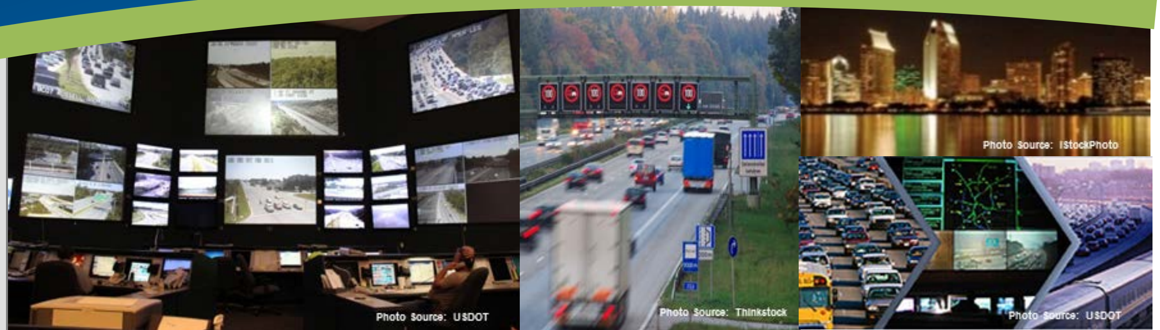
Integrated Corridor Management (ICM)

ITS Benefits, Costs, and Lessons Learned: 2014 Update Report

U.S. Department of Transportation



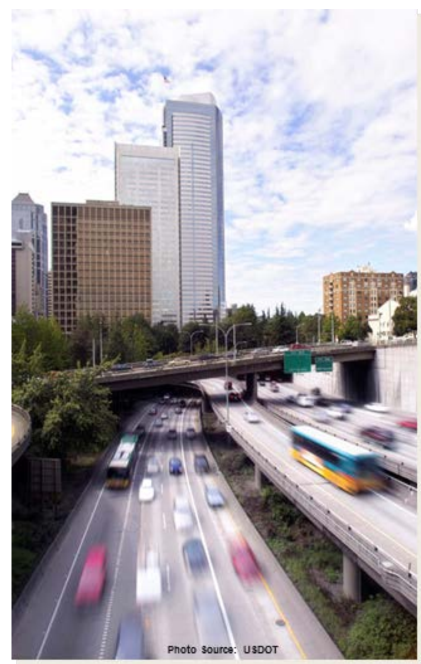
Highlights

- Decision Support System scenarios modeled on the ICM Corridor in Dallas Texas show travel time savings of 9 percent on arterials when vehicles divert from the freeway.
- Planning-level studies indicate that an effective combination of ICM strategies can be implemented for $7.5 million per year (annualized capital and O&M).

Introduction

This factsheet is based on past evaluation data contained in the ITS Knowledge Resources database at: www.itskrs.its.dot.gov. The database is maintained by the U.S. DOT's ITS JPO Evaluation Program to support informed decision making regarding ITS investments by tracking the effectiveness of deployed ITS. The factsheet presents benefits, costs and lessons learned from past evaluations of ITS projects.

As ITS technologies continue to evolve, new strategies for operating our roadways continue to be researched and deployed. By focusing on ITS strategies that include freeways, arterials, transit, and transportation management centers, agencies can look beyond individual networks and explore regional corridors that may offer an opportunity to operate and optimize the entire system. The U.S. DOT has introduced the concept of Integrated Corridor Management (ICM), the purpose of which is to demonstrate that ITS technologies can be used to efficiently and proactively manage the movement of people and goods in major transportation corridors by facilitating integration of the management of all networks in a corridor. The results of the initiative will help to facilitate widespread use of ICM tools and strategies to improve mobility through integrated management of transportation assets. The ICM initiative will also demonstrate how proven and emerging ITS technologies can be used to coordinate the operations between separate corridor networks (including both transit and roadway facilities) to increase the effective use of the total transportation capacity of the corridor. ICM Deployment demonstrations in Dallas and San Diego have been implemented and evaluations are currently ongoing. Additional information on this initiative is available at the ITS JPO's Web site: www.its.dot.gov/icms.



ICM is defined as a collection of operational strategies and advanced technologies that allow transportation subsystems, managed by one or more transportation agencies, to operate in a coordinated and integrated manner [1]. With ICM, transportation professionals can manage the transportation corridor as a multimodal system rather than a fragmented network of individual assets.

Using a wide variety of operating scenarios, operating agencies can manage demand and capacity across multiple travel modes in real-time to improve mobility, reduce fuel consumption and emissions, and increase travel time reliability and predictability. Initial guidance and lessons learned have been made available on the ICM Website.

ICM Implementation Guide and Lessons Learned
ICM Analysis, Modeling and Simulation (AMS) Guide

Benefits

Transportation researchers have used Analysis, Modeling, and Simulation (AMS) methodologies to estimate the impacts of proposed ICM solutions. Projected benefit-cost ratios range from 10:1 to 25:1 over a 10 year period.

Table 1: Benefits of ICM.

Evaluation Measures	San Diego (2011-00736)	Dallas (2011-00757)	Minneapolis (2012-00804)	San Francisco (2009-00614)
Annual Travel Time Savings (Person-Hours)	246,000	740,000	132,000	1.2 million to 4.6 million
Improvement in Travel Time Reliability	10.6%	3%	4.4%	-
Gallons of Fuel Saved Annually	323,000	981,000	17,600	3.1 million to 4.6 million
Tons of Mobile Emissions Saved Annually	3,100	9,400	175	20,400 to 20,800
10-Year Net Benefit*	$104 million	$264 million	$82 million	$570 million
10-Year Cost	$12 million	$14 million	$4 million	$75 million
Benefit-Cost Ratio	10:1	20:1	22:1	7:1 to 25:1

*The values of safety benefits were not included in the San Diego, Dallas, and Minneapolis estimates.

Costs

While the 10 year project cost estimate for a corridor-wide ICM solution can range from $4 million to $75 million, the cost of a traditional improvement such as lengthening commuter trains, expanding bus rapid transit (BRT), or building a new highway lane can be much higher ranging from $400 million to $1 billion over the same period [2]. ICM solutions are a better value over time compared to traditional improvements [3]. Cost estimates for ICM implementation are represented in Table 2.

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Table 2: Cost Estimates for ICM Implementations.

Planned ICM Deployments	Estimated Costs
ICM Strategies deployed on U.S. 75 in Dallas, Texas (2011-00236)	$13.6 million with annualized costs of $1.62 million per year for 10 years.
ICM strategies implemented on the I-15 Corridor in San Diego, California (2011-00219)	$12 million with annualized costs of $1.42 million per year for 10 years.
ICM Strategies deployed in Minneapolis, Minnesota (2012-00270)	$3.96 million
ICM Strategies deployed on the I-880 Corridor in San Francisco, California (2009-00194)	$7.5 Million Average Annual Capital and O&M Costs

Consistent with the ITS National Architecture cost estimates can be derived from ITS costs data housed in the U.S. DOT ITS Knowledge Resources. Table 3 provides an example of a planning-level cost estimate developed for the I-880 corridor. Additional data sets are available in the ITS Costs Database.

Table 3: Combined ICM Strategies, I-880 Corridor Estimate (2009-00194).

ICM System Components (2008)	Life (Years)	Capital Cost	Annual O&M Cost	Annualized Lifecycle Costs	Amount	Total Annual Cost
Common Infrastructure						
Basic TMC and Facilities				$633,333		$633,333
TMC Hardware and Software for Surveillance	20	$150,000	$7,500	$15,000		$15,000
Loop Detectors Double Set (each 0.5 mile)				$3,350	120	$402,000
Systems Integration	5-20	$1,435,000	$14,000	$155,750		$155,750
Communications						
DS3 Communications (Surveillance)	20			$2,700	120	$324,000
DS3 Communications (Transit and Traveler Info)	20	$8,000	$96,000	$96,400		$96,400
DS1 Communications (ETC and Signals)	20	$750	$6,000	$6,638	280	$1,858,500
Arterial Signal Control						
TMC Hardware for Signal Control	5	$22,500	$2,000	$6,500		$6,500
Linked Signal System LAN	20	$55,000	$1,100	$3,850		$3,850
Signal Controller Upgrade (per intersection)		$6,250	$350	$663	160	$106,000
Labor for Arterial Management			$540,000	$540,000		$540,000
Ramp Metering						
Ramp Meter (Signal, Controller)	5	$40,000	$2,000	$10,000	90	$900,000
Loop Detectors (2)	5	$11,000	$4,500	$6,700	90	$603,000
Transit and Traveler Information						
TMC Hardware and Software for Info Dissemination	5	$27,500	$1,375	$6,875		$6,875
Labor for Traffic Information Dissemination			$100,000	$100,000		$100,000
Info Service Center Hardware and Software	20	$457,000	$21,525	$44,375		$44,375
Map Database Software	2	$22,500		$11,250		$11,250
Labor for Information Service Center			$225,000	$225,000		$225,000
Transit Center Hardware	10	$22,500		$2,250		$2,250
Labor for Transit Center			$150,000	$150,000		$150,000
Electronic Toll Collection (ETC)						
Electronic Toll Collection Structure	20	$30,000		$1,500		$1,500
Electronic Toll Collection Software	10	$20,000		$2,000		$2,000
Software for Dynamic Electronic Tolls	5	$55,000	$2,700	$13,700		$13,700
Electronic Toll Reader (each 0.5 mile)	10	$10,000	$1,000	$2,000	120	$240,000
High-Speed Camera (each 0.5 mile)	10			$4,000	120	$480,000
Labor for HOT Lanes Management			$540,000	$540,000		$540,000
					TOTAL	**$7,461,283**

Lessons Learned

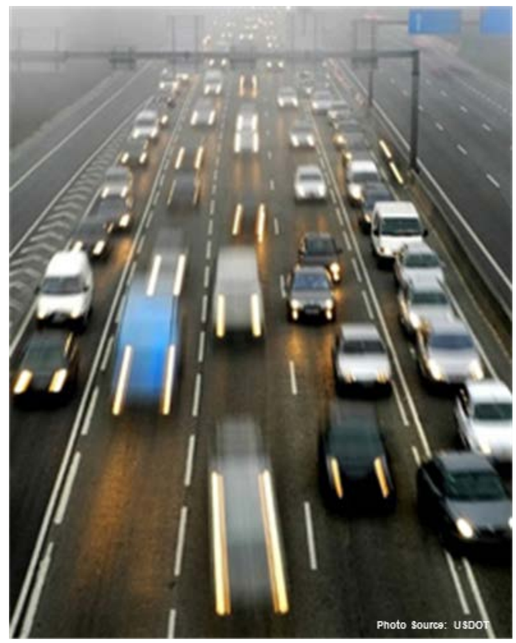
The U.S. DOT continues to encourage regions to become early adopters of Integrated Corridor Management System (ICMS). To assist with successful planning and implementation, a series of lessons learned have been collected from the Pioneer Sites to help others successfully apply the concepts to their region [4].

Foster Champions and Organize Stakeholders when initiating an effort to consider ICM for a regional corridor (2014-00666).

As a corridor is being considered for ICM, it is important that all agencies affecting the operation and maintenance of all networks are invited and participate in the planning of the ICM. The roles and level of involvement may differ, but to be most effective, the ICM Team should consider all transportation resources (those affecting supply and demand). This broad stakeholder list should include all of the agencies that are involved in transportation planning, operations, and management as well as groups that use the transportation system (e.g., fleet operators) or impact its operation (e.g., special event venue owner/operators).

The following are key lessons learned when initiating an effort to consider ICM for a regional corridor:

- **Include all potential stakeholders.** When initiating an effort to consider ICM for a regional corridor, look to include all potential stakeholders early in the process. Some agencies and organizations may choose not to participate, but all should be invited.
- **Encourage broad participation of stakeholders.** Let potential stakeholders decide what their involvement will be as the process moves forward, but encourage as broad participation as possible. Even if agencies or organizations choose not to participate at the start, keep them informed about the decisions being made. Initially reluctant partners can prove to be strong participants later on.
- **Involve executive leaders.** Involve executive leaders in facilitating the multi-agency partnerships vital to the long-term success of ICM. Their support is essential and it is particularly valuable if one (or more) of those executive leaders becomes a champion for ICM.
- **Obtain planner and modeler input early in the process.** Involve transportation planners and modelers, along with the transportation operations personnel, early in the process. Transportation planners and modelers can provide input into the performance measures selected and can help the team understand how best to track system performance against the established goals.



Plan for success of an ICM project by developing a knowledgeable and committed project team that can provide oversight, direction, and necessary reviews (2014-00667).

Developing and deploying an ICMS is not a trivial exercise. When establishing goals and objectives for developing a successful ICM project and planning for success, it is vital that the project team be knowledgeable and committed and that the managing agency be able to successfully assemble the team. Lessons to managing the team successfully include:

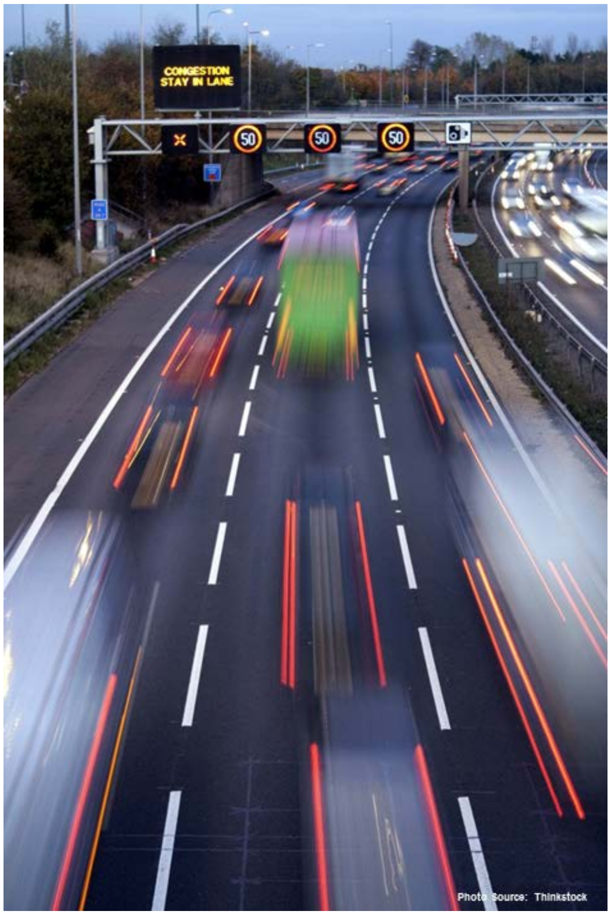
- **Confirm project responsibility, commitment and expertise.** ICM project teams need to be committed to the process, provide the correct project expertise (e.g., systems engineering, software and hardware design and integration, communications, etc.) take ownership of the work products, and see the work products through to successful completion. It is imperative that all stakeholders take responsibility for their part in the project and play an active role in providing successful outcomes. Key activities that can seem time-consuming but provide significant benefit later in the project include: the definition of the current corridor and system assets (both physical and data), identification of corridor needs, and the development of a common vocabulary among partners to describe existing systems and proposed capabilities.
- **Obtain buy-in from all stakeholders.** Before proceeding with the development of an ICMS, it is essential that the stakeholders be able to describe why the proposed system is needed and what the goals of the ICMS are.
- **Manage project procurements, costs, schedules, and risk to reduce the impact that multiple tasks have on a large project.** Multiple procurements from multiple agencies are a challenging endeavor. If, as a part of the

ICM project, one of the stakeholder agencies slips schedule or misses requirements in selection and procurement, this can affect the project as a whole. Procuring systems prematurely (prior to defining the requirements) could significantly impact the cost and schedule of the project.

- **Develop an acronym and terminology list that includes common definitions.** When working with multiple agencies, it was found that terminology and acronyms can differ in definition. Developing an acronym and terminology list that includes common definitions improves coordination and communication.
- **Provide concrete project guidance.** Make sure project guidance is concrete so the contractor is not confused or getting mixed messages. There should be a unified message when providing guidance. Developing a Project Management Plan and documenting all stakeholder roles and responsibilities is essential for project success.

The remaining lessons from the ICM Implementation Guide are provided below:

- Develop a Systems Engineering Management Plan (SEMP) to achieve quality in project development and ultimately produce a successful ICMS (2014-00668).
- Develop a Concept of Operations to define the system that will be built (2014-00669).
- Develop a logical architecture as one key resource for describing what the Integrated Corridor Management System (ICMS) will do (2014-00670).
- Write well-formed requirements from the perspective of the system and not the system user that are concise and include data elements that are uniquely identifiable (2014-00671).
- Analyze individual design possibilities to determine which are feasible, which provide the best performance, and which would be the most cost effective methods of system implementation (2014-00672).
- Coordinate among stakeholders and schedule periodic team meetings to make sure that the correct and necessary information is provided for all development and implementation activities (2014-00673).
- Adequately train all operations and maintenance (O&M) personnel and conduct regularly scheduled team meetings to continually improve processes and procedures as the ICM system operations matures (2014-00674).
- Develop a list of factors and metrics to analyze system performance to determine when system replacement or retirement may become necessary (2014-00675).



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Case Study – Dallas North Tollway (2013-00868)

In Dallas, Texas the concept of a real-time traffic network estimation and prediction tool with built-in decision support capabilities was tested as a potential solution to increasing congestion on the Dallas North Tollway. The system was designed to integrate a wide range of traffic control and traveler information strategies and provide traffic network managers with capabilities to estimate current network conditions, predict congestion dynamics, and generate efficient traffic management schemes to address recurrent and non-recurrent congestion.

As part of a feasibility assessment researchers used a large-scale dynamic traffic assignment (DTA) model with 400 links and 150 junctions to simulate traffic conditions on the Tollway and surrounding areas. A genetic algorithm was used to identify efficient traffic management schemes that could be incorporated into response plans and accepted by partnering agencies, and then several model runs were analyzed to estimate impacts across the network.

The following scenarios were modeled during evening rush periods with varied levels of congestion. Travelers were assumed to follow the most typical historical routes and no pre-trip or in-vehicle information was provided.

- Normal operation conditions (no incident).
- Travelers following historical routes experience incident delay on the freeway while the traffic management system is inactive.
- The traffic management system activated to manage the incident.

In all scenarios, response plans activated a dynamic message sign (DMS) located upstream from an incident on the Tollway, and signal timing changes were implemented at up to 30 intersections on parallel alternate routes. Calculated diversion rates ranged from 10 to 70 percent.

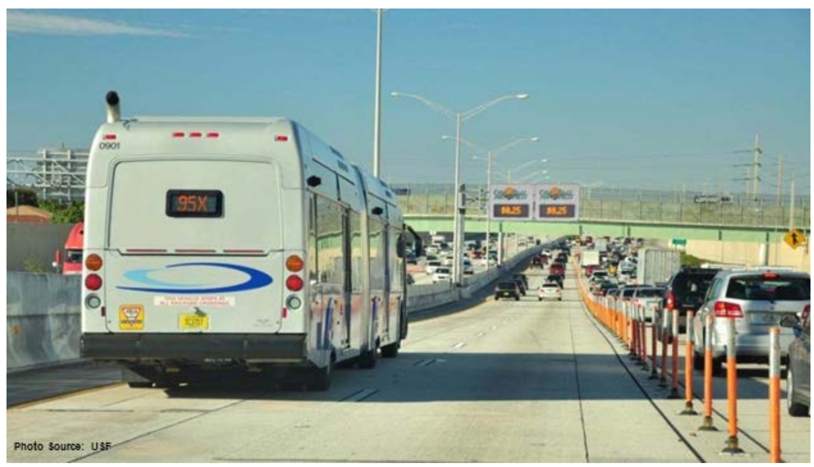
FINDINGS

Simulation results indicated that network performance improved when response plans were implemented.

- Average travel time on the network decreased nine percent when the system was implemented and signal timing was adjusted at all 30 intersections.
- In scenarios where signal timing changes were limited to frontage roads, average travel time over the network decreased by only 3 percent.
- More spatial coverage for signal timing plans increased diversion route capacity and improved average network travel times.

Overall, the DTA model proved to be a valuable tool for modeling congestion dynamics on a large-scale urban transportation network. Evaluation work continues as researchers examine additional applications for real-time traffic management.

References



[1] "ITS ePrimer: Module 3 (Presentation)," Professional Capacity Building (PCB) Program, U.S. DOT RITA. September 2013. URL: http://www.pcb.its.dot.gov/eprimer/documents/module3p.pdf. Last accessed 22 April 2014.

[2] Anton, Lubov, and Associates. "Economic Analysis," Presentation, Minneapolis, MN. 2003. URL: http://nexus.umn.edu/Presentations/Northstar_economics.pdf. Last accessed 30 January 2014.

[3] Integrated Corridor Management Newsletter – 2012. U.S. DOT RITA webpage. URL: http://www.its.dot.gov/icms/docs/knowledgebase/html/news_fall12.htm. Last accessed 22 April 2014.

[4] *Integrated Corridor Management: Implementation Guide and Lessons Learned*, U.S. DOT Federal Highway Administration website. URL: http://ntl.bts.gov/lib/47000/47600/47670/FHWA-JPO-12-075_FinalPKG_508.pdf. Last accessed 22 April 2014.

All data referenced is available through the ITS Knowledge Resources Database, which can be found at http://www.itsknowledgeresources.its.dot.gov/.