics, cultural acceptance, organizational development, and collaboration on a continual basis. The American Association of State Highway and Transportation Officials (AASHTO) currently has system operations and management guidance that offers a set of strategies to anticipate and manage traffic congestion and minimize the impacts of non-recurrent congestion on the system. (6) This guidance can serve as a starting point for developing a capability framework for ATDM. Such a framework can help ensure that ATDM becomes part of the vernacular and a natural consideration when facing the challenges of operating the system. Using this approach can help encourage the deployment of technology and see it as a key facilitating component of the solution. Furthermore, the framework can help agencies determine where they are on the ATDM continuum, where they want to be, and how they get there.

There is a need to institutionalize continuous improvement, which requires business processes, standardization, metrics, cultural acceptance, organizational development, and collaboration on a continual basis.

3.0 Moving from Idea to Implementation

When deploying ATDM, certain elements are beneficial to help ensure success. To that end, early adopters of ATDM in the United States provided insight into prerequisites for implementation, the project development process, resources to sustain the concept, and benefits they have seen as a result of ATDM. Specific enquiries focused on the following:

- What were some important attributes that allowed buy-in for the concept?
- What procedures were used for project planning, development, design, and procurement? What are some lessons and success factors?
- Who are your key internal and external stakeholders?
- How have you approached the planning of your project? Which agencies and partners have been parts of that process?
- What were the goals and objectives of the implementation?
- Do you feel that those objectives have been met?
- What do you see as the primary external public benefits (e.g., to the traveling public or broader society) of the implementation? Were these benefits expected or unexpected?
- What do you see as the primary internal agency benefits (e.g., more effective at your jobs, cost efficiencies, improved agency perception/reputation, improved worker safety)?
- What do you see as the primary internal agency costs/dis-benefits (e.g., higher maintenance and operations costs, more staff required, degraded agency perception/reputation)?
- What measures of effectiveness did you use/do you plan to use to assess the success of the implementation?
- How have you approached securing the funding of your implementation?

This chapter provides a summary of the viewpoints of early adopters regarding these issues. The following projects are summarized:

- *Minnesota: I-35W ATM project in Minneapolis* – This project, as shown in Figure 5, involved the opening of an HOT lane segment in the Crosstown Commons section of I-35W South between Highway 13 and downtown Minneapolis, which provided a 16-mi HOT lane in the northbound direction and a 14-mi HOT lane in the southbound direction. The installation included the creation of a PDSL and the display of advisory speed limits in the corridor (ATM). (7)

Source: MnDOT

Figure 5. Minnesota: priced dynamic shoulder lane on I-35.

- *Washington: I-5, SR-520, and I-90 ATM deployments in Seattle* – The project featured the installation of ATM on I-5, SR-520, and I-90 in Seattle. As shown in Figure 6**,** the installation included lane control, DMS, and enforceable speed limit signage to alert drivers of delays and to direct drivers out of incident-blocked lanes. (8) The installations on SR-520 and I-90 were part of the FHWA Urban Partnership Agreement (UPA) project.

Source: Texas A&M Transportation Institute

Figure 6. Washington: ATM on I-5.

- *California: Junction Control on the Northbound SR-110 Connector to Northbound I-5 in Los Angeles* – The project involved the installation of time-of-day junction control in the northbound connector from SR-110 to northbound I-5 in Los Angeles. The project, implemented by Caltrans and shown in Figure 7, was intended to improve safety and mobility on the connector and to eliminate the occurrence of drivers traveling on the shoulder of the connector during peak periods.

Source: Caltrans

Figure 7. California: junction control on northbound SR-110.

- *California: SFpark* – SF*park* is a demand-based parking pricing system deployed in downtown San Francisco with the intent to reduce traffic congestion related to parking. Using ITS technologies such as parking occupancy sensors, networked parking meters, and real-time parking information, parking prices are modified based on demand to optimize occupancy. (9)
- *Georgia: HOT Lanes on I-85 in Atlanta* – The Atlanta project involved the conversion of existing HOV lanes on I-85 into dynamically priced HOT lanes called express lanes. The project is located on a 16-mi portion of northeast I-85 from Chamblee Tuck Road to Old Peachtree Road. (10)

3.1 Keys Attributes for Success

Numerous factors have played into the success of the ATDM projects across the country. For instance, Minnesota credits strong partnerships and a multiagency organizational structure—with strong support from agency leaders—as helping the project from the outset. Partner agencies capitalized on strong working relationships to successfully implement and operate the project. The project's diverse partners included MnDOT; the Twin Cities Metropolitan Council; Metro Transit; the City of Minneapolis; Minnesota Valley Transit Authority; Anoka, Dakota, Ramsey, and Hennepin counties; the Center for Transportation Studies; the Hubert H. Humphrey School of Public Affairs at the University of Minnesota; and the transportation management organizations in the area.

With the UPA installation in Washington, leaders in the partner agencies (WSDOT, King County, Washington State Patrol, Puget Sound Regional Council, University of Washington, Washington State House and Washington State Senate, and Washington Transportation Commission) saw the need for the project in the beginning and were willing to pursue it in the political arena to ensure that it met the requirements for FHWA UPA funding. This need was supported by the preexisting regional strategies targeting mobility and effective investment in strategic capacity, operating existing assets more efficiently, and managing demand. (8) Strong partnerships and regular communication were the foundation of the project and helped ensure that the ATM projects and their related implementations met with success as well.

In Los Angeles, internal teamwork helped ensure the success of the project, with one group concentrating on the safety aspects and another concentrating on the mobility and operations aspects. The selling point for the project that garnered buy-in was the fact that the project would address a major crash problem at the interchange of the northbound SR-110 connector to northbound I-5. The interchange, which is a left-hand exit onto northbound I-5, is one where demand exceeds capacity. Problems were arising with drivers jumping the queue on the connector by using the shoulder to form a second lane at the split. Caltrans realized that the need for the additional capacity was only during the peak period. Thus, staff decided to formally open the second lane going into the connector during the peak period. Any major reconstruction of the connector was not feasible

Relationships, partnerships, teamwork, and continual outreach are key attributes for success.

given the geography of the interchange and the inability to realign the ramp. The project was justified given that its intent was to improve safety and mobility at the interchange, recognizing that they go hand in hand.

Intra-agency coordination helped move the SF*park* project forward, and the UPA project provided the region with the opportunity to advance the congestion pricing discussion. (9) The challenges with the project lay in the fact that the project scope shifted, modifying the roles and responsibilities of the partners and increasing tensions related to project ownership and authority. USDOT was asked to increase its coordinating role to help overcome some of these challenges as the partner agencies felt isolated. Furthermore, the overall challenges with inter-agency coordination limited joint outreach efforts. Despite these challenges, the San Francisco County Transportation Authority (SFCTA) and the San Francisco Municipal Transportation Agency (SFMTA) saw this project as a new way of doing business and increased their ability to work internally to coordinate activities. (9) The Metropolitan Transportation Commission (MTC) valued the project and thus allowed it to deliver enhancements to the 511 program, with the UPA project closing a funding gap.

Preexisting relationships among the partners in Georgia helped facilitate the HOT lane project, and clearly defined roles and responsibilities ensured continual cooperation. (10) A shared commitment for the project also helped maintain the strong partnerships among the various partners: the Georgia Department of Transportation (GDOT), Georgia Regional Transportation Authority, State Road and Tollway Authority, Atlanta Regional Commission, Georgia Department of Public Safety, Metropolitan Atlanta Rapid Transit Authority, Gwinnett County Government, Clean Air Campaign, and Georgia Institute of Technology. The past successful working relationships between these partners helped spell success for the project. The project presented an opportunity to implement a strategy to reduce congestion using pricing, which was new to the region. All of the partners agreed on the selected facility and the fact that it offered an excellent opportunity to move forward to reduce congestion in the absence of the funds to increase capacity. Stakeholders also concurred that the hands-on role of USDOT helped keep the project moving forward, and strong support from elected officials was invaluable as well. (10)

3.2 Goals and Objectives of Implementation

The first and perhaps most critical step in moving forward with an ATDM project is the establishment of project goals and objectives. Without these components, agencies will struggle with communicating the concept to stakeholders and partners and will not have a benchmark against which the project can be measured. Those agencies that have implemented ATDM strategies clearly established goals and objectives early in the project development. For example, the Minnesota UPA projects, of which ATM was a component, focused on reducing traffic congestion on the I-35W corridor and in downtown Minneapolis. Twenty-four multimodal projects were planned and implemented in tandem to facilitate this goal, including the PDSL intended to increase HOT lane usage in the region via connectivity to downtown.

The goal of the ATM project on I-5 was to improve operations and reduce crashes. The overall goal of the Seattle UPA projects, which included ATM implementation, was to reduce traffic congestion along the Lake Washington Corridor. Another example is that the primary goals for the Los Angeles project were to improve safety and mobility on the connector. The goal of the

SF*park* project was to reduce traffic congestion related to parking in downtown San Francisco. The objectives were to increase parking availability, reduce the number and duration of vehicle trips, and reduce double parking. (9)

The goal of the Atlanta Congestion Reduction Demonstration (CRD) project was to reduce traffic congestion in the I-85 corridor, primarily by introducing congestion pricing on the facility by converting the HOV lane to a HOT lane. By enhancing transit availability and facilities in the corridor, it was anticipated that congestion would decrease on I-85 in the project section and reliability would improve. In each of these instances, the implementing agency had clear, concise, and measurable goals and objectives that resonated with stakeholders and the public at large. This approach helps ensure that agencies focus on a consistent message that carries through the entire project and works in tandem with regional transportation goals.

3.3 Measures of Effectiveness and Benefits

Once an agency establishes goals and objectives for a project, the companion step is for the agency to select appropriate measures of effectiveness (MOEs) to determine if the project meets those goals and objectives. The selection of MOEs also drives the data that an agency must collect to calculate the MOEs and the equipment that must be installed to gather such data. Furthermore, the MOEs help an agency communicate with stakeholders and the public regarding the project and its realized benefits.

Measures of effectiveness help an agency determine success in meeting project goals and objectives.

Specific MOEs for the MnDOT project include volumes in the HOT lanes and the number of vehicles violating the occupancy requirements. Evaluation results indicate that use of the HOT lanes and PDSL by MnPASS users has increased since opening, and that MnPASS users have resulted in increased vehicle volumes in the HOT lanes. At the same time, significant numbers of carpools, vanpools, and buses use the HOT lanes at no cost during the morning peak hours. (7) The number of vehicles violating the occupancy requirements has declined over time. From the perspective of transit, the new and expanded park-and-ride lots have helped to increase usage, and bus ridership on routes serving the I-35W South park-and-ride lots has increased by 13 percent. Increased operating speeds for transit in the downtown area have been reported as well as increased operating speeds and reduced travel times in the HOT lanes. From an agency perspective, the partners see the project as a testament to the strong working relationships that are normal for the community and illustrate that they can successfully work through a complex project with diligence, communication, and collaboration.

The measures of effectiveness identified for the Washington UPA project include travel time and travel speeds, travel time reliability and variability, spatial and temporal extent of congestion, vehicle and person throughput, and user perception of congestion on facilities crossing Lake Washington. (8) Early analyses of the project indicate that average daily traffic volumes have decreased in the SR-520 corridor and reliability has improved in terms of median travel times and the 95th percentile travel time on SR-520. Median travel speeds have also increased. The ATM project on I-5 was intended to improve mobility in the corridor and help reduce crashes on the congested facility. Early findings have indicated that travel reliability has improved. Anecdotally, the ATM system was beneficial during a major closure of the Alaskan Way Viaduct as part of a reconstruction project. It has also improved merging at congested on-ramps in the downtown area. Overall, the traveling public has accepted the ATM signage, but some confusion remains regarding how to interpret the displayed variable speed limits when they are higher than actual travel speeds. (8)

The primary MOEs for the Los Angeles project are safety (crash rates) and delay on the connector (minutes). The primary benefits to the public have been an increase in safety and mobility on the connector. The SR-110 connector project has helped staff look beyond traditional solutions to address unique problems. Their hope is that it encourages more innovative thinking and risk-taking in the region in terms of trying a new approach. A project like this encourages others to pursue their own ideas of what they can do in terms of innovative solutions and look at different ways they can do their job.

SF*park* has a primary MOE of parking occupancy. This measure is the percent of time that a parking space is occupied by vehicles. Preliminary analyses conducted as part of the UPA evaluation suggest that pricing appears to be shifting parking to blocks experiencing a price decrease, but the magnitude of that impact seems to be site specific. (9) Another trend seen is that the shift appears to be somewhat larger in parking areas served by large employment centers rather than area wide.

The MOEs for GDOT's Express Lanes are travel time and travel speeds, travel time reliability, vehicle throughput, and user perception of congestion on I-85. Preliminary results from the UPA evaluation indicate that express lanes have been successful, though more definitive results are yet to come. To date, volume on the express lanes is growing, and lane performance has either improved or not degraded compared to when the facility operated as an HOV lane. (10) The related transit improvements also appear to have helped make the project a success. Transit service performance has improved since the opening of the I-85 express lanes. Park-and-ride lot use has increased in three of the four lots for which data are available, and average weekday ridership for bus routes that use the express lanes has increased in the peak periods since the opening of the facilities. (10)

3.4 Project Dis-benefits

ATDM projects may have some unforeseen impacts or dis-benefits that require agencies to modify operations, consider different approaches for current or future applications, or implement mitigation strategies. Learning how other agencies have handled unanticipated challenges and dis-benefits can help agencies considering similar ATDM applications. Agencies can use past experience to identify methods to overcome potential drawbacks prior to implementation and to establish policies and procedures to mitigate future challenges.

ATDM projects may have some unforeseen impacts or disbenefits that require agencies to modify operations, consider different approaches for current or future applications, or implement mitigation strategies.

The speed harmonization that sets variable advisory speed limits (implemented in Minnesota) often results in lower speed limits being posted than might ordinarily operate on the corridor. These lower speed limits result in slower speeds and longer travel times on I-35W South. This result conflicts with those expected from the other improvements in the corridor, which are intended to increase speeds and reduce travel times. (7) It is likely that these operational improvements may result in improved trip-time reliability and increased throughput, though the complex implementation of the diverse improvements in the corridor make it impossible to fully assess the impacts of these individual competing strategies.

Operational support for the ATM systems in Washington has most likely had the largest impact on WSDOT. As a result of implementing ATM, 3.5 full-time employees were added to the regional traffic management center, and operations migrated to 24/7 operations. The number of electronic signs increased from 60 to 300, which increased the agency's maintenance budget and responsibilities. WSDOT has made efforts to secure dedicated funds for maintenance of the ATM system to ensure that operations do not suffer over the long term.

The largest dis-benefit from the Los Angeles project is maintenance. The topography and physical attributes of the corridor make the system a challenge to maintain, and staff members are hesitant to make maintenance calls for the implementation, especially for anything that requires a lane closure. The in-pavement lighting and dynamic message signs are also a maintenance challenge. Operations personnel have worked diligently to meet with maintenance personnel to work out these issues, and they believe that many of the issues have been mitigated. The nature of the project means that the agency has devices that they have not used before in this application, which presents a challenge and is maintenance-intensive. A good lesson learned is that if the agency plans to deploy this in the future, maintenance input will be valuable from the beginning.

Another challenge of the Los Angeles project has been the fact that operations personnel were not familiar with overseeing the operation of such a unique deployment, so they may not have had the necessary skills to be as efficient as possible. Engineers and TMC staff are responsible for overseeing operations and assessing how the project has impacted mobility, travel time, speeds, delay, etc. This type of project requires analyzing data and operations differently, and staff may not necessarily have the skills or expertise to be able to say how it should operate.

The most significant challenge associated with the SF*park* project was the organizational tensions between the partners. The project shifted focus away from a major road pricing and reconstruction project to a demand-based parking project. This shift meant a shift in the UPA lead agency from SFCTA to SFMTA, which in turn affected the partnership collaboration, as SFMTA had the sole authority to plan, implement, and deliver the project since it was based on parking pricing.

The primary drawback for the I-85 express lanes in Georgia to date has been the fact that the formation of 3+ carpools continues to be a challenge. Preliminary results of the evaluation also indicate that the effects on the general purpose lanes may be mixed. (10)

3.5 Securing Funding

Funding for ATDM, as with all other transportation projects, can be a challenge. Experience has shown that agencies are successful at securing funding for ATDM when it is part of a larger, more comprehensive project that may already be in the planning stages. Leveraging resources with partnering agencies has also proved fruitful.

The Minnesota ATM and PDSL projects were part of the larger UPA project funded by the USDOT. The significant amount of Federal funding available through the UPA was a key mechanism for bringing the myriad of agencies and partners together in the initial application. The mix of funding and the flexibility in applying the funds were also important factors in the deployment process. (7) Specifically, non-Federal funding was used to pay for a Results Only Work Environment pilot program to increase teleworking and flexible work schedules in the I-35W corridor and to construct a southbound auxiliary lane on I-35W from 106th street to TH-13. (11)

Leveraging resources with partners and incorporating ATDM in larger projects has helped agencies secure funding.

The I-5 ATM project in Seattle was funded as part of a larger project, the SR-99 Alaskan Way Viaduct Replacement project. Funding for that project originated from a variety of sources, including gas taxes, State transportation funds, traditional Federal funds, local funds, toll revenues, and the Port of Seattle. Federal grant funding was secured for the UPA program. This included $43.7 million for the technology (ATM) portion of the program. (12)

Since the deployment of the Los Angeles project had a safety focus, Caltrans secured safety funding for the implementation. The crash rate was six to eight times what would be expected on a typical connector. Thus, Caltrans requested funds from the State Highway Operation and

Protection Program for the project, demonstrating that the agency was using technology to solve a safety problem.

SF*park* was funded through the USDOT UPA program. The funds aided MTC in closing a gap in its resources to implement 511 upgrades to enhance traveler information in the region. The project served as a mechanism to pilot congestion pricing in the region as well.

As with many of the other deployments, the Atlanta CRD was funded through the FHWA UPA program. The funds facilitated the introduction of congestion pricing in the region and also offered the opportunity to upgrade transit service on the congested I-85 corridor. The funds were also instrumental in implementing the new technologies necessary to make the project viable.

3.6 Improvements for Future Deployments

To promote the deployment of ATDM approaches on a broad basis, agencies are encouraged to include them in their long-range planning process and to consider specific implementations as they move forward with management and operations of their networks. Specific issues related to future deployments and planning for ATDM include but are not limited to anticipating future ATDM deployments and operational approaches, incorporating ATDM in a region's congestion management process, and considering features in future facilities that might accommodate ATDM.

ATM was recently included in the MnDOT Metro District Highway Investment Plan 2011–2030. (13) Specifically, the plan outlines a new investment strategy that recognizes that while congestion will not be eliminated within current fiscal constraints, its impacts can and must be mitigated to the fullest extent possible in order to preserve mobility levels essential to the region's economic vitality and quality of life. To that end, the plan recommends that ATM applications be implemented system wide to smooth the effects of congestion and reduce the number of incidents. Specific ATM approaches noted in the plan include traveler information systems, incident response programs, dynamic signing and rerouting, dynamic shoulder lanes, hard shoulder running, speed harmonization, and queue warning. (13) The plan notes that comprehensive ATM implementation can be more effective when combined with other corridor-wide improvements, such as the construction of a new managed lane. However, it recognizes that more limited ATM strategies can be implemented in an effective manner, on a case-by-case basis, to improve freeway and non-freeway highways.

To promote the deployment of ATDM approaches on a broad basis, agencies are encouraged to include them in their long-range planning process and to consider specific implementations as they move forward with management and operation of their networks.

WSDOT assessed the feasibility of ATM strategies in the Seattle region in 2008. The agency used the results to incorporate ATM into the regional ITS architecture and develop a concept of operations, which helped move the concept into implementation. WSDOT has adopted a policy, titled Moving Washington, which emphasizes the investment of resources in an integrated manner to operate the network more efficiently, to manage demand, and to strategically add capacity. (14) ATM has become part of that dialogue and is being considered in other corridors that are in need of attention. Moving forward, WSDOT has identified specific issues that can be considered to facilitate implementation. First, it is important to coordinate early with FHWA on sign messages, given that there are few accepted standards for MUTCD messaging. ATM messaging is the key mechanism for communicating with the traveling public, and working with FHWA is a key to success in that arena. Second, projects can benefit from the development of standard operating procedures. Partner agencies should spend time thinking beyond the normal situations to ensure that plans are in place when an unusual event occurs. They should also plan ahead to work through testing procedures prior to deployment to ensure that issues are addressed. Finally, education is essential—early, often, and continual. Agencies should take advantage of all media platforms to ensure that their messages are delivered to the right audience throughout the life of the project.

To date, ATDM is not the long-range planning process in the Los Angeles region. Momentum exists to move the concept into planning for the future in the region. The LA Metro (Los Angeles Regional Transportation Authority) highway program is taking a greater interest in operations and maintenance of the State highway and freeway system and getting more engaged in ITS. They are working with other regional and sub-regional agencies to look at deploying ITS-type projects on freeways, and while ATDM is not necessarily mentioned as a program, it is likely that some of the concepts will get into the regional planning process. While ATDM has not been branded as such in the region, agencies have been deploying approaches. Currently, ATDM is not identified as a strategy in the congestion management process (CMP).

Caltrans is likely to consider a variety of approaches and is working to secure funding to conduct a feasibility study and a preliminary concept of operations for ATM strategies in the district. This study is intended to be the first step, with the hopes that it could lead to implementation. Caltrans is not sure of the right strategies or where they should be implemented, so hopefully the study can help with that issue. The agency wants ATM as something to consider. It is being discussed from a planning perspective, though many issues make staff apprehensive, including the fact that many approaches can be very expensive. Caltrans is looking for criteria to use to determine what applications would be appropriate. The extra lane at the junction currently operates over a fixed time: from 3:00 to 7:00 p.m. Monday through Friday. Caltrans is considering moving to dynamic operations and connection of the application to the TMC.

As with the Los Angeles region, ATDM is not currently part of San Francisco's long-range planning process. The SF*park* project has provided a starting point to consider, including similar approaches into planning for the future in the region. Currently, ATDM is not in the CMP for the region either. However, SFCTA continues to pursue congestion pricing initiatives for the city, which indicates that the region sees the value of road pricing to mitigate congestion.

To date, ATDM approaches are not in the GDOT long-range planning process or CMP for the region. However, the success of the CRD may help bolster the consideration of other ATDM approaches if the public reaction is positive. The strong support received from elected officials shows promise moving forward. Also, the area will vote on an increase in the local sales tax next year to address the need for operating funds for the CRD. Should this initiative be passed by the voters, it could indicate that ATDM is seen as a viable congestion-reduction approach for the region. If the Atlanta CRD proves successful and viable with the public, it may serve as a precedent for considering other innovative approaches to managing congestion. GDOT is already working to implement variable speed limits on I-285 as an additional measure to address congestion in the region. (15)

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4.0 Discussion

In response to the growing pressure for agencies to do more with less and address congestion challenges from all aspects of the network, the Federal Highway Administration (FHWA) is working to promote a dynamic approach to manage the transportation network. The approach seeks to optimize performance and increase efficiency throughout the entire trip chain as seen from the traveler's perspective. Termed Active Transportation and Demand Management (ATDM), the program advances the ability to manage, control, and influence travel demand, traffic demand, and traffic flow of transportation facilities.

The program builds off the existing investments that state and local agencies have made in transportation systems management and operations. Investments on our transportation facilities are wide-ranging and include monitoring systems (detectors), communication backbones, advisory systems (message signs, highway advisory radios), field personnel and vehicles (safety service patrols), centers (traffic management centers), public information portals (websites, 511), control systems (traffic signal systems, ramp meters, road/lane closure systems), and operational information exchanges (Computer Aided Dispatch [CAD] integration, data warehousing). Leveraging these investments to realize a greater degree of real-time, dynamic management and operational capability is the primary goal of the program.

Active management is a tactical approach to operating systems, programs, and technologies differently; focusing on applying more "hands on" and dynamic approaches through real-time and predictive analyses. ATDM creates an environment where the occurrence and effects of problems can be reduced.

ATDM builds upon existing capabilities, assets, and programs and enables agencies to leverage existing investments — creating a more efficient and effective system and extending the service life of existing capital investments. All agencies and entities operating transportation systems can advance toward a more active management philosophy. This report documents the lessons learned and critical issues related to the deployment of ATDM across the country to date. It is the intent of this document to help other agencies across the country learn from their predecessors' experiences and work to move ATDM forward in their communities in the most appropriate ways to meet their regional goals and objectives and enhance mobility and the quality of life for the American traveler.

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U.S Department of Transportation
Federal Highway Administration
Office of Operations
1200 New Jersey Avenue, SE
Washington, DC 20590

Office of Operations Web Site
http://www.ops.fhwa.dot.gov

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