San Antonio's Medical Center Corridor

Lessons Learned from the Metropolitan Model Deployment Initiative

Reducing Delay Through Integrated Freeway & Arterial Management

Table of Contents

Figures

Tables

Prepared by

Science Applications International Corporation
for further information please contact
Mark Carter
Enterprise Center
P.O. Box 50132
8301 Greensboro Drive
McLean, Virgina 22101-3600
202-366-2196
carterm@saic.com

Preface

This report demonstrates the benefits and potential pitfalls of deploying and operating an integrated freeway and arterial management system. In particular, it discusses the lessons learned associated with the Medical Center Corridor Project deployed in San Antonio, Texas, in concert with the Metropolitan Model Deployment Initiative (MMDI).

As one of four sites participating in the MMDI effort, San Antonio was committed to pursuing integrated deployments of Intelligent Transportation Systems (ITS). One of the goals of deploying these integrated systems was to develop more effective, coordinated management of roadway incidents and their associated delays. In San Antonio, this was accomplished through integrating the region's highly successful freeway management system with a newly developed and deployed arterial management system in the city's north end.

This report details the lessons learned from this deployment and describes how, with careful implementation and operation, an integrated freeway / arterial management system can lead to significant reductions in delay, crash risk, and fuel consumption.

Background

Over the past decade, considerable progress has been made in the application of ITS toward improved freeway and arterial traffic management. To date, these advanced systems have demonstrated the ability to reduce delays, improve safety, and enhance customer satisfaction. However, as with any emerging technology, many pieces of the systems have evolved independently over time. For example, studies of the nation's 78 largest urban areas reveal that 22 percent of freeway lane miles are covered by roadway surveillance, and an impressive 49 percent of all arterial intersections are under computer control.

However, integration between these freeway and arterial systems is quite low, with such linkages occurring in only six of the cities examined.(1) Consequently, many practitioners feel that the true potential benefits of freeway and arterial ITS have not yet been achieved.

One of the few projects that has sought to unlock these potential benefits is the Medical Center Corridor (MCC) project in San Antonio, Texas. Deployed as part of San Antonio's MMDI, the MCC links an expanded freeway and incident management system with a newly deployed arterial management operation in an effort to provide faster, safer, and more fuel-efficient travel.

Evaluation of these efforts reveals that despite a number of potential institutional and operational challenges, the integrated system, when deployed strategically, can provide positive impacts across all three performance measures listed above. Furthermore, through simulation modeling, it was revealed that expected benefits were greater than may be achieved by any single element of the management system acting alone. Thus, the hypothesis of greater benefits through ITS integration is supported.

What Was Deployed?

As Figure 1 illustrates, the MCC is an approximately 5.4 mile long by 1.2 mile wide integrated arterial/freeway diversion and incident management corridor. Jointly developed and operated by the Texas Department of Transportation, the City of San Antonio, and the region's emergency service providers, the MCC is designed to identify, respond to, and manage incidents within the corridor in a coordinated, seamless fashion.

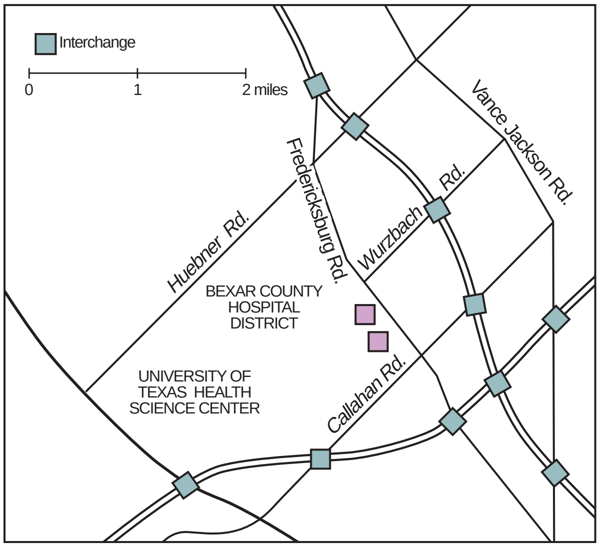


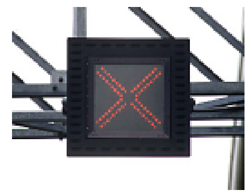
Figure 1: Schematic of San Antonio's MCC

Freeway operations are facilitated through an expansion of the region's pre-existing TransGuide freeway and incident management system and are centered on a 5.4-mile stretch of Interstates 10 and 410. Surface street operations are facilitated through a newly deployed arterial management system that is centered on the corridor's primary parallel arterial diversion route–Fredericksburg Road.

How Does the System Work?

As Figure 2 indicates, incidents and associated delays are first detected or confirmed through a number of freeway-based video and loop detector stations. This information is then relayed in real time to the TransGuide freeway operations center. From there, incident response plans are formulated and appropriate actions are undertaken. These may include dispatch of Texas Department of Transportation service patrols, and/or dispatch of emergency service equipment as directed by co-located emergency service providers.

The incident information is simultaneously provided back to travelers in the field. This information allows affected travelers the opportunity to either stay on their current course or to divert by getting off the interstate and taking an alternative route such as Fredericksburg Road. If they are already in the arterial system and are heading for the freeway, they may instead remain on the arterial until they have reached an interchange downstream of the incident.



On the freeway, this information is displayed through both lane control signs that indicate which lanes are blocked, and by variable message signs (VMSs) that carry textual messages such as incident type, expected delay, or suggestions for alternative routes. On the arterial, the information is displayed through a series of dynamic message signs (DMSs) deployed on the major approaches from Fredericksburg Road to the freeway system. These dynamic arterial signs differ from those on the freeway in that they may provide only a single message – whether there is a freeway incident or not.

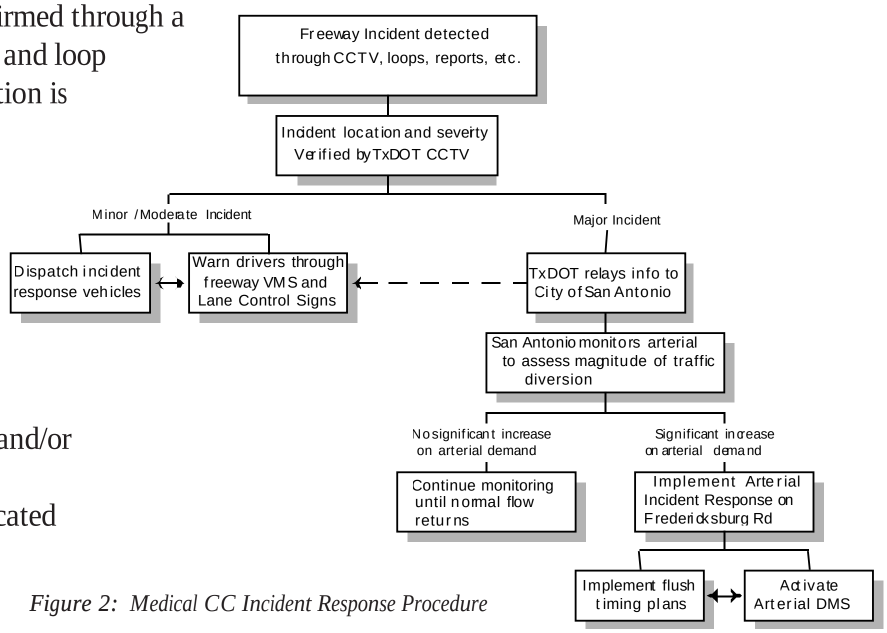


Figure 2: Medical CC Incident Response Procedure

Finally, the incident information is also shared with the City of San Antonio's traffic management center, co-located in the TransGuide facility. This arterial management facility then has the capability of implementing one of a small number of predetermined incident-response signal plans. These special incident plans have been developed off-line with the expectation that traveler diversion in response to information on freeway incidents will cause increased demands on Fredericksburg Road in the direction of the parallel interstate. Consequently, these plans are designed to provide increased capacity in that direction during the duration of the incident and its associated delay.

Costs Were Also Shared

A summary of the MCC costs is presented in Table 1. Freeway components include approximately 80 loop detectors, 6 camera systems, 15 VMSs, 14 lane control signal systems, and nearly $2,200,000 worth of communication infrastructure. Installation costs, while significant, were kept low by a strategic decision to conduct much of the deployment in concert with major highway reconstruction.

Arterial costs include deploying 10 loop stations, 3 camera systems, 9 DMSs, and a new arterial operations work station, as well as the developing the incident response signal plans. Arterial operations and maintenance costs are kept low by housing the operations center within the existing TransGuide operations center and taking advantage of the benefits offered by centralized staffing and maintenance plans.

But Does It Work?

A microsimulation model was constructed to determine the impact of the MCC project on the measures of delay, safety, and fuel consumption. This model, based upon the INTEGRATION analysis engine, is capable of approximating the impacts of various incident scenarios, the effects of the corridor's ITS operations, and the resulting actions of individual drivers within the network.

To ensure a close representation of actual operations, the model was carefully calibrated to real-world conditions. This involved collecting information related to a number of parameters, including the following:

- freeway and arterial volumes from annual counts,
- arterial turning movement counts and baseline signal timings collected during the generation of the incident signal plans,
- expected response rates to VMSs from previous studies and focus groups conducted for this analysis, and
- expected reductions in incident duration from previous studies.

Using these parameters, the model was calibrated to a level at which it was found to estimate traffic volumes to within 98 percent of observed values and travel times to within 88 percent of observed values.

Cost Type	Arterial Components	Freeway Components	MCC Totals
Deployment	$525,000	$4,900,000	$5,425,000
Annual operations and maintenance	$47,000	$163,000	$210,000

Table 1: Summary of Costs of San Antonio's MCC

Deployment Challenges

The first step in the evaluation was to identify potential pitfalls. As with the deployment of many complex systems, ITS applications are often met with a number of challenges and obstacles. Furthermore, these challenges become even more prevalent in projects such as San Antonio's MCC that involve the integration of multiple components, systems, and agencies.

Institutional Challenges

The most vexing of these issues are often institutional rather than technical. They revolve not around the integration of technologies, but around the integration of agencies. Specifically, the integration of ITS often requires the cooperation, if not the merging, of organizations representing different operating philosophies, priorities, budgets, and constituents.

In many cases, transportation agencies are concerned about integrated solutions that may require them to relinquish control of their systems to another entity. In addition to potential personal and historical reasons for this concern, the operators often feel that they simply know their operations better than anyone else. On a related note, many transportation agencies have relatively entrenched mission statements. For example, arterial operators are comfortable dealing with arterial operations and may not be inclined toward or comfortable with considering regional impacts on surrounding freeways. Finally, many transportation operators are concerned about incurring locally negative impacts within their jurisdiction, even if the results ultimately contribute to a greater regional good.

Fortunately, all of these concerns were addressed in San Antonio by following a number of simple steps. First, those considering an integrated ITS deployment, such as the MCC, must challenge local agencies to think regionally. Each agency must come together and essentially "remove their stripes." They must recognize that the traveler is not concerned about lines on the map, but about moving quickly, safely, and efficiently through the network. Consequently, regional transportation officials must also focus on this regional end result.

Second, cooperation may be improved through the adoption of a peer-to-peer permissive operating philosophy. Under this philosophy, management decisions may be generated regionally, but continue to be instituted locally. For example, in San Antonio, incident response signal plans continue to be implemented by the City of San Antonio.

Finally, initial cooperation may be secured by offering unique incentives. For example, the City of San Antonio was offered the opportunity to co-locate their MCC arterial management center within the Texas Department of Transportation's TransGuide center.

Technical Challenges: Optimal Signal Timing Application

In addition to these institutional challenges, the integration of ITS is often met with a number of technical or operational challenges. In the MCC deployment, the first of these operational challenges involved the operation of the system's incident response signal timings.

These special plans were designed to be implemented under situations in which delay is severe enough to cause a significant number of drivers to either divert from the freeway to Fredericksburg Road or to stay on the arterial for a greater portion of the travel. The signal plans function by taking green time from the cross streets and applying it to Fredericksburg Road. Under periods of significant diversion, this system offers substantial benefits. However, when diversion is low, implementation of the plans simply leads to unnecessary cross-street delays. As Table 2 illustrates, the application of the incident management plans to minor and moderate incidents can lead to significant reductions in efficiency. This scenario may actually increase delay, even with other elements of the system operating.

Fortunately, this situation was avoided through carefully monitored arterial operations. First, use of the incident response signal plans was restricted to more severe incidents, such as those blocking multiple freeway lanes for periods of 45 minutes or more. Second, video surveillance was used by the arterial operations personnel to monitor the impacts of the signal timing changes in real time and to turn these plans off and on when appropriate. Finally, San Antonio undertook a commitment to continually update and broaden the breadth of the incident signal plans.

Technical Challenges: Appropriate VMS Usage

The second technical challenge facing the operators of the MCC was the appropriate use of the system's VMSs. Owing to both the cost of the signs and feedback from the public, transportation operators may be inclined to use them to broadcast even the most minor of incidents such as a vehicle breakdown on the shoulder. However, under these situations the warning may be unwarranted or even disruptive to traffic operations.

In the MCC region, as with many areas throughout the nation, such minor incidents generate very little delay. Consequently, rerouting around the incident is often unnecessary and may even lead to increased delay; however, the posting of the situation to a VMS may cause some travelers to proceed with just such a suboptimal solution. For example, modeling of the MCC predicts a 2.5 percent reduction in delay for incident management alone. Under the same scenario, the delay reduction drops to just 1.9 percent when messages are displayed to accompany incident management. This scenario supports the hypothesis that the system may not be needed in every case.

As with the other challenges presented, this particular challenge may also be addressed through strategic system implementation. Specifically, the potentially negative impacts of VMS usage may be mitigated by either restricting use to incidents severe enough to justify diversion or by carefully selecting message sets for the signs that minimize erroneous routing decisions.

Incident Type	Base Delay (veh-hrs)	ITS Impact without Signal Timing Change	ITS Impact with Signal Timing Change
Minor	1313	1280 (-2.5%)	1395 (6.3%)
Moderate	1437	1323 (-7.9%)	1438 (0.1%)

Table 2: Impacts of Incident Response Signal Plans under Various Incidents

Results

When an optimal deployment is achieved, results can be significant. Such a deployment involves sound communication and coordination among agencies, judicious VMS use (moderate and major incidents only), and restricted incident signal timing implementation (severe incidents only).

As Figure 3 indicates, the impacts on delay range from approximately 2.5 percent to nearly 20 percent, with efficiency increasing as the severity of the incident increases.

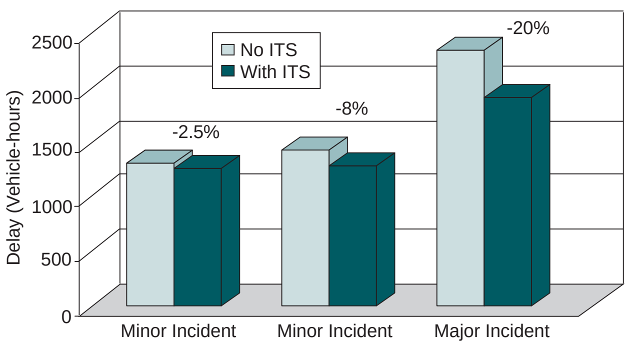


Figure 3: Impact of the Strategic ITS Deployment on Delay in the MCC

Table 3 indicates that the application of the MCC, in addition to reducing traveler delay, also leads to positive reductions in crash risk and fuel consumption.

However, while positive, these impacts for safety and fuel consumption are quite small when compared against the delay values.

For crash risk, while reducing the dangers of stop-and-go traffic on the freeway increases safety, some drivers will experience a slightly greater risk by diverting from the freeway to the arterial, where a greater number of potential conflicts exists. For fuel consumption, the muted impacts may be explained by the increased speeds that are generated from improved management. This increase in speed works to undermine the fuel savings generated by the reduced impacts of vehicle accelerations.

Measure	Minor Incident	Moderate Incident	Major Incident
Crash risk reduction	1.1%	2.2%	4.4%
Fuel consumption reduction	None measurable	0.2%	1.9%

Table 3: Impact of the Strategic MCC Deployment on Safety and Fuel Consumption

Annualized Impacts

Through simulation it was possible to annualize the impacts of the MCC over the course of an entire year. The results of this analysis are presented in Table 4. The most significant finding is that the average traveler using the corridor could expect an approximately 6 percent reduction in his or her entire incident-based delay.

Specifically, the impacts of the integrated MCC on traveler delay are nearly 25 percent greater than those effected by incident management alone, which is the most effective isolated element.

Annual Impact	Delay Reduction	Crashes Reduction	Fuel Consumption Reduction
System change	84230 veh-hrs	0.6 crashes/year	4469 L/year
User change	1.82 hrs/year	.05 crashes/million Km	0.1 L/year
Percentage change	5.9 %	2.0 %	1.4 %

Table 4: Annualized Impact of MCC Operations

Finally, it should be noted that the benefits of the integrated systems are even greater than could be achieved by the isolated deployment of any of the systems.

Treatment	Delay Reduction (vehicle-hours)	Delay Reduction (%)
Incident management	382	16.2 %
Feeway management	109	4.6 %
Arterial management	66	2.8 %
Integration system (all 3)	470	19.9 %

Table 5: Impacts of Isolated and Integrated MCC Components under Severe Incidents

Examining the case of a severe incident, as illustrated in Table 5, it is evident that the application of an integrated strategy is substantially more effective at reducing delay than any of the various components of the system acting in isolation.

Summary of Lessons Learned

It is apparent that integrated arterial/freeway management systems can offer benefits; however, some institutional and operational challenges may arise. Agencies must work together to overcome these challenges and must think regionally rather than locally. When solutions to such challenges are carefully planned and managed, significant benefits can accrue. The benefits of an integrated system are much greater than could be achieved through deployment of the elements in isolation.

[1] "Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA; FY 1997 Results," Federal Highway Administration, Washington, D.C., September 1998.

ITS Web Resources

ITS Joint Program Office:

http://www.its.dot.gov

ITS Cooperative Deployment Network (ICDN):

http://www.nawgits.com/jpo/icdn.html

ITS Electronic Document Library (EDL):

http://www.its.dot.gov/welcome.htm

ITS Professional Capacity Building Program Catalogue:

http://www.its.dot.gov/pcb/98catalg.htm

Federal Transit Administration:

http://www.fta.dot.gov

Intelligent Transportation Systems

U.S. Department of Transportation
400 7th Street, SW
Washington, D.C. 20590