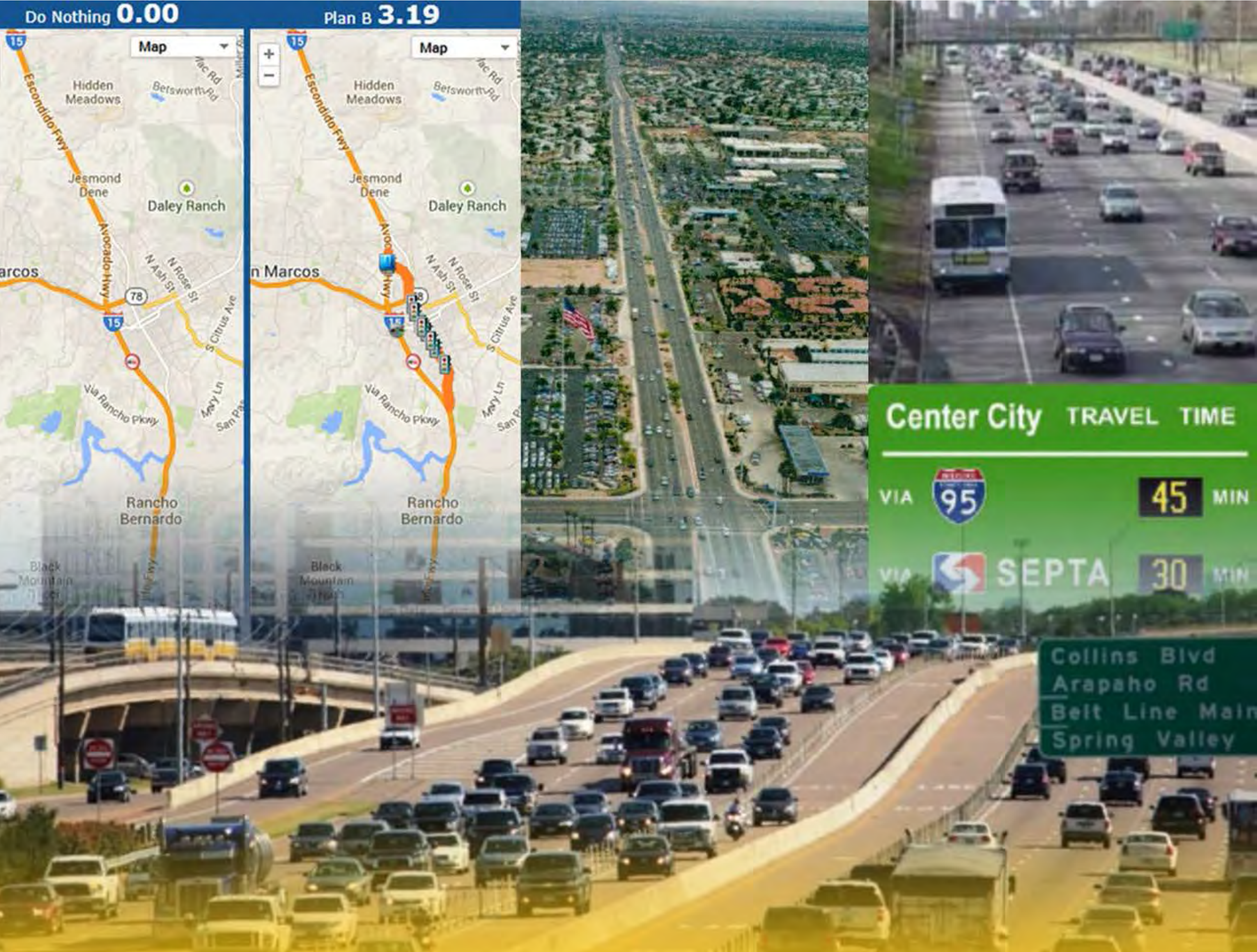

SCAN TEAM REPORT

NCHRP Project 20-68A, Scan 12-02

Advances In Strategies For Implementing Integrated Corridor Management (ICM)

Supported by the

National Cooperative Highway Research Program

The information contained in this report was prepared as part of NCHRP Project 20-68A U.S. Domestic Scan, National Cooperative Highway Research Program.

SPECIAL NOTE: This report IS NOT an official publication of the National Cooperative Highway Research Program, Transportation Research Board, National Research Council, or The National Academies.


Do Nothing 0.00
Plan B 3.19
Map
Hidden Meadows
Jesmond Dene
Daley Ranch
Rancho Bernardo
Black Mountain
Map Data
Terms of Use
Center City TRAVEL TIME
VIA 95 45
VIA SEPTA 30
Collins Blvd
Arapaho Rd
Spring Valley

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The purpose of each scan, and of Project 20-68A as a whole, is to accelerate beneficial innovation by facilitating information sharing and technology exchange among the states and other transportation agencies, and identifying actionable items of common interest. Experience has shown that personal contact with new ideas and their application is a particularly valuable means for such sharing and exchange. A scan entails peer-to-peer discussions between practitioners who have implemented new practices and others who are able to disseminate knowledge of these new practices and their possible benefits to a broad audience of other users. Each scan addresses a single technical topic selected by AASHTO and the NCHRP 20-68A Project Panel. Further information on the NCHRP 20-68A U.S. Domestic Scan program is available at http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1570.

This report was prepared by the scan team for Domestic Scan 12-02, *Advances in Strategies for Implementing Integrated Corridor Management (ICM),* whose members are listed below. Scan planning and logistics are managed by Arora and Associates, P.C.; Harry Capers is the Principal Investigator. NCHRP Project 20-68A is guided by a technical project panel and managed by Andrew C. Lemer, PhD, NCHRP Senior Program Officer.

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Disclaimer

Scan 12-02

Advances In Strategies For Implementing Integrated Corridor Management (ICM)

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October 2014

The information contained in this report was prepared as part of NCHRP Project 20-68A U.S. Domestic Scan, National Cooperative Highway Research Program.

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Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADOT	Arizona Department of Transportation
ALERT	Arizona Local Emergency Response Team (Arizona Department of Transportation)
AMS	Analysis, Modeling, and Simulation
APC	Automatic Passenger Counter
AVL	Automatic Vehicle Location
AZDPS	Arizona Department of Public Safety
BRT	Bus Rapid Transit
C2C	Center to Center
Caltrans	California Department of Transportation
CCTV	Closed Circuit Television
CMAQ	Congestion Mitigation and Air Quality (Program)
CMM	Capability Maturity Model
ConnDOT	Connecticut Department of Transportation
ConOps	Concept of Operations (Dallas)
DART	Dallas Area Rapid Transit
DMS	Dynamic Message Sign
DSS	Decision Support System
DVRPC	Delaware Valley Regional Planning Commission
FHWA	Federal Highway Administration
FTE	Full-Time Equivalent
HAR	Highway Advisory Radio
HOV	High-Occupancy Vehicle
ICM	Integrated Corridor Management
ICMS	Integrated Corridor Management System
IGA	Intergovernmental Agreement
ITS	Intelligent Transportation System
IVR	Interactive Voice Response
MAG	Maricopa Association of Governments (Phoenix)

MCDOT	Maricopa County Department of Transportation (Phoenix)
MnDOT	Minnesota Department of Transportation
MoDOT	Missouri Department of Transportation
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MS/ETMCC	Message Sets for External Traffic Management Center to Traffic Management Center Communication
NCHRP	National Cooperative Highway Research Program
NCTCOG	North Central Texas Council of Governments
NJDOT	New Jersey Department of Transportation
NJTA	New Jersey Turnpike Authority
NJTPA	North Jersey Transportation Planning Authority
NJ Transit	New Jersey Transit
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
NYCDOT	New York City Department of Transportation
NYSDOT	New York State Department of Transportation
O&M	Operations and Maintenance
OIC	Operations Information Center (New York/New Jersey)
OR	OpenReach (a TRANSCOM project)
PANYNJ	Port Authority of New York & New Jersey
PennDOT	Pennsylvania Department of Transportation
PIO	Public Information Officer
RA	Regional Architecture (New York/New Jersey)
RADS	Regional Archive Data System
REACT	Regional Emergency Action Coordinating Team (Maricopa County Department of Transportation)
RIMIS	Regional Integrated Multimodal Information Sharing (Philadelphia)
SANDAG	San Diego Association of Governments
SMU	Southern Methodist University
SRPMIC	Salt River Pima-Maricopa Indian Community
TIM	Traffic Incident Management
TMC	Transportation Management Center
TMDD	Traffic Management Data Dictionary

TMS	Transportation Management System
TRANSCOM	Transportation Operations Coordinating Committee
TRB	Transportation Research Board
TTI	Texas A&M Transportation Institute
TxDOT	Texas Department of Transportation
U.S. DOT	United States Department of Transportation
VMS	Variable Message Sign
WisDOT	Wisconsin Department of Transportation

Executive Summary

Many jurisdictions have implemented a variety of strategies for maximizing flow on facilities by using all available pavement and managing their facilities by using new technologies and better techniques. Most recognize the importance of interjurisdictional coordination with emergency responders, maintenance and incident response, and construction management, as well as providing timely notification to the public in managing their systems. Monitoring traffic operations through traffic management centers with reliable detection and surveillance and available deployment strategies (e.g., incident response) is an active engagement in reducing recurrent and nonrecurrent congestion.

Pulling this all together through Integrated Corridor Management (ICM) is essential to successful system management. ICM actively integrates the separate strategies (e.g., ramp metering, arterial coordination, detour planning, traveler information, managed lanes in a real-time manner, and new challenges in traffic management center staffing and funding.

The scan team visited five locations over two, one-week scans to review existing and planned ICM programs. The team asked the agencies to discuss the following, along with their ICM programs:

- What are best practices in staffing real-time corridor management?
  - Classifications, team assignments
  - Interjurisdictional staff sharing
  - After-hours staffing or call-out processes
- How are ICM projects and operations funded?
- What is the role (if any) of contracted services?
- What system-support staffing changes are needed?
- How can ICM technologies be most efficiently implemented?
- How are staffing issues addressed?
- Are certain functions outsourced?

Common Themes

The scan team identified several key attributes that regions need to implement for their ICM program to be successful: institutional integration, technical integration, and operational integration. The scan team found that these attributes have various levels of maturity at the sites visited.

Institutional Integration

An institutional partnership is needed among the operating agencies. The key areas required for ICM include:

- Agreements/memorandums of understanding/policies focused on joint operations and information sharing
- Identified funding or initial and sustained operations
- An identified champion
- Executive buy-in and commitment
- Documented organizational structure
- Defined roles and responsibilities
- Involvement of all modes and stakeholders in the corridor
- External and internal marketing, outreach, and education

Technical Integration

Intelligent Transportation System (ITS) infrastructure and technology are needed. The key areas required for ICM include:

- ITS infrastructure (existing or funding for new), to include field infrastructure for monitoring, information dissemination, and operations center systems (i.e., traffic management, traffic signal control, and transit management systems)
- Analytics/performance measures were available for analytics, modeling, travel information, and decision support systems
- Traveler information dissemination, including 511 systems, roadside devices, and feeds to the media
- ITS standards for easier integration of systems (e.g., regional ITS architecture, center-to-center, National Transportation Communications for ITS Protocol, and Traffic Management Data Dictionary)
- A common linear reference system to integrate multiple sources of data
- Various levels of a decision support system (i.e., a basic response plan book to full performance-based model used to generate responses)

Operational Integration

The agencies within the corridor need a cooperative operational mindset. The key areas required for ICM include:

- An interagency concept of operations defined and supported by all agencies
- Interagency data and information sharing
- Integrated transportation management center operations (multiagency/ multimode)
- Traffic incident management program/collaboration

Key Items for an ICM Program

Based on the desk scan's findings, the United States Department of Transportation's (U.S. DOT's) ICM program, and the scan tour, the scan team agreed on several key items that are needed for any area considering an ICM program.

Funding

The scan team found funding to be a major concern at all scan locations. Funding has been available for ICM planning and some deployment; however, in some areas, there is no commitment to sustainable funding for ongoing operations and maintenance.

Staffing

As with any new program, staffing requirements must be considered. Agencies have staffed ICM in a variety of ways. Many add ICM duties to existing staff members' responsibilities (e.g., existing Dallas Area Rapid Transit operations staff was given additional duties). However, the agency did fund one full-time equivalent to serve as the ICM coordinator for the US-75 corridor.

In general terms, operations have continued as part of the ongoing operational roles of the agencies involved. System support for ICM has been outsourced to private companies for the development and ongoing operation and maintenance of the software and hardware used for ICM programs. However, depending on staffing constraints, technical capabilities could be provided by any combination of public agencies and/or private companies. This should be considered a long-term commitment for an ICM program.

Champion or Lead Agency

Most ICM projects have had a champion or lead agency (hereafter, the terms and purpose are essentially interchangeable) to get the project started, funded, and driven toward deployment. This agency would typically be in a position to lobby its peers and/or offer its assistance in absorbing the administrative duties necessary to serve as the nexus among the ICM agencies. In short, it can obligate sufficient staff and resources to help incubate the regional deployment.

The scan team found that a champion is necessary to induce progression toward ICM. While this role going forward remains desirable for purposes of regional identity, stability, and as a point of contact, it is not mandatory that it continue, at least not in that same capacity. Ideally, the program needs to get to a point where ICM becomes standard operating procedure and the agencies and relationships live on to provide the necessary momentum and support so that the program will continue under new leadership, even if the champion should leave.

As an example, the Phoenix area has a cooperative ITS organization, AZTech™[1], that began as part of the U.S. DOT's Model Deployment Initiative in the mid-1990s. Today, AZTech is still being used as the regional organization that cooperatively implements multijurisdictional ITS projects focused on operations, including ICM.

Lead Coordinator

This person or office is more or less the daily manager of operations overseeing the status of the daily ICM deployment and reviewing and inspecting the resultant response plans. An ICM deployment may or may not have a lead coordinator identified as such; however, by some measure, one person or one office from one of the member agencies is probably filling this role by rote. The lead coordinator is the person or office one calls to ask questions about ICM operation. This person may or may not be the champion previously described, or necessarily an employee of the lead agency.

The lead coordinator may retain prior job duties for his or her employer. It is probable, however, that those job duties (new or continuing) would naturally tailor to serve this purpose anyway, only now on behalf of the affiliated ICM agencies.

ICM Benefits

ICM provides benefits, no matter how simple or complex the program. A system that simply provides notification of events provides benefits. Interagency contact provides benefits by promoting understanding and enabling discussions of events that affect both agencies.

ICM Building Blocks

As part of this report, the scan team discussed the need to provide assistance to agencies thinking of starting an ICM program by providing an overview of program requirements. The scan team agreed that there are six basic areas that are needed to begin an ICM program:

1 What is AZTech™, http://www.AZTech.org/

- Coordinated operations (see Chapter 4)
- Multi-agency data sharing (see Chapter 5)
- Traveler information (see Chapter 6)
- Decision support system (see Chapter 7)
- Model of corridor (see Chapter 8)
- Memorandums of understanding (see Chapter 9)

Capability Maturity Model

This model, a tool for objectively reviewing business processes, is used extensively worldwide in government offices, commerce, industry, and software-development organizations. Within the transportation community, the Capability Maturity Model is used for evaluating the maturity of various ITS programs. U.S. DOT workshops have been held to help states identify areas for improvement for their Transportation Systems Management and Operation programs and for Intelligent Transportation System programs in general.

CHAPTER 1

Introduction

Scan Team

The scan team was made up of a sampling of representatives from a variety of backgrounds. The team included members from the public sector, ranging from professionals overseeing a state's entire intelligent transportation system (ITS) programs and individuals who oversee statewide ITS, Traffic, Signing, and Engineering Divisions, to individuals who bridge the gap between engineering and operations programs, United States Department of Transportation (U.S. DOT) employees involved with the ICM program, and private consultants with ICM planning and deployment expertise. Biographical sketches of each member are provided in Appendix A.

The scan team members can help your agency or organization share the team's findings with your stakeholders. Contact any of the team's members if you or your agency would like additional information or presenters for a particular purpose. Appendix B provides contact information for the scan team's members.

The scan team comprised the following individuals:

- Dennis Motiani (Co-Chair), New Jersey Department of Transportation2 (NJDOT)
- Neil Spiller (Co-Chair) Federal Highway Administration[3] (FHWA)
- Nick Compin, California Department of Transportation[4] (Caltrans)
- Anne Reshadi, PE, Wisconsin Department of Transportation[5] (WisDOT)
- Brian Umfleet, PE, Missouri Department of Transportation[6] (MoDOT)
- Todd Westhuis, PE, New York Department of Transportation[7] (NYSDOT)
- Kevin Miller, PE, Schneider Electric[8]
- Ahmad Sadegh, Schneider Electric

2 New Jersey Department of Transportation, http://www.state.nj.us/transportation/
3 Federal Highway Administration, http://www.fhwa.dot.gov/
4 California Department of Transportation, http://www.dot.ca.gov/
5 Wisconsin Department of Transportation, http://www.dot.state.wi.us/
6 Missouri Department of Transportation, http://www.modot.org/
7 New York State Department of Transportation, https://www.dot.ny.gov/index
8 Schneider Electric, http://www.schneider-electric.com/us/en/

Scan Tour Participants

The scan team performed a search of agencies to identify potential site participants in the more detailed investigative phase(s). The team followed a proven process to evaluate various agencies, technologies, and industry practices to determine the areas the team would evaluate further.

A scan includes several stages, including:

- The preliminary desk scan
- The exploratory phase, which includes further questioning of potential candidates
- On-site visits where the chosen agencies host the team to provide an up-close look at what each believes is key to its program's success.

Rather than focus on all of the agencies that were involved or included in all phases of the research, the scan team's findings and resulting recommendations are predominantly based on findings from the agencies that hosted the on-site visits. The team is grateful for the willingness of these agencies to open their doors, share information, and allow the team an open-ended opportunity to ask questions and tour each facility.

The scan tour host agencies were the following

- New Jersey Department of Transportation (NJDOT), with support from:
    - New York State DOT (NYSDOT)
    - Transportation Operations Coordinating Committee[9] (TRANSCOM)
    - Delaware Valley Regional Planning Commission[10] (DVRPC)
    - New York City Department of Transportation[11] (NYCDOT)
    - New Jersey Turnpike Authority[12] (NJTA)
    - New Jersey Transit[13] (NJ Transit)
    - Port Authority of New York & New Jersey[14] (PANYNJ)
    - Pennsylvania Department of Transportation[15] (PennDOT)

9 TRANSCOM, http://xcm.org/XCMWeb site/Index.aspx
10 Delaware Valley Regional Planning Commission, http://www.dvrpc.org/
11 New York City Department of Transportation, http://www.nyc.gov/html/dot/html/home/home.shtml
12 New Jersey Turnpike Authority, http://www.state.nj.us/turnpike/
13 New Jersey Transit, http://www.njtransit.com/hp/hp_servlet.srv?hdnPageAction=HomePageTo
14 Port Authority of New York & New Jersey, http://www.panynj.gov/
15 Pennsylvania Department of Transportation, http://www.dot.state.pa.us/

- North Jersey Transportation Planning Authority[16] (NJTPA)

- Dallas (Texas) Area Rapid Transit[17] (DART), with support from:
  - Texas Department of Transportation[18] (TxDOT)
  - City of Richardson, Texas[19]
  - City of Plano, Texas[20]
  - City of Dallas, Texas[21]
  - North Central Texas Council of Governments[22] (NCTCOG)
  - Schneider Electric
  - Texas A&M Transportation Institute[23] (TTI)
  - Southern Methodist University[24] (SMU)
- Minnesota Department of Transportation[25] (MnDOT), with support from:
  - Minneapolis Metro Transit[26]
- Maricopa County (Arizona) Department of Transportation[27] (MCDOT), with support from:
  - Arizona Department of Transportation[28] (ADOT)
  - City of Scottsdale[29]
  - City of Phoenix[30]
  - Maricopa Association of Governments[31] (MAG)

16 North Jersey Transportation Planning Authority, http://www.njtpa.org/
17 Dallas Area Rapid Transit, http://www.dart.org/
18 Texas Department of Transportation, http://www.dart.org/
19 City of Richardson (Texas), http://www.cor.net/
20 City of Plano (Texas), http://www.plano.gov/
21 City of Dallas (Texas), http://www.dallascityhall.com/
22 North Central Texas Council of Governments, http://www.nctcog.org/
23 Texas A&M Transportation Institute, http://tti.tamu.edu/
24 Southern Methodist University, http://www.smu.edu/
25 Minnesota Department of Transportation, http://www.dot.state.mn.us/
26 Minneapolis Metro Transit, https://www.metrotransit.org/
27 Maricopa County (Arizona) Department of Transportation, http://www.mcdot.maricopa.gov/
28 Arizona Department of Transportation, http://azdot.gov/
29 City of Scottsdale (Arizona), http://www.scottsdaleaz.gov/
30 City of Phoenix (Arizona), http://www.visitphoenix.com/index.aspx?gclid=CM_x3qj-5sICFUVk7Aod3XoAaA
31 Maricopa (Arizona) Association of Governments, http://www.azmag.gov/

  - Valley Metro[32]
  - Arizona Department of Public Safety[33] (AZDPS)
  - Salt River Pima-Maricopa Indian Community[34]
  - Kimley-Horn and Associates Inc.[35]
  - OZ Engineering[36]
- San Diego Association of Governments[37] (SANDAG), with support from:
  - California Department of Transportation (Caltrans)
  - City of Escondido[38]
  - City of Poway[39]
  - Kimley-Horn and Associates Inc.

Refer to Appendix C for host agency contact information.

Prior to the scan tour, the scan team asked potential participants to complete a list of amplifying questions (see Appendix D). The responses provided by Dallas, Phoenix, and San Diego are provided in Appendix E.

32 Valley Metro (Arizona), http://www.valleymetro.org/
33 Arizona Department of Public Safety, http://www.azdps.gov/
34 Salt River Pima-Maricopa Indian Community, http://www.srpmic-nsn.gov/
35 Kimley-Horn and Associates, Inc., http://www.kimley-horn.com/
36 OZ Engineering, http://ozengineering.org/
37 SANDAG (San Diego Association of Governments), http://www.sandag.org/
38 City of Escondido (California), https://www.escondido.org/
39 City of Poway (California), http://poway.org/

CHAPTER 2

Overview of Site Visits

New York/New Jersey/Pennsylvania

The scan began with a two-day session with the New York/New Jersey/Pennsylvania region, discussing the regional ICM-related activities they currently plan and provide. This region of the country does not have an ICM project; however, it has been doing activities for many years that would be considered ICM in other areas. NYSDOT and NJDOT are involved with Traffic Incident Management (TIM) activities and coordination that are the building blocks for an ICM program.

Within the region, TRANSCOM provides the data collection, fusion, and dissemination that can be used to coordinate ICM operations. TRANSCOM is a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut metropolitan region that was created in 1986 to provide a cooperative, coordinated approach to regional transportation management.

DVRPC is the local Metropolitan Planning Organization (MPO) in charge of the South Jersey and Philadelphia region. It has deployed regional information-sharing on behalf of its member agencies and has planned for many ICM corridors within its ITS strategic plan. The main ICM activities included:

- Coordinated operations between multiple agencies
- Multiagency data sharing system
- Centralized coordinated operations agency (TRANSCOM)
- Memorandums of Understanding (MOUs) in place
- Robust traveler information systems (i.e., 511NY, 511NJ, and 511PA; see Chapter 6)

Dallas

Dallas, Texas, is one of two U.S. DOT ICM Demonstration Project sites. The Dallas ICM Pioneer Site covers the US-75 corridor from downtown Dallas to SH-121, with the North Dallas Toll Way to the west and DART light rail and various arterials to the east as their corridor. DART is the lead agency; however, subsequent to the scan, TxDOT (Dallas District) took over the role as lead ICM coordinator. The Dallas ICM partnership also includes the Cities of Dallas, Richardson, Plano, and University Park; the Town of Highland Park; the North Central Texas Council of Governments; the North Texas Tollway Authority; and the TxDOT Dallas District.

The Integrated Corridor Management System (ICMS) is a component-based system that supports corridor management by sharing internal and external incident, construction, special event, transit, and traffic flow data, and using this data to provide operational planning and evaluation through a decision support system (DSS).

As part of the ICM project, a regional 511 system was developed and deployed. The main ICM activities included:

- Coordinated multimodal (i.e., freeway, arterial, transit, and emergency response) operations between agencies
- Multiagency data sharing system
- Robust traveler information systems (511DFW[40])
- Pre-agreed response plans
- DSS to select a response plan
- Real-time model of corridor
- Real-time transit information (i.e., automatic vehicle location [AVL], automatic passenger counter [APC], and parking at stations)

Minneapolis

Minneapolis, Minnesota, was a U.S. DOT ICM Pioneer Site for Stages 1 and 2 of the ICM program; developed the concept of operations, system requirements for Stage 1; and participated in the Stage 2 analysis, modeling, and simulation of the corridor. Minneapolis' I-394 corridor is ICM critical in Minneapolis because of its heavily traveled commuter route with limited space to improve physical capacity.

The I-394 ICM corridor extends from the Minneapolis central business district to the area's rapidly developing western suburbs. For the purposes of this project, the corridor's western limit is defined as the Hennepin County border, a distance of approximately 25 miles. I-394 is the primary commuter route and runs through the heart of the corridor. The corridor is bounded by parallel routes, on the north by Highway 55 and on the south by Highway 7.

The main ICM activities include:

- Coordinated operations between freeway and signal operation
- Robust traveler information systems (511)
- Field infrastructure in place for ICM
- Available real-time transit information (AVL and APC)
- Managed lanes

40 511DFW, http://www.511dfw.org/

Phoenix

The Maricopa Association of Governments (MAG) has established a regional goal of implementing an ITS ICM system within several corridors in the region. Currently, ICM corridors have been identified for I-10, the Loop 101 corridors, and a potential I-10/I-17 Spine ICM project.

The ICM program has some strong building blocks. As part of the 2012 Regional ITS Strategic Plan, the region's focus on ICM strategies is the result of the evolution of the region's transportation network and ITS program. ICM addresses a key need for the region to be more proactive in managing recurring and nonrecurring congestion. MAG began planning for an ICM program in 2007 in the west portion of the metropolitan area on I-10. This corridor segment is prone to daily congestion during morning and evening commute periods, and it carries a significant number of freight vehicles.

AZTech is a regional traffic management partnership in the Phoenix metropolitan area. All of the major governmental transportation agencies in the region are members, as are public safety agencies and media companies. This partnership, led by the Maricopa County DOT (MCDOT) and ADOT and working through several collaborating committees, guides the application of ITS technologies for managing regional traffic. The goal is to achieve more-efficient mobility, less congestion, and a higher level of safety for travelers throughout the metropolitan area. As a pilot project, AZTech has implemented Loop 101 ICM in the region.

Lastly, the region has two incident management response teams that coordinate responses to incidents. ADOT's ALERT (Arizona Local Emergency Response Team), and MCDOT's REACT (Regional Emergency Action Coordinating Team). The teams comprise highly trained and dedicated members who respond to incidents 24 hours a day, seven days a week, 365 days a year at the request of and along with other public safety agencies to provide traffic incident management for incidents that affect regular traffic flow and safety on freeways and arterial roads. During these events, the responders' primary purpose is to establish improved incident-scene safety and traffic mobility through well-developed and practiced TIM plans and procedures.

The main ICM activities within the area include:

- ICM corridors (two planned, one implemented)
- Regional system for collecting data (Regional Archive Data System)
- Coordinated operations between agencies
- Robust traveler information systems (511 AZ)
- Long-standing interagency cooperation (AZTech)
- Mature TIM program led by AZDPS

San Diego

San Diego, California, is one of two U. S. DOT ICM Demonstration Project sites. The I15 corridor in San Diego is a model for the multimodal deployment of the latest and evolving technologies in the region. The region continues to seek the benefits of ITSs through capital investments in transit, highway, and arterial systems while focusing on data sharing through early adoption of the regional ITS architecture. The San Diego region has a rich history of partnership among the San Diego Association of Governments (SANDAG) and its member agencies and diverse stakeholders, who are all committed to the ICM vision and implementation of the ICMS to support ICM programs.

ICM consists of the operational coordination of multiple transportation networks and cross-network connections comprising a corridor and the coordination of institutions responsible for corridor mobility. ICM programs provide:

- Better information
- Coordination of network junctions
- Proactive management of capacity and demand
- Advanced technologies and systems
- Improved institutional arrangements

ICM is a system of systems; that is, a transportation management system (TMS) that connects the individual network-based TMS, provides decision support, and enables joint operations according to a set of operational procedures agreed to by the network owners. The main ICM components include:

- Coordinated multimodal operations between agencies
- A multi-agency data sharing system
- Robust traveler information systems
- A DSS
- A real-time model of corridor
- DSS-created response plans
- Real-time transit information (AVL and APC)

Common Themes

The scan team identified several key attributes that areas will need to implement a successful ICM program. These attributes, which have various levels of maturity at the sites the team visited, have been grouped into three general areas: institutional integration, technical integration, and operational integration. These areas are discussed in the following sections.

Key Attributes for Successful ICM

- **Institutional integration—An institutional partnership is needed among the operating agencies, including these key aspects**
  - Agreements/MOUs/policies
  - Identified funding for initial and sustained operations
  - Executive buy-in and commitment
  - Documented organizational structure
  - Defined roles and responsibilities
  - Involvement of all modes and stakeholders in the corridor
  - Internal and external marketing
- **Technical integration—Basic ITS infrastructure and technology, including these key aspects**
  - ITS infrastructure (existing or funded for new)
  - Available analytics/performance measures
  - Robust traveler information dissemination
  - ITS standards for easier integration of systems (center-to-center [C2C], National Transportation Communications for ITS Protocol [NTCIP] and Traffic Management Data Dictionary [TMDD[41]])
  - Identification of a common linear reference system to integrate multiple data sources

41 Traffic Management Data Dictionary Standard for Traffic Management Center-to-Center Communications http://www.standards.its.dot.gov/content/documents/advisories/tmdd_2013.aspx

    - Various levels of a DSS (from a basic response plan book to a full performance-based model used to generate responses)

- Operational integration—The agencies within the corridor need a cooperative operational mindset, including these key aspects:
    - Defined concept of operations
    - Information sharing
    - Integrated TMC operations (multi-agency/multimodal)
    - TIM program/collaboration

Key Items for an ICM Program

Funding

The scan team found that funding was a major concern at all scan locations. Funding has been available for planning and some deployment of ICM; however, funding for ongoing operations and maintenance (O&M) has been a struggle in some areas.

In San Diego, for example, the ICM program has funding through the end of the year; long-term funding will be determined once the U.S. DOT demonstration is completed. As a result of the ICM project, ICM is a key strategy under the multimodal integration and performance-based management transportation system management area of the long-term regional transportation plan. San Diego ICM Program was recently approved for funding through December 2015.

Similarly, in Dallas, the ICM program is funded through the end of 2014. The partner agencies have recently approved the inter-local agreements to provide the funding for 2015.

Staffing

As with any new program, staffing requirements must be considered. Agencies have staffed for ICM in a variety of ways. Many add ICM duties to existing staff.

In Dallas, for example, existing DART operations staff members were given additional duties; however, DART funded one full-time equivalent (FTE) to serve as the ICM coordinator for the US-75 corridor. In general terms, operations have continued as part of the ongoing operational roles of the agencies involved. System support for ICM has been outsourced to private companies for the development and ongoing O&M of the software and hardware used for ICM programs. However, depending on constraints on FTEs, the technical capabilities of the agencies's staffing could be provided by any combination of public agencies and/or private companies.

Champion or Lead Agency

Most ICM projects have had a champion or lead agency (hereafter, the terms and purpose are essentially interchangeable) to get the project started, funded, and driven toward deployment. This agency would typically be in a position to lobby its peers and/or offer its assistance in absorbing the administrative duties necessary to serve as the nexus among the ICM agencies. In short, it can obligate sufficient staff and resources to help incubate the regional deployment.

The scan team found that a champion is necessary to induce progression toward ICM. While this role going forward remains desirable for purposes of regional identity, stability, and as a point of contact, it is not mandatory that it continue, at least not in that same capacity. Ideally, the program needs to get to a point where ICM becomes standard operating procedure and the agencies and relationships live on to provide the necessary momentum and support so that the program will continue under new leadership, even if the champion should leave.

As an example, the Phoenix area has a cooperative ITS organization, AZTech™[42], that began as part of the U.S. DOT's Model Deployment Initiative in the mid-1990s. Today, AZTech is still being used as the regional organization that cooperatively implements multijurisdictional ITS projects focused on operations, including ICM.

Lead Coordinator

This person or office is more or less the daily manager of operations overseeing the status of the daily ICM deployment and reviewing and inspecting the resultant response plans. An ICM deployment may or may not have a lead coordinator identified as such; however, by some measure, one person or one office from one of the member agencies is probably filling this role by rote. The lead coordinator is the person or office one calls to ask questions about ICM operation. This person may or may not be the champion previously described, or necessarily an employee of the lead agency.

The lead coordinator may retain prior job duties for his or her employer. It is probable, however, that those job duties (new or continuing) would naturally tailor to serve this purpose anyway, only now on behalf of the affiliated ICM agencies.

42 What is AZTech™, http://www.AZTech.org/

Coordinated Operations

Coordinated operations is an area that was common among the agencies the scan team visited. For ICM to be successful, this includes various levels of coordination and cooperative operations for the region and for the corridor. Some locations are co-located with other agencies, but most seem to be virtually connected and coordinate operations through computer systems and operators speaking to each other via radio or telephone.

New York/New Jersey/Pennsylvania

The New York/New Jersey area has mature freeway operations coordination due to the necessity of managing traffic into and out of the New York City metropolitan area. TRANSCOM is the backbone of the region's coordinated operations and is a coalition of 16 transportation and public safety agencies in the New York/New Jersey/Connecticut metropolitan region. TRANSCOM was created in 1986 to provide a cooperative, coordinated approach to regional transportation management.

Dallas

Operations in the Dallas area are mostly virtualized. TxDOT manages the freeways within the region at the DalTrans[43] facility. DART manages bus, rail, and paratransit from its operations centers. High-occupancy vehicle (HOV) operations are co-located with TxDOT at the DalTrans facility. The cities within the corridor each have their own operations centers and staff; however, they have coordinated their signal operations on some of the bordering arterials so that travelers do not notice a major difference when traveling between cities.

For ICM, the US-75 corridor has coordinated operations among the five operating agencies that will implement response plans to major incidents on US-75. If a major closure of US-75 occurs, the response plan could include recommending that travelers use the light rail system, changing signal timings along the parallel arterials to prioritize flow around the closure, and using dynamic message signs (DMSs) and 511 to inform travelers of the closure and alternate routes.

Minneapolis

Operations within the Minneapolis area are mostly agency independent. MnDOT's operations center currently provides freeway, traffic signal, and emergency management operations. As part of the ICM program, MnDOT's traffic signal group coordinated with the local cities and county traffic signal departments to include the City of Minneapolis, Hennepin County, St. Louis Park, Plymouth, and Golden Valley.

43 Dallas ITS website, http://dfwtraffic.dot.state.tx.us/DAL/dal.htm

The approach to coordinated signal operations included developing scenarios for various events that would require traffic signal changes. Canned signal timing plans were developed to mitigate the traffic issue.

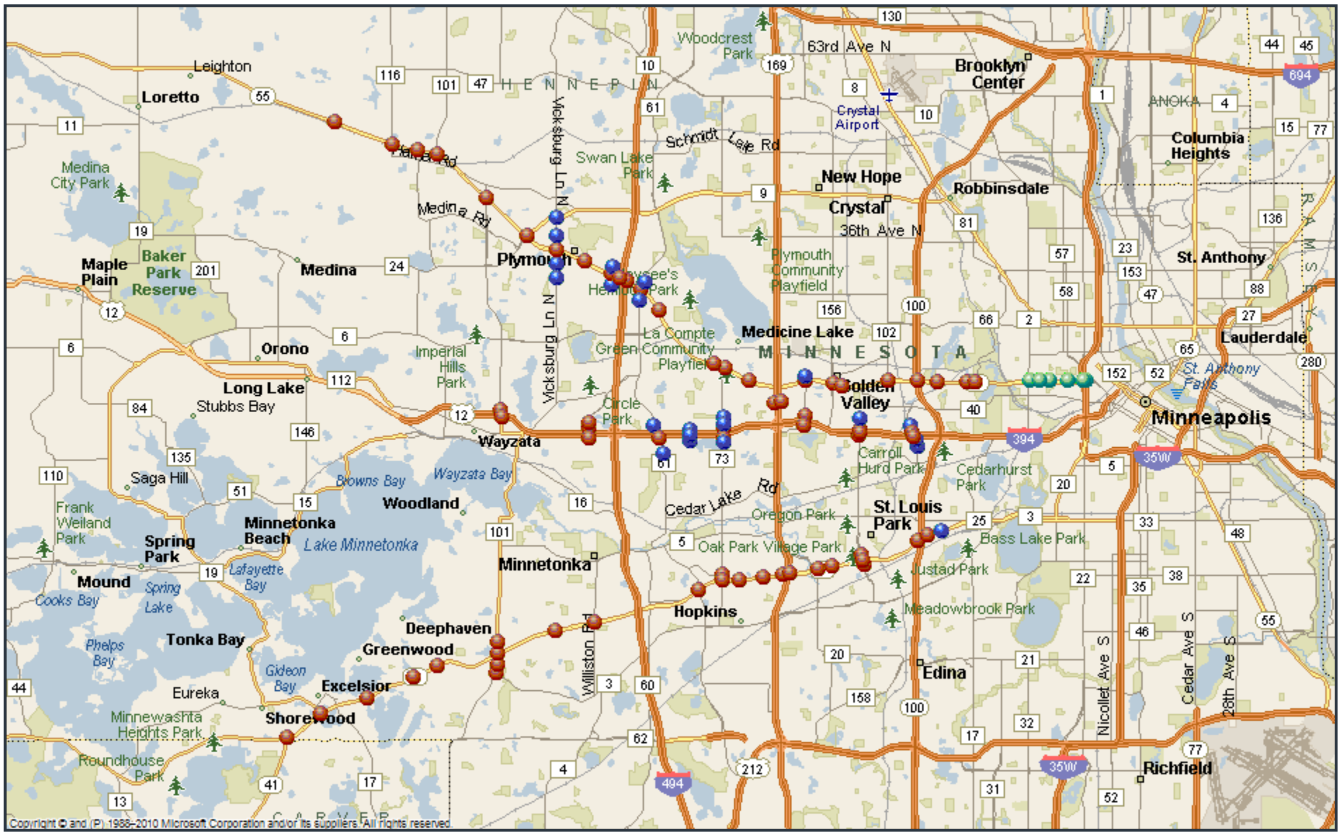

Figure 4.1 Minneapolis ICM signal system

With the Bus Rapid Transit (BRT) facilities on I-35W, which were funded as part of the U.S. DOT Urban Partnership Program, MnDOT coordinates I-35W operations with the Metro Transit to operate the BRT.

The Orange Line uses roadway improvements, upgraded transit stations, park-and-ride facilities, and improved bus routes to provide fast, frequent, and reliable all-day service along I-35W. The 16-mile corridor has been the most heavily traveled express bus corridor since the 1970s, with about 14,000 daily rides.

Multiagency Data Sharing

Sharing data among agencies is a key component of an ICM system. This can be accomplished through manual methods (e.g., phone calls, text messages, and on-line messaging) or through systems that are more automated. Most of the sites the team visited have some form of an ITS standards-based C2C system that allows automated exchange of data among agencies. However, many sites do not use the full functionality of the C2C systems, and not all partner agencies are connected to the systems.

New York/New Jersey/Pennsylvania

All three states are sharing data using various systems and objectives. All three are part of the I95 corridor coalition, which shares data on transportation-related activities.

New York/New Jersey

In the New York/New Jersey area, a common system for exchanging data is provided by TRANSCOM. TRANSCOM supplements state and regional traffic and incident management through proactive regional coordination for incident management and multiagency construction coordination. An Operations Information Center (OIC) collects and disseminates real-time incident and construction information 24 hours a day, seven days a week. Over 100 agencies and affiliates in the New York City metropolitan area are a part of the overall operations, receiving advisories and coordination from TRANSCOM. Incident and construction notifications are distributed selectively to affected member agencies that include highway and transit agencies; state, county, and local police departments; and media traffic services. TRANSCOM is designed around a centralized architecture consisting of a central database server connected to workstations located at member agencies' facilities.

The original regional architecture (RA) system provided TRANSCOM member agencies' operations centers with a gateway to a wide area network of the region's Transportation Management Centers (TMCs). Through this network, agencies share incident and construction data, transit schedules, Variable Message Sign (VMS) and Highway Advisory Radio (HAR) information, closed-circuit television (CCTV), and real-time traffic and transit conditions. This database of shared data is the foundation for both the New Jersey and New York 511 traveler information systems.

The TRANSCOM RA system provides technical coordination among TRANSCOM member agencies to ensure that all ITS technologies implemented in the region are designed to be compatible for communications among the systems and with the National ITS Architecture[44]. The TRANSCOM RA system itself provides the links between systems to make these communications possible.

44 National ITS Architecture, ITS Joint Program Office, U.S. Department of Transportation, http://www.its.dot.gov/arch/

TRANSCOM's OpenReach (OR) Project transformed the TRANSCOM RA system from a system that could only be accessed by a centralized workstation at each agency to a system that is accessible anywhere Internet access is available. TRANSCOM OR uses the Google Maps[45] system to improve the user friendliness of the system. Additionally, TRANSCOM OR provides real-time event and link content to the public via TRANSCOM's free data service[46].

Data interfaces have been developed between the TRANSCOM OR system and the Connecticut DOT[47] (ConnDOT's) Crescent and NYSDOT Region 10 TMSs. Data interfaces will also be developed between the OR system and other member agencies' TMSs, such as the New York State Thruway's[48] CARS system. These data interfaces will ensure the reliable transfer of information between these systems without the double entry currently required of the various operations centers.

In addition, the video layer will be enhanced to improve reliability by directly connecting the member agencies' video feeds to the TRANSCOM OR on a separate connection. This work will also allow for the sharing of video from a member agency that currently does not have a web browser for its video feeds.

Pennsylvania

Information sharing in the Philadelphia area is done through a system developed by TRANSCOM called Regional Integrated Multimodal Information Sharing[49] (RIMIS), which is a web-based tool that provides several key functions:

- Provides timely and clear incident notifications and information on the transportation situation
- Broadcasts situational information to a wide array of agencies
- Improves knowledge of the "big picture"
- Reduces the time and cost of obtaining information during emergencies

45 Google Maps, https://www.google.com/maps

46 Transcom's free data service, https://data2.xcmdata.org/DEWeb/Pages/index.jsp

47 Connecticut Department of Transportation, http://www.ct.gov/dot/site/default.asp

48 New York State Thruway, http://www.thruway.ny.gov/index.shtml

49 Regional Integrated Multi-Modal Information Sharing (RIMIS) Project, Delaware Valley Regional Planning Commission, http://www.dvrpc.org/Operations/RIMIS.htm

Figure 5.1 illustrates the many RIMIS partners in the Delaware Valley Regional Planning Commission region.

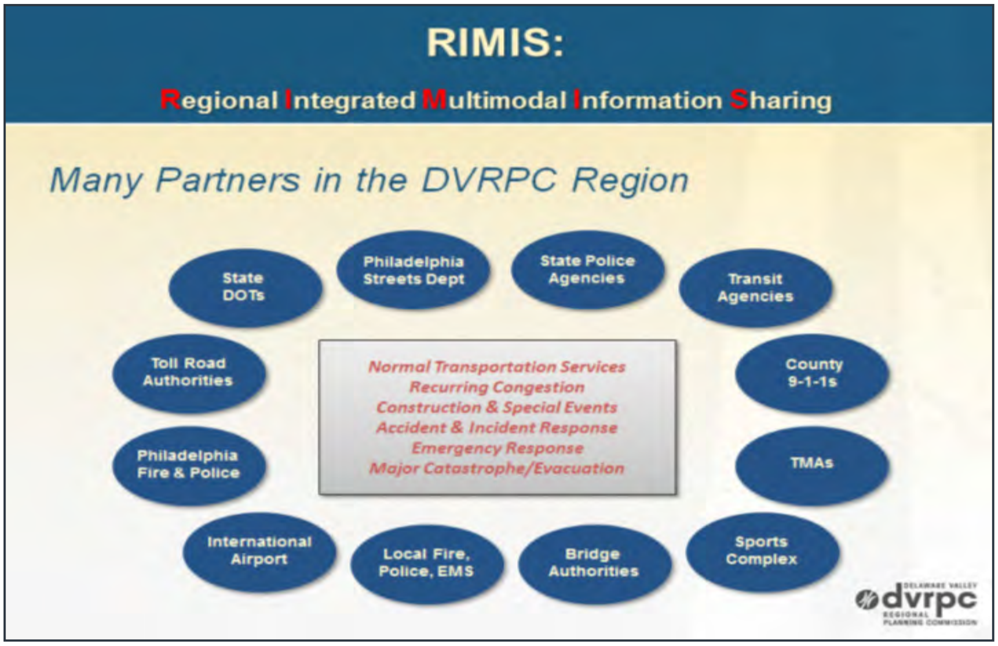

Figure 5.1 *RIMIS partners*

Dallas

The daily operation of the US-75 corridor is coordinated through the existing agreements and information exchange through two systems: the TxDOT C2C project (see Figure 5.2) and the ICMS. The central point of coordination for the corridor is the DalTrans facility; TxDOT, Dallas County, and DART are co-located at the facility.

Figure 5.2 *TxDOT C2C web site*

The ICMS is a mixture of an interagency information exchange tool that allows the agencies within the corridor to coordinate responses to incidents within the corridor, a data fusion engine, and a DSS that selects pre-agreed response plans to coordinate responses to incidents within the corridor.

Development of the C2C project began in 1999. It was originally implemented using the evolving ITS TMDD standard, the message sets associated with TMDD, and protocols (e.g., DATEX) from the NTCIP C2C Working Group[50]. A significant upgrade in functionality was initiated in 2003, and the underlying protocol was changed to XML/SOAP[51]. At the time, the C2C interfaces were defined and the underlying support software was developed, XML schemas were not available from TMDD. A set of XML schema that was optimal for the TxDOT project was developed. It is anticipated that TxDOT will update the C2C infrastructure to use the schema sets after TMDD publishes them.

The C2C project provides an infrastructure for information exchange that has a well-defined interface that allows systems to deposit and retrieve data in a highly predictable fashion. The infrastructure does not permanently store information; all data is kept in memory and is lost when a software process is restarted.

Phoenix

The AZTech public jurisdiction agencies agree to share traffic-management system data with each other, including traffic signal and detector data (e.g., timing plans, approach/depart volume count data, and similar related data).

Data an agency chooses to make available will go to the Regional Archive Data System (RADS), where it will be available through the C2C system once access protocols have been provided to other authorized public jurisdictions. Authorized users will not release data from another owning agency. Requests for data from an outside entity for research, legal, or any other purpose will be referred to the owning agency, where it can be processed according to each agency's policies.

The AZTech C2C specification has been developed through the consensus input of regional stakeholders. Following a systems engineering methodology, a user needs assessment and concept of operations (ConOps) was developed. Based on the ConOps, system functional requirements and a regional stakeholder agreement were then developed.

The system functional requirements for DMSs and traffic management systems are the basis for the development of technical specifications for information exchange among centers in the region.

The technical specifications are based on stakeholder input and review of the requirements analysis and design prepared in 2006. A recently updated, high-level AZTech system diagram is shown in Figure 5.3.

50 Center-to-Center Working Group, National Transportation Communications for ITS Protocol, http://www.ntcip.org/library/groupstatus/default.asp?groupid=2

51 Extensible Markup Language/Simple Object Access Protocol

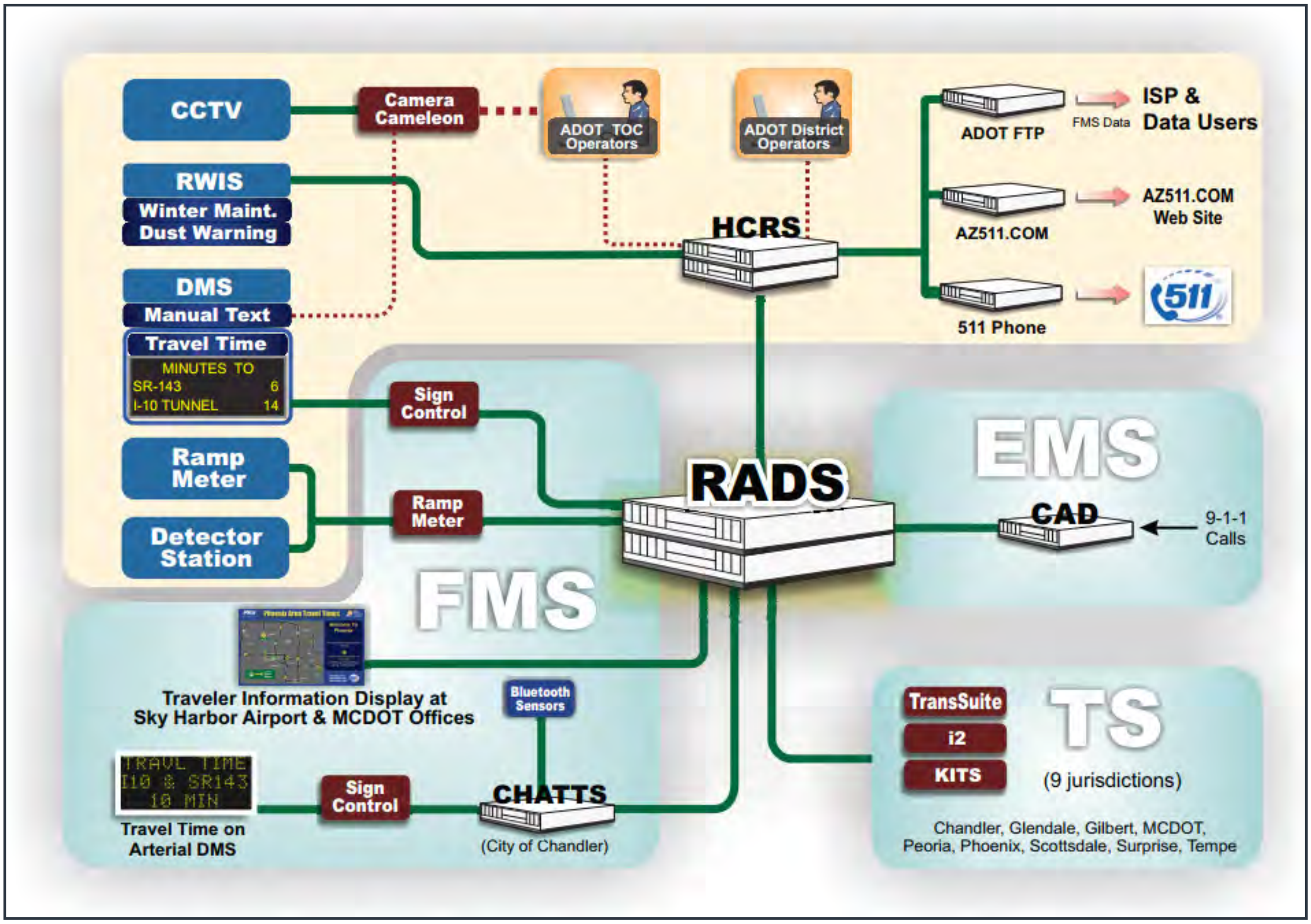

Figure 5.3 *AZTech C2C system*

CHAPTER 6

Traveler Information

As defined in the ITS National Architecture, traveler information services collect traffic conditions, advisories, general public transportation information, toll and parking information, incident information, roadway maintenance and construction information, and air quality and weather information and broadcasts this information to travelers using various technologies. The information can be provided directly to travelers or to merchants and other traveler service providers so that they can better inform their customers of travel conditions. Successful deployment of this service relies on the availability of real-time traveler information from roadway instrumentation, probe vehicles, or other sources.

Each scan tour host site provides traveler information to the public, usually through 511 services, including interactive voice response (IVR), web sites, media feeds, mobile applications, and personalized information.

New York/New Jersey/Pennsylvania

All three states have 511 systems, which are discussed in the following sections.

511NY

NYSDOT's goal for 511NY[52] is to increase travel and transportation satisfaction through increased mobility and reliability, enhanced safety and security, environmental sustainability and impact, economic sustainability and competitiveness, and social equity. 511NY has progressed from a traditional web page and telephone-based traffic information service to a full-featured traveler information portal that provides a range of traveler information services for all modes of surface transportation.

NYSDOT has recognized the true power and critical nature of accurate and comprehensive traveler information and has taken this system from a simple service to a critical tool for managing transportation services and providing guidance to travelers during major events, natural and manmade disasters, and other events affecting the state. NYSDOT has established a vision for the 511NY system to continue to provide comprehensive travel information, including new information as it becomes available, and to add additional formats and capabilities for the traveling public to access this information.

52 511NY, http://511ny.org/

511NJ

511NJ[53] is a free phone and web service that consolidates traffic and transportation information into a one-stop resource for commuters and motorists in New Jersey. 511NJ provides up-to-the-minute traffic conditions and is available seven days a week, 365 days a year. The 511NJ web site was designed to complement the 511NJ telephone service and provides an easy, user-friendly way for commuters to interact with and access the region's transportation information (see Figure 6.1). Users can see where incidents, accidents, congestion, and events like weather and construction are happening before they leave their office or home.

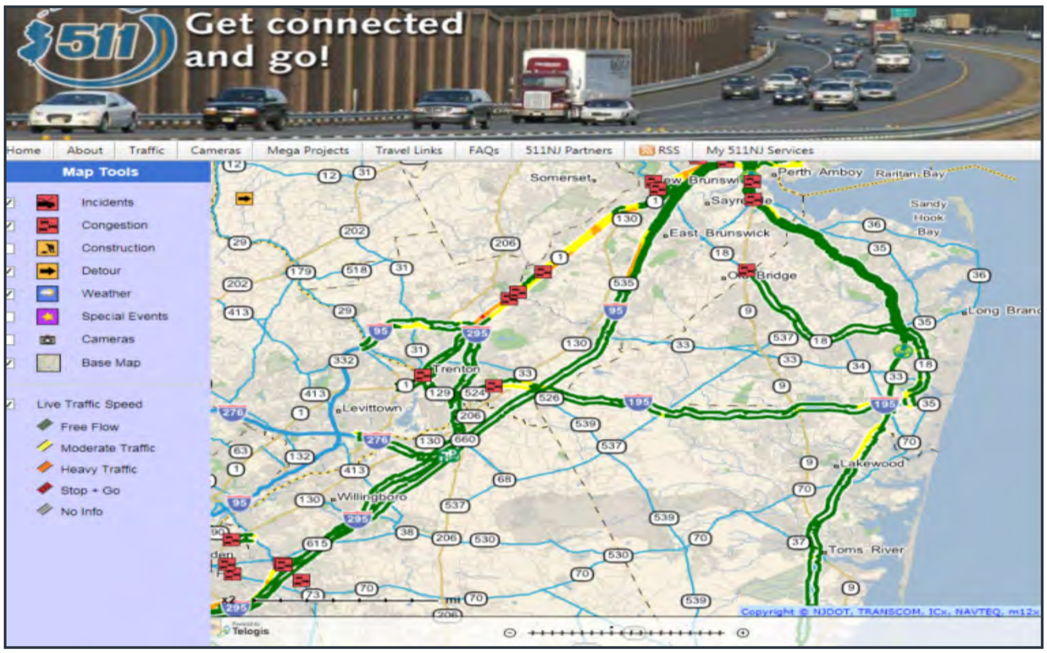

Figure 6.1 *511NJ web site*

511PA

511PA[54] provides free, 24-hour information services, including traffic delay warnings, weather forecasts, regional tourism information, and links to transit agencies and major airports. The service is available by calling 511 from cellular phones and landlines or through the Internet. Users are also able to register through the web site to receive personalized traveler alerts, which are provided through e-mail and text messaging.

The 511PA roadway network includes all 1,759 miles of interstate, including the Pennsylvania Turnpike, as well as other major roadways in Harrisburg, Philadelphia, and Pittsburgh. Traffic information for most of this network includes incident reports (e.g., crashes and construction activities) and, starting in November, winter road conditions. Additionally, average traffic speeds are available for several interstates and other major roadways in urban areas.

53 511NJ, www.511nj.org

54 511PA, www.511pa.com

Dallas

The Dallas ICM project deployed an advanced traveler information system comprising three basic subsystems: a telephony/IVR platform, a public web site[55], and a personalized travel information system (My511[56]). There are plans to develop and deploy a mobile app in the near future.

Dallas SmartNET[57] serves as the central information-sharing system for the ICM agencies and includes a C2C messaging component that facilitates the ability to interface with and share data among transportation systems.

The Dallas ICM project developed the state's first 511 system. The system provides regional traveler information for the Dallas and Fort Worth area. It was not focused solely on US-75, since a 511 system for a single corridor would not be effective.

Minneapolis

MnDOT's 511[58] is a public service to help travelers access information about road conditions, traffic incidents, commercial vehicle restrictions, and weather information via the phone or the web, 24 hours a day, seven days a week. The 511 service provides continual updates about weather-related road conditions, roadwork, commercial vehicle restrictions, road closures, and other travel information via the phone or Internet.

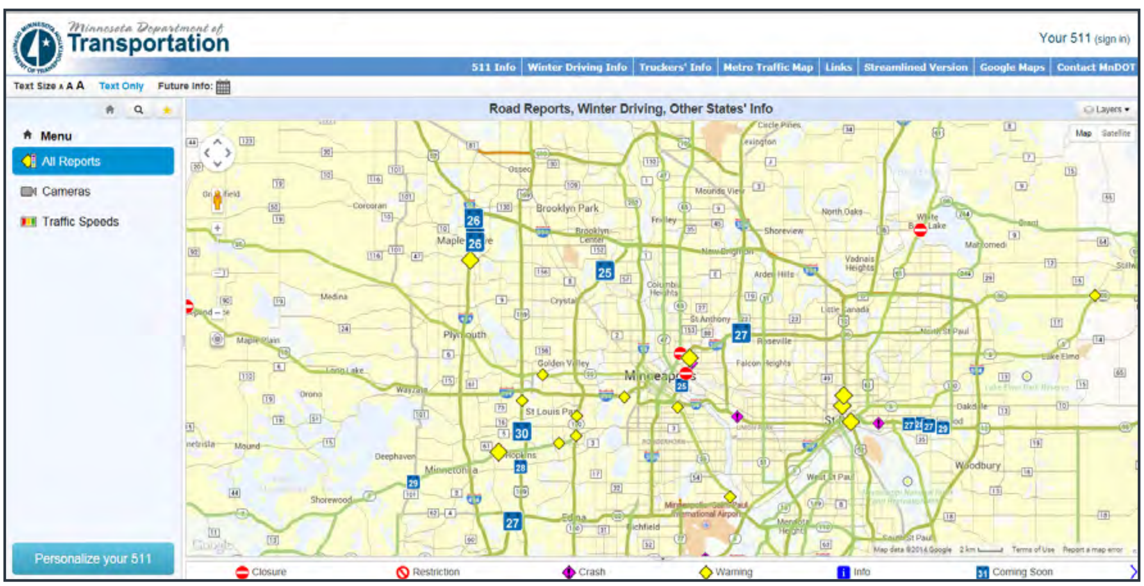

Figure 6.2 *Minnesota 511 web site*

Minnesota introduced 511 in 2002 and was one of the first states in the country to offer this service. In 2009, MnDOT added high bandwidth, and in July 2013, it launched its free mobile app.

55 511DFW, www.511dfw.org

56 My 511DFW, http://511dfw.org/my511/home.aspx

57 US-75 Integrated Corridor Management: SmartNET, http://www.its.dot.gov/icms/pdf/ICMSmartNET.pdf

58 511, Minnesota Department of Transportation, www.511mn.org

Phoenix

The AZ511[59] web site provides the latest information on road conditions and closures, lane restrictions, selected route travel times, border wait times, and weather conditions, allowing users of the Phoenix transportation systems to choose the best route, the best system, and the best time for travel. CCTV cameras capture current travel conditions on many freeway intersections in the Phoenix metropolitan area. Much of this real-time information is also available to travelers by dialing 5-1-1 on any phone.

Early in 2002, AZTech sponsored the adoption of the newly established 511 automated telephone traveler information system for Arizona. Later that same year, a federal model deployment grant for 511 put Arizona in the national spotlight for enhancements to the service. Major improvements that were incorporated included a dedicated traveler information web site with live CCTV images, upgrades to the automated telephone information system, selected freeway travel times, and upgrades for the reporting tools used to enter data for the 511 service.

More recently, AZTech has sponsored a number of updates to make the 511 web site easier to use. In addition to a zoom in/zoom out user feature, the enhancements include easier identification and location of road condition information, expanded road condition and incident information (to include city- and county-owned major streets), and more freeway travel time information. Additional updates are planned for the telephone information portion of the 511 system.

San Diego

In California, instead of a statewide 511 system, the major metropolitan regions provide their own 511 systems. San Diego's 511 system[60] is a free phone and web service that consolidates San Diego's regional transportation information into a one-stop resource. 511SD provides up-to-the-minute information on traffic conditions, incidents, and driving times; schedule, route, and fare information for public transportation; carpool and vanpool referrals; bicycling information; and more. The automated 511 service is available 24 hours a day, seven days a week.

SANDAG leads 511, and a partnership of public agencies (i.e., the California Highway Patrol, Caltrans, the Metropolitan Transit System, and the North County Transit District) manages it:

Recently, as part of the ICM program, a 511 mobile application was developed (see Figure 6.3). This app provides real-time access to traveler information supplied by Caltrans; the Metropolitan Transit System; and the Cities of San Diego, Escondido, and Poway, in partnership with SANDAG. The 511 San Diego app features:

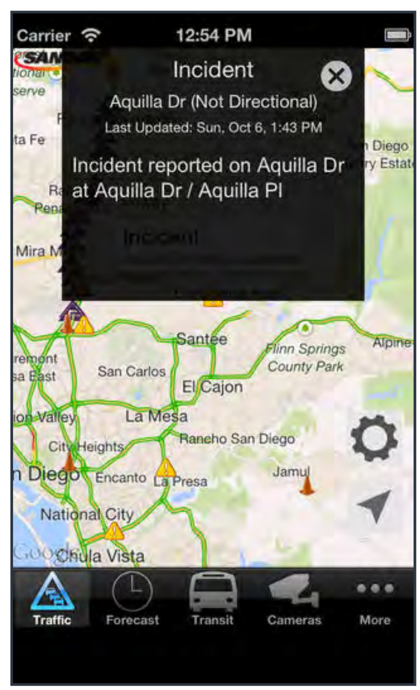

Figure 6.3 ***San Diego 511 mobile app***

59 AZ511, www.az511.gov

60 511SD, www.511sd.com

- Maps with current traffic conditions and the latest incident and construction information on all interstates and state routes in the San Diego region
- Real-time dynamic toll rates for the I-15 Express Lanes
- Predictive travel times, congestion information, and special event information for the I-15 corridor
- Ability to view current roadside camera images
- Access to the Metropolitan Transit System bus routes, fares, and arrival times
- Links to other resources to improve users' commutes

As users drive through the roadway network, the map shows their location and provides optional text-to-speech and look-ahead speech commands for hands-free use while driving.

Decision Support System

A DSS is the foundational methodology behind the deployment of ICM. It is the underpinning of this information-fed, objectives-driven, software-intensive system. Since nominal traffic operations already exist vis-à-vis the individual agencies, the DSS screens for anomalies that are, for the most part, nonconforming to the region and require a coordinated response.

The DSS identifies sudden or pending nonrecurring events (e.g., incidents or weather) or atypical recurring congestion beyond the norm via predictive modeling. This modeling compares "that which should be" to that which presents and is forming, thereby triggering broad response strategies. A DSS constantly mines the real-time data (e.g., detectors, incidents, speeds, warnings, and weather) and evaluates and rates the response plan alternatives for recommendation to the ICM coordinator or team to identify the highest rated plan and associated mitigations. For example, in the San Diego and Dallas deployments, the DSSs are each averaging from one to five response plans per week. Monthly debriefs evaluate the system's success and recommend any fine-tuning that might be needed.

There is no one DSS template. San Diego and Dallas, and indeed many other regions formed or forming, have developed unique approaches, any one of which satisfies the function of a DSS. DSSs can be simple or complex, depending on the users' needs, the data available, and the corridor's model. A simple DSS could be a set of written incident response plans that agencies consult when an incident occurs. For the sites that the scan team visited, more-complex systems were in use and are discussed below.

The Dallas ICM system uses an expert rules system to select a pre-agreed response plan based on numerous variables (e.g., location, time of day, and lanes affected) and then uses a real-time model to validate that the selected plan will provide a benefit. The San Diego system relies on its real-time model much more and allows the model to use engineering principles and algorithms to generate a response plan for an event within the corridor. The system has the capability to be fully automated or fully manual in responding to the event.

Dallas

The Dallas DSS (see Figure 7.1) provides candidate response plans to the SmartFusion subsystem based on network conditions received from the SmartFusion subsystem, prediction analysis, and on a rule-based assessment of the recommended response plans. The subsystem consists of three major components: expert rules, prediction (model), and evaluation.

In response to an incident, the process begins with the expert rules and the model collecting information on corridor performance and incidents from the data fusion system. The model develops an assessment of the current roadway operations based on the data received from the data fusion system. In addition, the model periodically forecasts the current and predicted performance of the network based on the current conditions and sends them to the expert rules system.

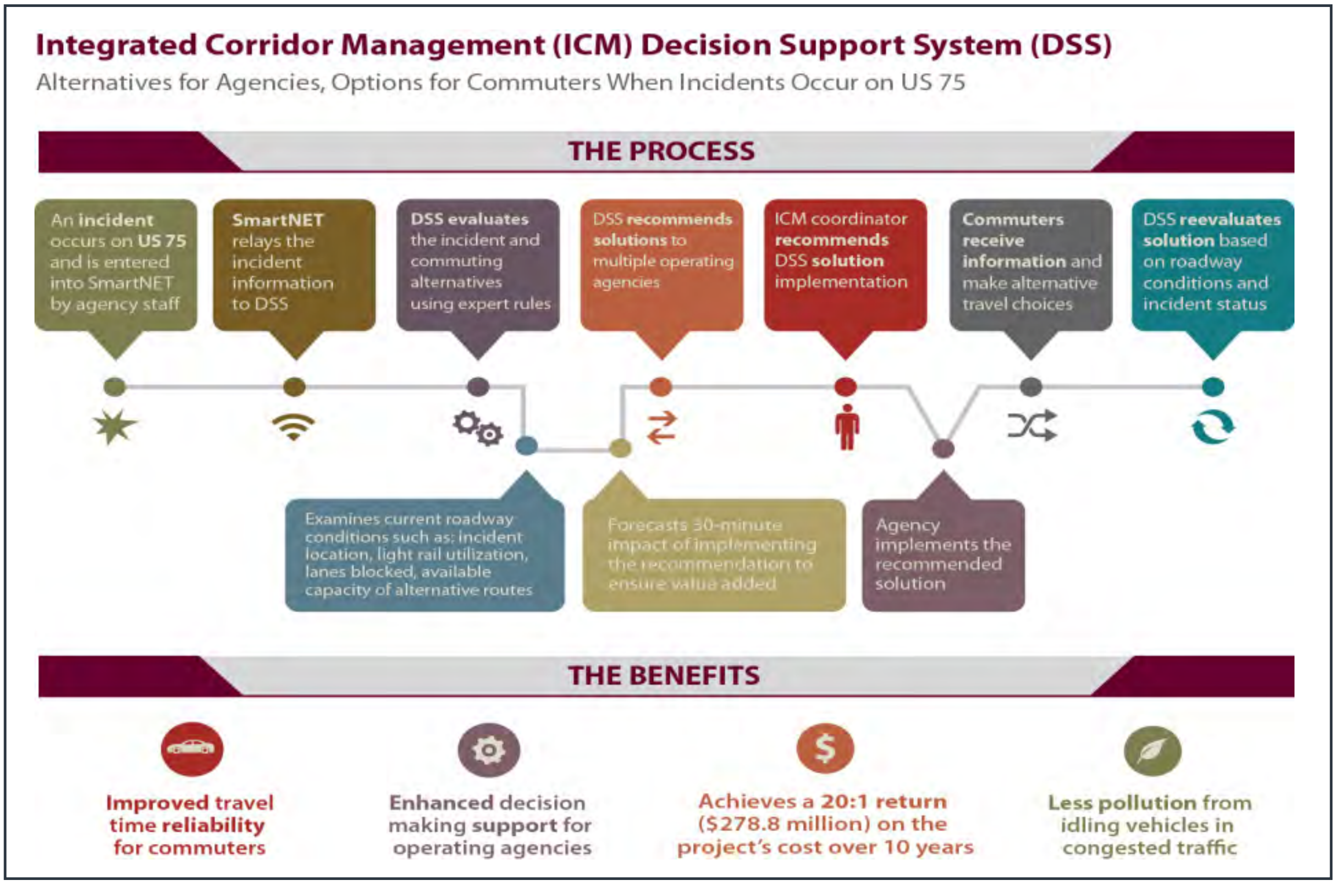

Figure 7.1 *Dallas DSS process*

Given the information about the current conditions of the network and the predicted performance of the network, the expert rules develop candidate response plans that are delivered to the ICM coordinator via the DSS dialog. The ICM coordinator approves or rejects the candidate response plan from the recommendation of the expert rules.

If the ICM coordinator approves the validation decision, then the DSS pushes candidate response-plan information to the involved agency users for plan implementation. The expert rules collect the users plan readiness status and plan decision from the DSS dialog.

After implementing the ICM coordinator's plan decision, each agency user confirms the plan's operational status. The plan is terminated once the event owner agency user or the ICM coordinator closes the event in the ICM System.

San Diego

A key element of San Diego's ICM project includes the implementation of a real-time dynamic DSS. The system uses predictive capabilities to aid stakeholders in managing and operating the corridor proactively and is composed of seven key system components, including an on-line real-time simulation analysis and network predictive system and the application of a dynamic rule-based strategy assessment engine to generate real-time response plan strategies.

The DSS collects information on current network conditions by taking in data from an array of ITS and modal management systems, including, but not limited to, traffic signal systems, ramp metering, transit management, and freeway management systems located along the corridor. Data also include hundreds of traffic volume and speed detectors in the roadway infrastructure and automated passenger counters and location data from transit systems, video camera feeds, and changeable message signs.

Through the DSS data fusion engine, if changes in demand (based on incident or recurring conditions) are measured that meet pre-established thresholds (e.g., a minimum change in speed on the freeway of 10 mph less than free flow), the DSS generates a set of response plans containing recommended strategies to manage the congestion. The DSS assesses the impacts of the response plans on level of service; volume-to-capacity ratio; and speed 15, 30, 45, and 60 minutes in the future.

With the DSS response plan evaluation engine, a set of response plans are evaluated and scored using a traveler, not vehicular, delay-based algorithm to derive the scores for each plan when compared to the "do nothing" case. ("Do nothing" is the base scenario where no new actions would be taken along the corridor and devices maintain normal operations.) The response plan with the best score, representing the most congestion relief, is recommended for implementation.

Once response plans are recommended, the affected agencies are notified, and the specific assets associated with a given response plan are implemented (e.g., en-route and pretrip traveler information, corridor ramp metering, and signal coordination on arterials with freeway ramp metering). The implementation of the preferred response plan can be set to automated implementation or implementation upon approval. Because the DSS is dynamic, it does not contain a set of predefined response plans. It was designed and built to take a performance-based approach to corridor operations and management.

The business rules engine drives how response plans are implemented, how or what key actions the response plans should include, and under what conditions. The engine reflects agreed-upon regional and corridor-level operational principles discussed and set by the ICM partners. This includes, for example, how the assets available on the corridor will be used in response to certain conditions or setting constraints to reflect localized operational demand conditions (e.g., traffic cannot be rerouted onto certain arterials during school zone hours).

The DSS corridor visualization tool gives the ICM stakeholders the ability to view in real-time the specific response plans being implemented. After a plan is implemented, the DSS continues to forecast traffic conditions. As conditions change, the system continues to monitor the extent of the congestion based on the total distance upstream of the event to the end of the congestion. As congestion continues or grows, the system will re-evaluate and generate new response plans to ensure that the best strategy continues to be applied. Once the congestion starts to dissipate and the upstream length of the congestion is reduced, the system steps out of the response plan and places the device back into the normal operations for that time of day.

Each prediction is given a score (see Figure 7.2) using the following formula:

$$\text{Corridor Score} = \frac{D_0 - D_z}{D_0} *100$$

- D_0 = Person-delay under "do nothing" case
- D_z corresponds to the response plan evaluation
  - D_1 = Person-delay under Response Plan A
  - D_2 = Person-delay under Response Plan B
  - D_3 = Person-delay under Response Plan C

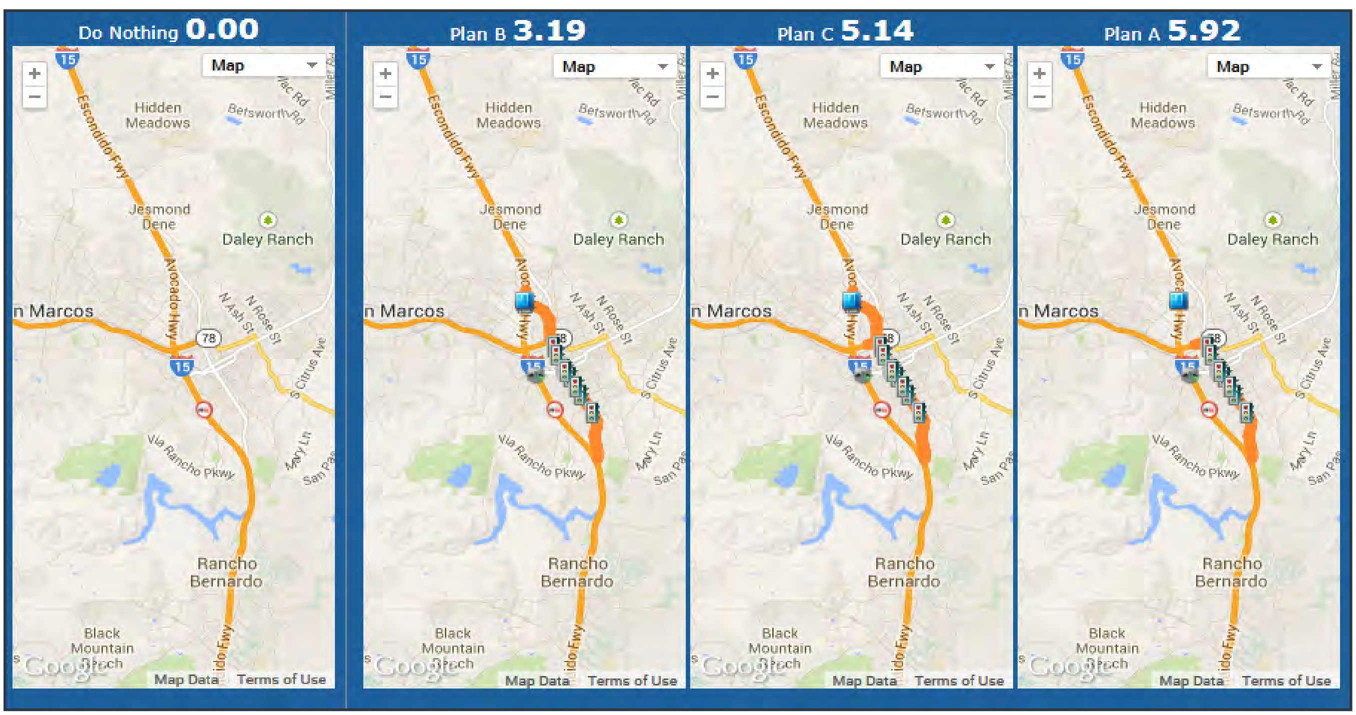

Figure 7.2 San Diego DSS – response plan score

Model of Corridor

In late 2008, the U.S. DOT selected Dallas, Minneapolis, and San Diego to conduct analysis, modeling, and simulation (AMS) of their ICM strategies. These three sites built models to analyze how the proposed application of ICM strategies would affect their respective corridors under different conditions (e.g., planned special events, high traffic congestion, or major incidents).

For ICM to be successful, both a planning-based modeling approach and an operations-modeling approach may be needed. The planning models are used to evaluate scenarios to ensure that the ICM program will provide benefits to the corridor prior to implementation. The operations model is used for validating and potentially developing response plans to events in the corridor.

Dallas

To evaluate the benefits of the proposed ICMS that it developed, Dallas used three modeling tools to look at how the ICMS would work in the real world under simulated conditions. By integrating the results of the travel demand modeling (using TransCAD[61]), and the mesoscopic simulation model (DIRECT[62]), Dallas has been able to look at where bottlenecks could occur and where travel times are unacceptable. Figure 8.1 is an illustration of the DIRECT model.

For ICM operation, the Dallas ICM team uses a mesoscopic model to evaluate the proposed response plans. This mesoscopic model is a subset of the one used during the AMS phase, which has been optimized to be used as a real-time model. The DIRECT model, developed by SMU, is a dynamic traffic-assignment simulation model that captures the dynamic interaction between travel demand and network supply, considering a wide range of operation management strategies. Examples of these strategies include pre-trip and en-route traveler information, dynamic signal timing, HOV and managed lanes, and congestion pricing.

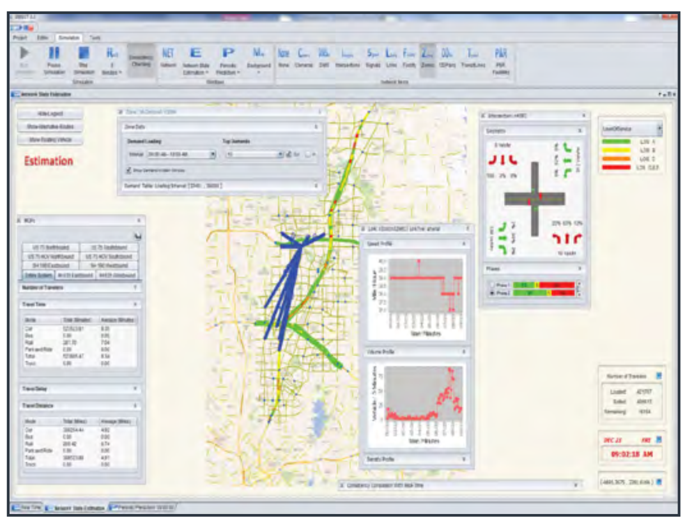

Figure 8.1 *DIRECT model*

61 TransCAD Transportation Planning Software, http://www.caliper.com/tcovu.htm

62 What is DIRECT?, Transportation Research Laboratory, Bobby B. Lyle School of Engineering, Southern Methodist University, http://lyle.smu.edu/~khaled/DIRECT_bro.pdf

Minneapolis and San Diego

The AMS approach was designed to leverage the strengths of various analysis tools, such as travel demand models. The ICM AMS methodology can support corridor management planning, design, and operations by integrating simulation tools and combining their capabilities. Minneapolis integrated macroscopic (Metromodel in TP+) and mesoscopic (DynusT[63]) tools, while San Diego integrated macroscopic (TransCAD) and microscopic (TransModeler[64] Micro) tools.

San Diego used these three levels of models (microscopic, mesoscopic, and macroscopic) to evaluate several ICM scenarios and see how ICM would influence the behaviors in the corridor:

- Daily operations (no incident)
- Major freeway incident
- Major arterial incident
- Transit incident
- Special event
- Disaster response scenario

The San Diego ICM system uses the Aimsun[65] product to provide a multilevel model analysis tool to provide a comprehensive network prediction and analysis tool for day-to-day operations. The Aimsun on-line subsystem uses live data feeds to understand existing conditions and predict traffic conditions 15, 30, 45, and 60 minutes ahead every 5 minutes. The system is the basis for monitoring and anticipating congestion hot spots and launching evaluations of the available strategies to select the best response, minimizing congestion and guaranteeing more accurate travel times for drivers and users of the transportation network. The micro-simulation on-line tool plays a key role in the response-plan evaluation process. It provides the ability to dynamically capture real-time (see Figure 8.2) and projected network and corridor level demand and/or

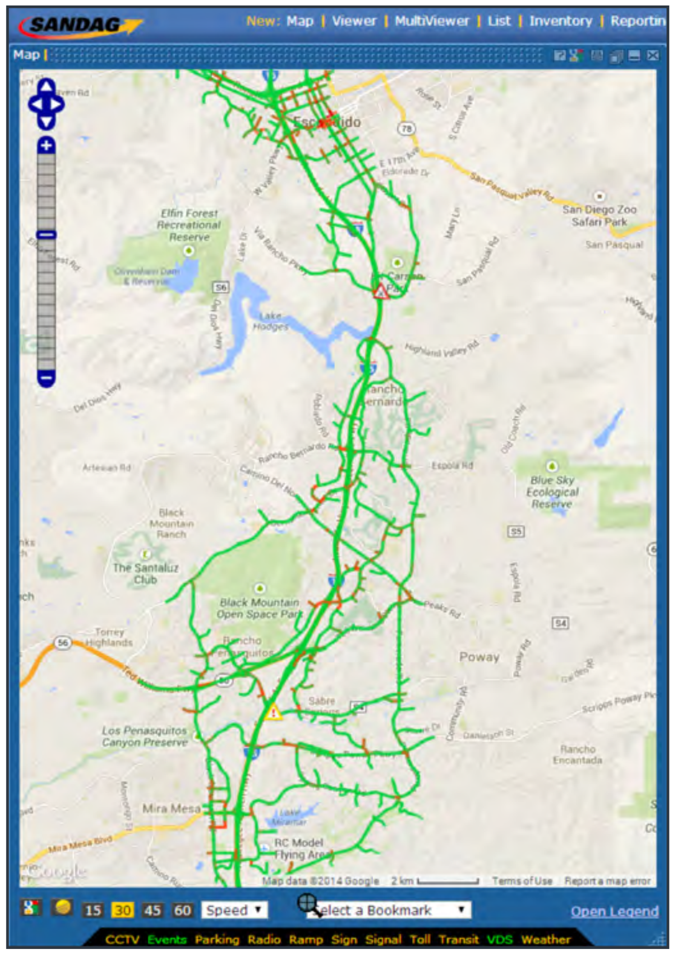

Figure 8.2 San Diego real-time model

63 DynusT, http://dynust.net/

64 TransModeler Traffic Simulation Software, http://www.caliper.com/transmodeler/ListOfProjects.htm

65 TSS-Transport Simulation Systems, http://www.aimsun.com/wp/

capacity imbalances.

Memorandums of Understanding

New York/New Jersey/Pennsylvania

TRANSCOM supplements state and regional traffic and incident management through proactive regional coordination for incident management and multiagency construction coordination. TRANSCOM's member agencies developed and signed a multiyear agreement to fund and provide direction to the committee (see Figure 9.1). While not directly related to ICM, the multiyear agreement provides the region with a cooperative institutional structure for operating the transportation infrastructure within the New York metropolitan region.

Dallas

A blanket ITS cooperative agreement for the region was in place and used by the ICM stakeholders for this project. The ICM program was a part of the transportation improvement program to ensure regional support by the Council of Governments.

An O&M document was developed cooperatively among all the operating agencies in the corridor during the operations phase of the ICM demonstration. The ICM O&M manual has the potential to act as a more detailed agreement.

Phoenix

AZTech began as a federally sponsored traffic management Model Deployment Initiative in 1996. Its beginnings were an experiment in regional cooperation on both institutional and technological levels. At its start, AZTech was one of four regions in the country seeking to demonstrate successful methods of using technology for traffic management and traveler information.

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MEMORANDUM

TO: TRANSCOM Board of Trustees
FROM: Matthew Edelman
DATE: September 10, 2009
SUBJECT: **Executed 2009-2013 TRANSCOM Multi-Year Agreement**

COPY TO: Technology & Operations Committee (w/o enclosure)

Enclosed for your files is an executed copy of the TRANSCOM 2009-2013 Multi-Year Agreement. It contains thirteen original signature pages from each of the agencies which are a party to this agreement. (Please note that the New York State Thruway Authority has asked us to insert a photo copy of their notarized signature page after their original signature page, as well).

Thank you very much.

Matthew Edelman
Executive Director

Enc.

TRANSCOM IS A NON-PROFIT CORPORATION FUNDED IN PART BY ITS MEMBER AGENCIES AND THE FEDERAL HIGHWAY ADMINISTRATION

Figure 9.1 *TRANSCOM multiyear agreement*

AZTech completed the initiative in 2000, and its accomplishments represented a validation of new, real-time, technology-driven traffic management and traveler information systems. Building on that success, in 2005 AZTech began transitioning into a regionally integrated, traffic data sharing, and permanent partnership entity. The C2C system, whereby Model Deployment Initiative-validated traffic management tools and information could be shared among traffic and emergency management agencies in real time, became the central data-sharing system for accomplishing the integration goals that AZTech had envisioned from the beginning.

Throughout the initial demonstration project and continuing into a permanent partnership, AZTech has now evolved into a successful regional traffic management entity. The partnership has carefully integrated individual traffic management strategies and technologies for the region's benefit, yet has retained most operational control protocols important to individual units of government.

Early on, AZTech adopted several values, goals, and strategies to guide its growth from a demonstration project to what has become a full-fledged regional partnership:

- Values
  - Collaboration
  - Leadership
  - Integration
  - Results
- Goals
  - Integrate the existing ITS infrastructure into a regional system
  - Establish a regional integrated traveler information system
  - Expand the transportation management system for the Phoenix metropolitan area
- Strategies
  - Establish education and outreach programs
  - Expand and strengthen partnerships
  - Optimize regional operations and management
  - Plan, develop, and deploy integrated regional systems
  - Research and test new technological opportunities

San Diego

Initial related documentation that was created during the project included a project charter and individual MOUs. Such documents provided high-level guidance on the needed coordination/cooperation. During the ICMS's design and development, the focus turned to the needed operational consensus. These agreements were documented through agency-level memorandums, which served as the platform for an ICMS operational framework document. The operational framework establishes and sets the conditions for using the individual network assets under the ICMS environment and reflects the input and agreement of all partner agencies.

Summary of Key Findings

Based on the findings from the desk scan, the U.S. DOT ICM program, and the scan tour, the scan team agreed on several key item areas considering an ICM program will need.

A Champion

Most ICM projects have had a champion from one of the agencies to help get the project started, funded, and driven to completion. The scan team found that while a champion is necessary to get an ICM program started, the interjurisdictional nature of an ICM project necessitates that the program reach the point where it becomes routine and the agencies and organization provide the necessary momentum and continued support. This way, even if the champion leaves, the program will continue.

As an example, the Phoenix area has a cooperative ITS organization that began as part of the U.S. DOT Model Deployment Initiative in the mid-1990s. Today, AZTech is still being used as the regional organization that cooperatively plans ITS projects, including ICM.

Benefits of ICM

ICM provides benefits, no matter how simple or complex the program. A system that only provides notification of events provides limited benefit; however, interagency contact provides benefit by understanding and discussing events that affect other agencies.

Building Blocks of ICM

As part of this report, the scan team discussed the need for assistance for agencies thinking of starting an ICM program. The scan team agreed that four basic areas are needed to begin an ICM program.

Available Capacity

There must be available capacity within the transportation network to manage a corridor through a multiagency or multimodal ICM approach. If a freeway is congested, there must be capacity on an alternate freeway, the adjacent arterial network, or transit servicing the corridor for ICM to be considered.

Exchange of Data

There must be an exchange of data between agencies responding to an event with the managed corridor. This could be as simple as telephone calls discussing and agreeing to a response; this would be the minimum. For data exchange to be effective, the scan team recommends an automated data sharing system. Since these systems may vary among agencies responding to events, a standards-based system (e.g., C2C, TMDD, Message Sets for External Traffic Management Center to Traffic Management Center Communication (MS/ETMCC), or transit communications interface profiles) should be used for easier integration.

Institutional Cooperation

There must be open communication and cooperation among agencies to operate the assets within the corridor. This can be done informally (i.e., operational personnel share information and coordinate responses among agencies) or more formally (i.e., through intergovernmental agreements or MOUs that define roles and responsibilities). Some areas have been successful using high-level ITS cooperative MOUs, while others have developed ICM-specific MOUs.

The scan team found that formal agreements seem to be required for the long-term success of ITS programs, especially ICM programs. Without these formal agreements, it may be difficult to sustain higher level management and political buy-in. Formal agreements also assist with the funding process and help with planning for the operational costs each agency will need to provide for an ICM corridor.

MPOs should be involved with ICM programs from a programming and funding point of view. In some areas of the country, MPOs are also involved with some aspects of operations; their involvement has been critical due to their regional point of view.

Finally, ICM is a name, a concept, a tool, as a part of the much bigger concept of cooperation among regional agencies to better operate a corridor, a city, a region, and more. ICM has to become an integral part of any future local, regional, and statewide ITS strategic plans. It is hoped that proper planning will ensure the essential political buy-in of the concepts and funding.

Coordinated Response

For ICM to work properly, all agencies involved with the corridor's operations must coordinate their response to events. An agency that does not coordinate its response has the potential to negatively affect the corridor. Once the ICM program is in place and operational, it is time to test, update, and validate the response plans used by the corridor.

Recommended Next Steps

Capability Maturity Model

CMM was originally developed as a tool for objectively assessing the ability of government contractors' processes to perform a contracted software project. The model is a framework that demonstrates the key elements of a process. CMM describes an evolutionary improvement path for agencies for various transportation areas from ad hoc, immature processes to a mature, disciplined process in a path laid out in five levels (see Table 11.1). When using the CMM, transportation professionals in government and industry can develop and improve their ability to identify, adopt, and use sound management and technical practices for delivering transportation services to a state, region, or corridor.

Within the transportation community, the CMM model has been used for evaluating the maturity of various ITS programs, and workshops developed by U.S. DOT have been held to help states identify areas for improvement in their transportation system management and operations programs and in ITS programs in general.

Applying CMM to ICM

Based on the levels of maturity of the different building blocks of ICM, the scan team believes that the application of a CMM for ICM can help agencies evaluate their ability to deploy an ICM program, as well as identify areas for improvement.

The CMM model is a five-level process-focused model (see Table 11.1) that shows the evolutionary processes within the process areas that the scan team believes are most important for implementing and improving an ICM program. As previously stated, however, the basic building blocks of having a champion and having the infrastructure in place are needed to begin an ICM program.

This CMM model for ICM is designed to compare a corridor agency's existing processes to best practices developed by members of industry, government, and academia that were shown and discussed as part of this scan. These best practices reveal possible areas for improvement and provide ways to measure progress.

Table 11.1 *ICM capability maturity model*

		Level 1 Silo	Level 2 Centralized	Level 3 Partially Integrated	Level 4 Multimodal Integrated	Level 5 Multimodal Optimized
Institutional Integration	Inter-agency Cooperation	Agencies do not coordinate their operations	Some agencies share data, but operate their networks independently	Agencies share data, and some cooperative responses are done	Agencies share data, and implement multi-modal incident response plans	Operations are centralized for the corridor with personnel operating the corridor cooperatively
	Funding	Single Agency	MPO tracks funding	Coordinated funding through MPO	Cooperatively fund deployment projects	Cooperatively fund deployment and operations and maintenance of projects
Technical Integration	Traveler Information	Static information on corridor travel modes	Static trip planning with limited real-time alerts	Multimodal trip planning and account based alerts	Location-based, on-journey multimodal information	Location-based, multimodal proactive routing
	Data Fusion	Limited or Manual	Near real-time data for multiple modes	Integrated multi-modal data (one-way)	Integrated multi-modal data (two-way)	Multi-source multi-modal data integrated and fused for operations
Operational Integration	Performance Measures	Some ad-hoc performance measure based on historic data	Periodic performance measures based on historic data	High-level performance measures using real-time data	Detailed performance measures in real-time for one or more modes	Multi-modal performance measures in real-time
	Decision Support System	Manual coordination of response	Pre-agreed incident response plans	Tool selection of pre-agreed plans	Model based selection of pre-agreed plans	Model based creation of incident response plans

Interagency Cooperation

Purpose

The interagency cooperation process area is focused on the cooperation among agencies for the operation of the corridor.

Specific Goals and Practices

- Level 1: Agencies do not coordinate their operations with other agencies. They manage their own network independent of neighbors.
- Level 2: Some agencies share data but operate their networks independently. Traffic or operational data may be shared either through an automated process or manually.
- Level 3: Agencies share data, and some cooperative responses are done. Data is shared through an automated feed (e.g., Center to Center) or manually.
- Level 4: Agencies share data and implement multimodal incident response plans. Incident response uses a multimodal approach with defined detour routes.
- Level 5: Operations are centralized for the corridor, and personnel operate the corridor cooperatively. A central system is used to coordinate operations, and personnel may be co-located or work virtually with robust communication among agencies.

Funding

Purpose

The funding process area focuses on the funding mechanisms and cooperation among agencies to coordinate funding decisions for the corridor. Traditionally, funding is available from the federal government for planning and deployment of ITS projects; however, local jurisdictions fund O&M.

Specific Goals and Practices

- Level 1: Agencies fund projects without input or coordination with other agencies.
- Level 2: The MPO tracks funding of projects within the region.
- Level 3: Agencies coordinate funding of deployment projects through the MPO.
- Level 4: Agencies and the MPO cooperatively fund deployment projects for the corridor.
- Level 5: Agencies and the MPO cooperatively fund deployment and O&M of projects for the corridor.

Traveler Information

Purpose

The funding process area focuses on the availability of transportation information for the public. This could include a range of information, from basic static information (e.g., maps and transit schedules) to more real-time, personalized information based on current conditions, travel profiles, and recommendations on alternate routes and modes.

Specific Goals and Practices

- Level 1: Travelers can access static information by mode, such as routes and schedules for transit or freeway and arterials maps for route planning.
- Level 2: Travelers can access some real-time information for individual modes, but information is not integrated in one place. Trip planning is available based on static information.
- Level 3: Travelers can access real-time information for all modes, and trip planning includes comparison travel times. Travelers can set up personalized travel alerts.
- Level 4: Travelers can access real-time information for all modes, and trip planning includes comparison travel times. Travelers receive personalized travel alerts, and multimodal information is provided based on current location.
- Level 5: Travelers can access real-time information for all modes, and trip planning includes comparison of travel times. Travelers receive personalized travel alerts and multimodal recommendations on alternate routes and modes. Travelers also receive predictive travel times.

Data Fusion

Purpose

The data fusion process area relates to transportation agencies' ability to accept and disseminate information across multiple modes to enable informed decision-making. This integration extends the security and privacy concerns arising from data collection because it increases the scope and reach of the information generated. Data collection functions provide necessary "raw material" for transport network management; however, decisions cannot be made on data. In fact, many transportation agencies have too much data. To be useful, the data must be integrated and transformed into information.

Specific Goals and Practices

- Level 1: Individual agencies have data on their systems, and some sharing is done either through a data feed or manually.
- Level 2: Multiple agencies have near real-time data, which is provided to the travelers in the corridor; however, the data is not centralized.
- Level 3: Multiple agencies have near real-time data, which is integrated into a central data system and provided to the travelers in the corridor. Data is only one way; that is, agencies provide data to the central system, but do not receive fused data from the central system.
- Level 4: Multiple agencies have near real-time data, which is integrated into a central data system and provided to the travelers in the corridor. Data is provided to the agencies, so that their operational systems are updated with fused data.
- Level 5: Multiple agencies and modes have near real-time data, which is integrated into a central data system and provided to the travelers in the corridor. Data is provided from both private and public sources and fused together to provide more coverage of the entire corridor. Data is provided back to the agencies, so that their operational systems are updated with fused data.

Performance Management

Purpose

The performance management process area is concerned with actively managing the transportation network by using performance measures. With the requirements of MAP-21[66], many states are moving to a performance measures based approach.

Specific Goals and Practices

- Level 1: Performance is not measured. Agencies have specific operating missions and fulfill that mission within their budgets.
- Level 2: Performance is measured by mode-specific metrics. Agencies focus on operations based on their specific facilities.
- Level 3: Performance is measured across modes and may affect some planning or investment activities, but not operations.
- Level 4: Performance is measured across multiple modes, and operational performance is measured using real-time data. Planning and investment activities are affected by performance of the individual modes, but not across all modes.

66 MAP-21 – Moving Ahead for Progress in the 21st Century, https://www.fhwa.dot.gov/map21/

- Level 5: Performance is measured across all modes, and operational performance is measured and optimized using real-time data. Planning and investment activities are affected by performance of all modes within the corridor.

Decision Support System

Purpose

The DSS process area is concerned with the tools used to respond to events within the corridor. A simple DSS could be a set of written incident response plans that agencies consult when an incident occurs. This system matures as it becomes more automated, and eventually the system creates response plans based on engineering principles and lessons learned from previous plans.

Specific Goals and Practices

- Level 1: Agencies coordinate responses via communication with one another on an ad hoc basis.
- Level 2: Agencies have a written pre-agreed incident response plan for most situations.
- Level 3: A tool is used to select the pre-agreed incident response plans based on various factors, including incident location and current traffic conditions.
- Level 4: A model is used in real time to validate and enhance the tool used to select response plans.
- Level 5: A tool uses a model, engineering rules, and infrastructure status to create incident response plans for conditions within the corridor

Industry Outreach

Lastly, the scan team developed an implementation plan for informing the industry of the scan results. This includes presenting at various conferences, publishing papers on the findings of this research, and developing the CMM for ICM (see page 11-1).

Appendix A: Scan Team Biographical Sketches

DHANESH (DENNIS) MOTIANI (AASHTO CO-CHAIR), a 24-year veteran of the New Jersey DOT, was appointed to the position of Assistant Commissioner, Transportation Systems Management, in 2013. He is responsible for ensuring safe and reliable travel for people and goods on New Jersey's highway system through the oversight and management of a 24/7 statewide operation broken down into two sections (Division of Traffic Operations and Division of Mobility and Systems Engineering). In cooperation with the New Jersey State Police, Motiani oversees the Statewide Incident Management Program and traffic coordination for special events, such as the 2014 Super Bowl. Motiani is a member of the Strategic Highway Research Program's Technical Coordinating Committee for Reliability; the Transportation Research Board's Work Zone Traffic Control Committee; the American Association of State Highway and Transportation Officials Subcommittee on Systems Operation and Management, where he is a member of the leadership team; and the National Cooperative Highway Research Program's Study Team, which is focusing on work zones and speed management. Motiani has served as Chairman of the Intelligent Transportation Society of New Jersey (ITSNJ) since January 2013 and is a member of the Policy and Business Council for the Intelligent Transportation Society of America, the parent organization of ITSNJ. Motiani holds a bachelor's degree in civil engineering from the University of Gujarat in India and a master's degree in transportation engineering, from the New Jersey Institute of Technology, Newark, New Jersey.

NEIL SPILLER (FHWA CO-CHAIR) is a Transportation Specialist with the Federal Highway Administration's Office of Operations at its headquarters in Washington, DC. He manages the Integrated Corridor Management program, the Localized Bottleneck Reduction program, and is co-manager of the Managed Lanes program, with emphasis on legislative concerns and public inquiries. He is a member of the TRB Access Management Committee. In his capacity for ICM, Spiller facilitates FHWA's participation in U.S. DOT's ICM initiative, along with staff from the offices of the Federal Transit Administration and the Department of Transportation's Joint Program Office. Spiller is a member of the FHWA Operations Council, which exists to promote all facets of operations' activities to FHWA field offices and disseminate important research and initiatives to peers elsewhere. Prior to joining FHWA in 2002, Spiller was the transportation engineer and planner for Frederick County (Maryland); prior to that, for 12 years he was a traffic and transportation engineer with a traffic firm. He has a bachelor's degree in civil engineering from the University of Maryland at College Park and also attended James Madison University in Harrisonburg (Virginia).

DR. NICHOLAS COMPIN is currently the project manager for the California Department of Transportation's Connected Corridors Project (California ICM). He is responsible for coordinating all aspects of the project, including the interaction between UC Berkeley PATH research personnel, Caltrans multi-division headquarters and district personnel, and personnel from the Metropolitan Transportation Authority (MTA) in Los Angeles as Caltrans begins to pilot active corridor management on a highly congested corridor in the Los Angeles region. This is a monumental effort that combines existing and near-term completion research provided by UC Berkeley and others with existing personnel and information technology structures at Caltrans and MTA and relies on results of ongoing ICM efforts in Dallas and San Diego and related efforts throughout the world. Prior to his current assignment, Compin managed Caltrans' Performance Measurement System (PeMS) and

Caltrans's Traffic Census Program. He also held positions in the Caltrans Director's Office and with the California Transportation Commission previously. Compin has served on the panels of NCHRP 20-24(37) Measuring Performance among State DOTs: Congestion, SHRP 2 (Project L33) Technical Expert Task Group on Urban Freeway Models Validation, and NCHRP 08-62 Transportation System Performance Management: Insight from Practitioners. Compin received his doctoral degree from University of California, Irvine.

ANNE RESHADI, PE, is the Traffic Systems & Management Engineering Manager for the Wisconsin Department of Transportation's Bureau of Traffic Operations. In this role since 2010, she is responsible for the Statewide Traffic Operations Center; ITS design, operations, and maintenance; signal, lighting, and electrical policy and standards; and operational strategies, performance, and management. She has been with the department for 24 years, holding positions in traffic operations, signal operations, traffic incident management, and freeway design. Reshadi is a graduate of the University of Wisconsin–Milwaukee with a bachelor's degree in civil engineering and is a licensed professional engineer.

BRIAN UMFLEET, PE, is a Traffic Operations Engineer with the Missouri Department of Transportation's St. Louis District. Umfleet manages the department's St. Louis Transportation Management Center and Motorist Assist programs. He is a member of the Operations Working Group of Heartland ITS, Institute of Transportation Engineers, and the Transportation Engineering Association of Metropolitan St. Louis. Umfleet has been with the Missouri Department of Transportation for 18 years, holding positions in highway design and traffic engineering. He recently led a team that developed a statewide comprehensive Traffic Incident Management program for the state of Missouri. Umfleet is a 1996 graduate of the Missouri University of Science and Technology with a bachelor's degree in civil engineering. He is a licensed professional engineer in the state of Missouri.

TODD WESTHUIS, PE, is the Director of the Office of Traffic Safety and Mobility in the Operations Division at the New York State Department of Transportation. He is responsible for delivering solutions that employ new systems and technology to improve and guarantee safe, reliable travel in New York State. This wide-ranging role includes overseeing the department's mobility and safety programs, managing emergency transportation operations, and leading Governor Cuomo's "Drivers First" initiative. Westhuis is a licensed professional engineer and has been with NYSDOT for 20 years, where he has served in a number of capacities. Westhuis is a graduate of Rensselaer Polytechnic Institute and a former Army officer. He has supported his alma mater, Rensselaer, as an adjunct in the Civil Engineering Department.

DR. KEVIN T. MILLER, PE (SUBJECT MATTER EXPERT), is the Integrated Corridor Management Practice Lead for Schneider Electric. He is based in Troy (Michigan) and is currently the Deputy Project Manager for the US-75 ICM Demonstration Project in Dallas (Texas). His work includes developing and updating all project documentation for the ICM demonstration, including the concept of operations, system design documents, and system test plans, among others. Since joining Schneider Electric in 2005, he has worked on several projects using his expertise in the systems engineering process and background in information technology. Before joining Schneider

Electric, Miller served in a variety of technology-related jobs and industries, including working for General Motors, Lockheed Martin, and the Federal Highway Administration. Miller has a doctoral degree in civil and environmental engineering from the University of Iowa, is a registered Project Management Professional with PMI, and is a registered professional engineer in seven states.

DR. AHMAD SADEGH (SUBJECT MATTER EXPERT) is Vice President of Schneider Electric. Since 1995, he has managed the development and deployment of many regional integration and information-sharing systems. He served as the Project Manager, providing expertise in ITS development to TRANSCOM (a 16-member consortium of transportation and public safety agencies in the greater New York City metropolitan area) for implementation of its regional architecture application. For the past eight years, Sadegh has managed all stages of the Dallas ICM corridor and 511DFW projects. He currently serves as the Project Manager for the deployment of the US-75 ICM project, which includes the 511DFW deployment and operations and maintenance services. He has managed this project for the past eight years, which included the development of concept of operations, requirements and design, development and integration of systems, deployment, and operations and maintenance services.

Appendix B: Scan Team Contact Information

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Appendix D: Amplifying Questions

Building Blocks

- What agreements/MOUs are in place for operations and maintenance among agencies in the region? Is there one agreement covering the broad spectrum or multiple agreements?
- Is there an established traffic incident management program/partnership?
- What are your interjurisdictional challenges (e.g., political, institutional, and operational)?
- What data sharing (e.g., center-to-center and video) exists among the agencies?
- What existing multiagency working groups/committees are established?
- Is there a multijurisdictional oversight/advisory committee created for the region?
- What funding sources are available?

ICM Organization

- How many agencies are involved?
- Is there one lead agency?
- What is the staffing? Is contracted staff involved? What is the organizational structure? Is interjurisdictional staff co-located?
- Is there a DOT TMC or an interjurisdictional TMC?

Concept: How (and why) did you pick your corridor? What is its vision?

- What is your region's definition of ICM?
- What criteria were used to select which freeway corridors/arterials are a part of the ICM? Describe the operating characteristics/challenges pre-ICM.
- Please explain the timeframe, from initial planning to deployment.
- What are the key objectives of the ICM deployment?
- How did you define success?
- Which agencies were involved with defining the corridor?

Evaluation – Performance Measures

- What evaluation method was used to identify potential ICM strategies and their benefits?
- What criteria were used as part of the evaluation of potential strategies?

- What modeling was used as part of the evaluation methodology?
- What analysis was used as part of the development and implementation approach?
- What performance measures are in place? Who is collecting the data? What reporting is being done, including how and with whom is it shared?
- Is a study available?
- What are the lessons learned?

Technology

- What technologies have been considered, updated, deployed, and integrated as part of your ICM?
  - Adaptive ramp metering? What controllers and firmware are planned/used?
  - Traffic signal systems (e.g., traffic responsive or adaptive)? If it is included, what system was chosen? Multijurisdictional control?
  - Parking management?
  - 511 systems/traveler information kiosks/apps?
  - Travel times for alternate routes?
  - Private sector/public authorities?
  - Center to center?
  - HOT lanes?
  - AVL/APC on transit?
  - Transit signal priority?
  - Provide data to public?
  - TDM strategies?
  - Weather/environmental sensors?
  - Hard shoulder running?
  - Others?

Funding

- What is the level of funding for deployment?
- What is the level of funding for long-term operations?
- How are equipment upgrades handled and funded?
- What resource sharing is done (e.g., fiber sharing or cabinet sharing)?

Operation

- Is there a standardization of equipment (e.g., signal controllers and signal poles)?
- Transit capacity increases during incidents?
- Common objectives for operations (e.g., signal timing plans across jurisdictions)?
- What Traffic Incident Management (TIM) programs are in place?
- Do you have enabling legislation for quick clearance?

Public Awareness

- What traveler information strategies were considered and deployed?
  - Comparative travel times (freeway, arterial, transit)?
  - 511/travel apps?
  - Parking availability?
  - Travel times on DMS?
  - Data portal to public?
- How is your public outreach measured?
- What public outreach was done as part of the process?
- What has been the public perception post deployment?

Appendix E: Host Agency Answers to Amplifying Questions

Only Dallas, Phoenix, and San Diego have fully implemented ICM. Their responses to all amplifying questions are provided in this appendix. The other sites provided responses to some questions during their presentations as part of the scan.

Dallas

Building Blocks

What agreements/MOUs are in place for operations and maintenance among agencies in the region? Is there one agreement covering the broad spectrum or multiple agreements?

> A blanket ITS cooperative agreement for the region was in placed and used by the ICM stakeholders for this project. The ICM program was a part of the transportation improvement project to ensure regional support by the Council of Governments. The ICM O&M Manual has the potential to act as a more detailed agreement.

Is there an established traffic incident management program/partnership?

> Yes. The agencies have been participating in incident management and regional training for many years.

What are your interjurisdictional challenges (e.g., political, institutional, and operational)?

> Ongoing capital, operating, and maintenance funding is a continued challenge.

What data sharing (e.g., center-to-center and video) exists among the agencies?

> TxDOT and NCTCOG have led regional data-sharing efforts, including, C2C and video sharing.

What existing multiagency working groups/committees are established?

> Within the ICM program there is an ICM Steering Committee, ICM Operations Committee, and ICM 511 Committee. Within the region, NCTCOG includes a Transportation Committee and an ITS Committee.

Is there a multijurisdictional oversight/advisory committee created for the region?

> Yes, through NCTCOG. In the ICM project, the stakeholders committee serves as this.

What funding sources are available?

> NCTCOG provides various funding for ITS projects, including Congestion Mitigation and Air

Quality Improvement (CMAQ) Program[67] funds. U.S. DOT funds, local soft match, and local hard match funds from DART and NCTCOG have funded the ICM program.

ICM Organization

How many agencies are involved?

Nine public agencies (DART; NCTCOG; TxDOT; the Cities of Dallas, Plano, Richardson, University Park, and Highland Park; and NTTA) and three universities (Texas A&M, Southern Methodist University, and University of Texas-Arlington) are involved.

Is there one lead agency?

Yes, for Federal Funding purposes; this agency is currently DART.

What is the staffing? Is contracted staff involved? What is the organizational structure? Are inter-jurisdictional staff co-located?

Existing operations staff is used for the daily operation of the system. The ICM coordinator, provided by DART, leads the ICM responses. The DART HOV operations team is co-located with TxDOT at the DalTrans facility. The other operating agencies (i.e., DART bus, light rail, North Texas Tollway Authority[68], and cities) operate out of their normal operations center.

Is there a DOT TMC or an interjurisdictional TMC?

DOT TMC (DalTrans) has both DART and Dallas County Sheriff (courtesy patrol) co-located. DART has operations centers for bus, light rail. And cities have traffic management centers for their traffic signal operations.

Concept: How (and why) did you pick your corridor? What is its vision?

What is your region's definition of ICM?

Our vision is to operate the US-75 corridor in a true multimodal, integrated, efficient, and safe fashion where the focus is on the transportation customer.

What criteria were used to select which freeway corridors/arterials are a part of the ICM? Describe the operating characteristics/challenges pre-ICM.

The primary criteria were to select a congested corridor where there are both transit and other alternative routes available for diversion in the case of an incident. US-75 is fully built

67 Congestion Mitigation and Air Quality Improvement (CMAQ) Program, Federal Highway Administration, http://www.fhwa.dot.gov/environment/air_quality/cmaq/

68 North Texas Tollway Authority, https://www.ntta.org/Pages/default.aspx

out, with no ability for new capacity additions. A DART transit line and regional arterials parallel it. The existing agencies do very well with day-to-day operations. What causes problems with the corridor operations are non-recurring events, such as incidents. Multi-jurisdictional responses were not being attempted before ICM.

Please explain the timeframe, from initial planning to deployment.

The ConOps and requirements were done over a one- to two-year period, the AMS phase was done over 18 months, and the development and deployment phase was completed in three years. The program began in October 2006 and became operational in April 2013.

What are the key objectives of the ICM deployment?

These are the goals and objectives of the US-75 ICM program.

Goals	
Increase corridor throughput The agencies within the corridor have done much to increase the throughput of their individual networks, from both a supply and operations point of view, and they will continue to do so. The integrated corridor perspective builds on these network initiatives, managing delays on a corridor basis, using any spare capacity within the corridor, and coordinating the junctions and interfaces between networks to optimize the corridor's overall throughput.	■ Increase the vehicle person throughput of the US-75 corridor ■ Increase transit ridership, with minimal increase in transit operating costs ■ Maximize the efficient use of any spare corridor capacity such that delays on other saturated networks may be reduced ■ Facilitate intermodal transfers and route and mode shifts ■ Improve preplanning (e.g., developing response plans) for incidents, events, and emergencies that have corridor and regional implications
Improve travel time reliability The transportation agencies within the corridor have done much to increase the mobility and reliability of their individual networks and will continue to do so. The integrated corridor perspective builds on these network initiatives, managing delays on a corridor basis, using any spare capacity within the corridor, and coordinating the junctions and interfaces between networks, thereby providing a multimodal transportation system that more adequately meets customer expectations for travel time predictability.	■ Reduce overall trip and person travel time through the corridor ■ Improve travel predictability ■ Maximize the efficient use of any spare corridor capacity such that delays on other saturated networks may be reduced ■ Improve commercial vehicle operations through and around the corridor ■ Increase travel time reliability (i.e., lower the 95% travel time)

Goals	
Improved incident management Provide a corridor-wide and integrated approach to the management of incidents, events, and emergencies that occur within the corridor or that otherwise affect the operation of the corridor. The approach includes planning, detection and verification, response, and information sharing, so that the corridor returns to "normal" more quickly.	■ Provide/expand means for communicating consistent and accurate information regarding incidents and events between corridor networks and public safety agencies ■ Provide an integrated and coordinated response during major incidents and emergencies, including joint-use and sharing of response assets and resources among stakeholders and development of common policies and processes ■ Continue a comprehensive and ongoing training program – involving all corridor networks and public safety entities – for corridor event and incident management ■ Reduce secondary crashes
Enable intermodal travel decisions Travelers must be provided with a holistic view of the corridor and its operation through the delivery of timely, accurate, and reliable multimodal information, which then allows travelers to make informed choices regarding departure time, mode, and route of travel. In some instances, the information will recommend travelers to use a specific mode or network. Advertising and marketing to travelers over time will allow a greater understanding of the modes available to them.	■ Facilitate intermodal transfers and route and mode shifts ■ Increase transit ridership ■ Expand existing automatic terminal information systems to include mode shifts as part of preplanning ■ Expand coverage and availability of ATIS devices ■ Obtain accurate real-time on the current status of the corridor network and cross-network connections

How did you define success?

Improvement in corridor throughput, travel time, and reliability without creating anything to the detriment of others in the corridor. Also, building the coalition of agencies and integrating their operations during and after an incident.

Which agencies were involved with defining the corridor?

DART; NCTCOG; TxDOT; the Cities of Dallas, Plano, Richardson, University Park, and Highland Park; and NTTA

Evaluation – Performance Measures

What evaluation method was used to identify potential ICM strategies and their benefits?

Traffic simulation modeling and operating agencies' knowledge and experience

What criteria were used as part of the evaluation of potential strategies?

Congestion levels in the corridor, available capacity on alternate routes and light rail, ITS infrastructure availability, and signal controller spare capacity for new timing plans

What modeling was used as part of the evaluation methodology?

A mesoscopic model (DIRECT) developed by Southern Methodist University

What analysis was used as part of the development and implementation approach?

Incident cluster analysis, modeling, and incident responsive traffic signal plans

What performance measures are in place? Who is collecting the data? What reporting is being done, including how and with whom is it shared?

This is a multipronged effort:

- Battelle evaluation study collects performance measures pre- and post-ICM as U.S. DOT's lead evaluator.
- The stakeholders review each event with a recommended plan monthly. Data collected is duration of event, severity, and performance of agencies' dialogue to implement the recommended actions.
- The ICM team collects detailed performance metrics for certain incidents. The performance metrics are travel time on US75, frontage roads, and Greenville and 511 usage statistics. These are compared against non-incident days.

Is a study available?

U.S. DOT/Battelle is developing an evaluation report that will not be completed until 2015.

What are the lessons learned?

Still being evaluated

Technology

What technologies have been considered, updated, deployed, and integrated as part of your ICM?

Data integration and fusion, regional information sharing, DSS, 511 system, parking management, signal system, and real-time weather information

- Adaptive ramp metering? What controllers and firmware are planned/used?
  - No – no ramp meters in the region
- Traffic signal systems (e.g., traffic responsive or adaptive)? If it is included, what system was chosen? Multijurisdictional control?

- An adaptive signal system was evaluated and tested in Richardson, but did not meet the expectations. A real-time responsive signal timing system was used as a replacement.

- Parking management?
  - Yes. A system provides lot occupancy in real time at five light-rail park-n-ride stations. The parking facilities were equipped with parking management as part of the ICM.

- 511 systems/traveler information kiosks/apps?
  - The 511DFW system was developed as part of the ICM program, this includes a web site (www.511dfw.org), and IVR system. Future enhancements planned include a mobile app and social media integration.

- Travel times for alternate routes?
  - Yes. Bluetooth and Navteq data are used on the alternate routes. Through personalized My511, users are able to see travel times for alternate routes. The 511 web site also provides multiple transit trip itineraries with travel times for each.

- Private sector/public authorities?
  - Navteq speed data for all Dallas-Fort Worth arterials and highways was incorporated to support the 511 system.

- Center to center?
  - TxDOT C2C was used.

- HOT lanes?
  - Not yet. Currently managed HOV lanes have the capability in the future to be HOT lanes, but are not used.

- AVL/APC on transit?
  - As part of the ICM program, the Federal Transit Administration provided additional funding to instrument 20 light rail vehicles to complement approximately 25 vehicles already instrumented. As part of the FTA grant, all the data on the Red Line is now real time.

- Transit signal priority?
  - Transit signal priority was already in existence in downtown Dallas for the light rail vehicles. We considered deploying transit signal priority in Richardson and Plano; however, due to institutional issues, we were unable to complete that portion of the project.

- Provide data to public?
  - Data is provided to the public via the 511 system, including the 511DFW web site and IVR system. TxDOT provides traffic information via DMS. An XML-based data feed will be provided to the public in the near term to allow public use of the data for mobile app development, and company web sites.
- TDM strategies?
  - Not at this time, except organic TDM from better traveler information
- Weather/environmental sensors?
  - No. However, we do receive real-time weather data and forecasts from a third-party provider, which is integrated into the ICM system.
- Hard shoulder running?
  - With continuous frontage roads, hard shoulder running has not been needed.
- Others?
  - A DSS that uses a mesoscopic simulation model is used as part of the DSS.

Funding

What is the level of funding for deployment?

U.S. DOT provided $6.3 million for funding the system design, development, and deployment as part of the Stage 3 grants. In addition, $900,000 was provided for the AVL/APC.

The total cost of the project, excluding the cost of the 511DFW traveler information system, is approximately $9.9 million. The cost for the first year of 511DFW operation is approximately $1.2 million.

What is the level of funding for long-term operations?

The partner agencies are currently in discussions for operation of both the 511 system and ICM system for 2015.

How are equipment upgrades handled and funded?

Some IT upgrades were performed during the deployment of the Stage 3 ICM system. This included new servers and software to support the 511 system and ICMS.

What resource sharing is done (e.g., fiber sharing or cabinet sharing)?

CCTV, DMS, TMC, and fiber

Operation

Is there a standardization of equipment (e.g., signal controllers and signal poles)?

Not yet

Transit capacity increases during incidents?

The DART light rail has not the capability to reduce headways and/or increase the number of light rail vehicles on the Red and Orange Lines in the North Central Corridor. On the North Central Corridor, DART operates peak frequency of minutes between trains. On all other lines the frequency is 15 minutes Due to station platform length on the North Central Corridor, two car trains are the largest supported. DART is seeking funding to allow platforms on the system to accommodate three car trains, but this is unlikely to happen until after 2016.

Common objectives for operations (e.g., signal timing plans across jurisdictions)?

Provide more green time on diversion routes (frontage roads and Grenville Avenue), public awareness via DMS and 511, and promote transit mode shift

What Traffic Incident Management (TIM) programs are in place?

Stakeholders conduct post-mortem evaluations of major ICM events.

Do you have enabling legislation for quick clearance?

Not in the Dallas region

Public Awareness

What traveler information strategies were considered and deployed?

- Comparative travel times (freeway, arterial, transit)?
  - Comparative travel times were considered in the development of the ICM response plans and for personalized My511 users.
- 511/travel apps?
  - 511 was deployed. Travel apps may be in future program if funding is available.

- Parking availability?
  - Yes, for the light rail stations within the corridor. There is surplus capacity on the stations within the corridor at present.
- Travel times on DMS?
  - TxDOT published travel times on DMS prior to ICM. As part of ICM the DMS are now used to inform the public of alternate routes or use of light rail.
- Data portal to public?
  - Planned for the near future – waiting for institutional legal coordination

How is your public outreach measured?

This will be part of the U.S. DOT national evaluation task. Metrics for the 511 system are reported monthly to the ICM stakeholders. Metrics include, for example, number of hits and phone calls.

What public outreach was done as part of the process?

DART implemented a public campaign that consisted of billboards and in-transit information. The national evaluation included surveys. The stakeholders' team continues to attend various local and national meetings and make presentations on the project status.

What has been the public perception post-deployment?

This is still under evaluation. Comments received through the 511 system have been positive and have also included suggestions for expansion of the coverage area.

Phoenix

The responses to these amplifying questions focus primarily on the Loop 101 ICM pilot corridor.

The Phoenix metropolitan region has been focusing on the concept of ICM since the early 2000s. The 2003 Maricopa Association of Governments (MAG) Regional Concept of Transportation Operations identified a regional goal of establishing three integrated freeway/arterial corridors by 2008. The Maricopa County Department of Transportation (MCDOT) submitted a pioneer site ICM application as part of the original U.S. DOT pioneer site opportunities in 2006; the application was not selected. In 2007, MAG submitted an ICM-focused application as part of the U.S. DOT Urban Partnership Agreements; it also was not selected.

The region has maintained its commitment to implementing strategies and integrating systems to support improved freeway/arterial coordination as part of a longer-term ICM goal. This has been accomplished primarily by MAG directing regional CMAQ Program funds for ITS projects that support ICM, along with local agency contributions. This has resulted in incremental improvements in processes and systems using regional and local funds.

The 2012 MAG ITS strategic plan not only identified ICM as an important priority for the region, it also identified a target of allocating 25 percent of ITS funds programmed at the MPO for ICM projects. Per this plan, ICM strategies will support real-time system operations needs during nonrecurring events (e.g., a major incident on the freeway that diverts traffic onto arterials) and support day-to-day congestion management and mobility options for travelers in the region.

Many of the strategic ITS priorities in the MAG plan point to a need for better real-time data, improved coordination and information sharing among agencies, and operational strategies that balance demand across modes and help to respond to real-time conditions on freeway, arterial and transit systems.

Steps toward this objective include:

- Plan for ICMs—evaluate key corridors and unique issues that could be addressed through ICM strategies and develop specific plans to update and implement ITS equipment and the necessary institutional and operational relationships
- Identify ITS technology and infrastructure needs—use the TIP programming process to implement projects that help to achieve ICM goals
- Evaluate freeway management system (FMS) needs to support ICM—assess infrastructure needs and evaluate the priority of FMS improvements to incorporate ICM strategies
- Implement a pilot program—deploy, operate, test, and evaluate ICM under recurring and nonrecurring conditions, and report on performance

Several key corridors in the region would benefit from ICM strategies. The I-10 corridor was the subject of the prior two ICM-focused federal grant applications and remains a high priority for ICM focus. MAG also has initiated a comprehensive corridor study of the I-10/I-17 "Spine" through the metropolitan area, and this study is looking at ICM and potential active traffic management strategies in addition to infrastructure improvements.

AZTech partners have developed an ICM approach and are pilot testing improved coordination and traffic management processes for incidents that close the Loop 101 corridor in Scottsdale. Loop 101 was selected for the initial pilot based on three factors:

- The unique density of arterial ITS infrastructure
- Staff expertise and resources for arterial traffic management during emergency reroutes
- The ability to establish some initial operating parameters that could eventually be considered for other corridors in the region

Responses to amplifying questions below primarily focus on the ICM implementation for Loop 101.

Building Blocks

What agreements/MOUs are in place for operations and maintenance among agencies in the region? Is there one agreement covering the broad spectrum or multiple agreements?

For Loop 101, the following agreements support coordination and operations activities:

- AZTech charters
- Regional Emergency Action Coordinating Team (REACT) Intergovernmental Agreement (IGA) (MCDOT and City of Scottsdale)
- ADOT, MCDOT, and City of Scottsdale (Master IGA)—This is currently under development.
- MCDOT and Salt River Pima-Maricopa Indian Community (SRPMIC) (signal operations IGA)
- AZTech freeway/arterial operations white paper
- AZTech operational guidelines
- Mutual aid agreements (fire)

Is there an established traffic incident management program/partnership?

Yes. A multiagency, multidisciplinary AZTech TIM Coalition was established in 2010. The AZDPS leads this coalition, which includes ADOT, MCDOT, local fire and police departments, and towing operators. The coalition meets every two months to review performance statistics, discuss major incident debriefings, detail progress on TIM training, and discuss operations/coordination issues and other topics. Although no formal MOU is in place for this coalition, the established relationships through the AZTech partnership as a result of several of the agreements identified in the answer to the previous question benefit the AZTech TIM Coalition and partnership (in particular, AZTech charters, IGAs for REACT support, mutual aid agreements, and AZTech operating guidelines for CCTV and DMS).

Other AZTech efforts, including incident management data available through the RADS, support improved local agency notifications of arterial and freeway incidents, allowing for more proactive traffic management and emergency rerouting during incidents.

What are your interjurisdictional challenges (e.g., political, institutional, and operational)?

A key interjurisdictional challenge is that the metropolitan area has a decentralized structure, with ADOT operating freeways and each local agency operating its respective road and traffic management system. While this structure benefits local operations (as agencies can design and implement systems that best suit local needs), it requires interagency collaboration and system integration for regional initiatives. AZTech provides a platform for interagency collaboration for operations.

Funding for operations is a challenge, particularly funding to expand or enhance systems in the near term, as well as for longer-term maintenance and sustainability. Programming local projects through the TIP is typically a three- to five-year process. Operational agreements take time to develop and work through. There are some established good relationships for the implementation for Link 101; however, other corridors could be more challenging, based on current level of partnering, available field equipment and infrastructure, and other factors. Integrating new partners (e.g., SRPMIC and local police) can also be challenging, particularly if they have not been active in system operations/management discussions. Resource constraints can make getting all agencies to the table for joint training challenging.

Currently, there are about 12 TMCs in the region. However, no local traffic management center in the area has 24/7 staffing. The ADOT Transportation Operations Center is the only 24/7 traffic operations/management center, but ADOT does not have the ability to operate local agency-owned traffic management systems. Because of the limited business-hour operations of the local TMCs in the region, information sharing after hours becomes challenging. For Loop 101 operations though, both MCDOT and Scottsdale have remote access capabilities for staff to access critical system elements from secure connections if they are away from their respective TMCs.

From an operations perspective, partners do a good job with operating their respective systems. Presently, there is no shared, automated, decision-support capability to support ICM and freeway/arterial coordination. Partner collaboration and strategy implementation are handled through direct communication among TMCs and staff. This is supplemented by the existing tools that support data sharing and automated incident notifications (as described in our answer to the next question).

What data sharing (e.g., center-to-center and video) exists among the agencies?

This region has implemented several tools and processes to enable multi-agency data sharing to support ICM in the Loop 101 and other corridors.

- The AZTech RADS supports C2C communications to allow sharing of freeway/arterial incident data between transportation management agencies, as well as local agency signal timing/operations data. This provides a neutral platform for agencies to share data and view adjacent agency data.
- The AZTech Regional Information System is a new tool that supports notifications of incidents/closures, allowing agencies to select specific areas for which they want to receive notifications. Speed maps and volume information for freeways are also accessible.
- Video sharing is enabled through the MAG Regional Community Network and web-based tools.
- ADOT's Highway Condition Reporting System is accessible to local agencies; this data also feeds into the RADS and AZTech Regional Information System (ARIS).
- The City of Scottsdale TMC supports information sharing with the Scottsdale Police Department.

What existing multiagency working groups/committees are established?

Operations: Multi-agency committees/groups:

- AZTech Executive Committee
- AZTech Strategy Task Force
- AZTech Advanced Traveler Information Systems (ATIS) Working Group
- AZTech Operations Committee
- AZTech TMC Operators Working Group
- AZTech TIM Coalition

Regional planning:

- MAG ITS Committee

Figure E.1 depicts the current interactions among the various stakeholder entities involved in planning, implementing, and operating ITS in the region. The MAG ITS Committee consists of representatives of individual local agencies who also participate in AZTech committees.

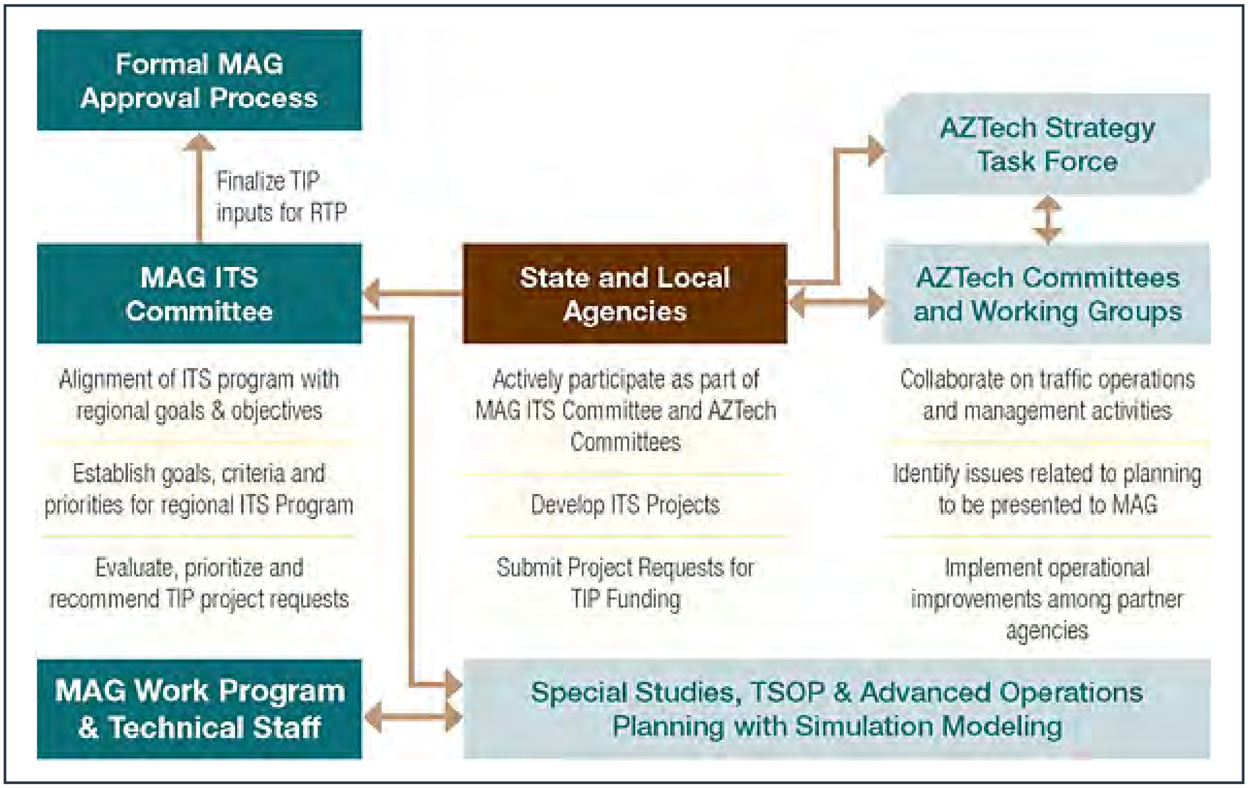

Figure E.1 ***2012 MAG ITS strategic plan***

Is there a multijurisdictional oversight/advisory committee created for the region?

A Loop 101 ICM Operations Partnership was established for this pilot project, and a master agreement is in progress. The partners have collectively analyzed routes and processes for coordinating on Loop 101 closures and reroutes, and developed the initial strategies and communication processes. This group met for a tabletop exercise and post-incident analysis. The AZTech Strategy Task Force also provides ICM operations input.

The MAG ITS Committee, as part of its 2012 ITS Strategic Plan, identified ICM as a priority for the region. This committee includes several members of the Loop 101 ICM Operations Partnership (i.e., ADOT, AZ DPS, MCDOT, and the City of Scottsdale), as well as other transportation agencies throughout the region. MAG provided modeling for the Loop 101 plan.

What funding sources are available?

In addition to local agency funds, local agencies also receive funding for ITS infrastructure through the MAG planning process. Each agency provides its own funding for infrastructure and O&M. Staff positions involved in supporting ICM for city, county and state employees are also funded from their respective agencies. MCDOT did receive a federal grant in fiscal year 2009 for expanding REACT operations in the Cities of Peoria, Glendale, and Scottsdale.

Funding for future infrastructure enhancements to support ICM is not currently programmed in the Loop 101 corridor, but could be available through the regional TIP if projects are submitted and approved. This would include a combination of CMAQ Program and local funds (minimum of 5.7 percent local match).

ICM Organization

How many agencies are involved?

Several partner agencies support ICM coordination efforts on the Loop 101 Corridor. They include:

- ADOT: Traffic Operations Center, Communications/Public Information Officer (PIO), ALERT Response Team
- Arizona Department of Public Safety: Dispatch, Patrol
- MCDOT: Traffic Engineering, Traffic Management Center, and REACT
- MAG: Modeling and Analysis
- City of Scottsdale: Traffic, Transportation Management Center, Police, and Fire
- SRPMIC: Fire

Is there one lead agency?

Loop 101 ICM supports incident management only; thus, incident command leads field operations. Key resources involved in incident traffic management and emergency rerouting include Arizona DPS, ADOT, MCDOT (including REACT), City of Scottsdale (TMC, police, and fire), and SRPMIC fire.

MCDOT and ADOT lead activities related to overall operations development and processes, lessons learned, and other activities for the Loop 101 ICM.

What is the staffing? Is contracted staff involved? What is the organizational structure? Are inter-jurisdictional staff co-located?

Staffing represents agency staff; contractor staff is not involved in the operations. Interjurisdictional staff is not co-located.

- **ADOT:** The ADOT TOC maintains 24/7 operator coverage from its facility. There are four to five operators on duty during peak weekday travel, and one to two operators on evenings/weekends. The ALERT team includes staff available 24/7 to respond to major freeway incidents and closures. ADOT has PIO staff at the TOC for 18 hours each day to be able to quickly send notifications and updates on major incidents or closures. Four PIO staff members rotate shifts to provide coverage.
- **MCDOT:** REACT has two full-time staff and 17 additional responders (mostly secondary job assignment); the TMC has five staff (includes supervisor, signal analyst, senior ITS specialist, and operators). The MCDOT TMC is not open 24/7; TMC staff has remote access capabilities to be able to monitor and operate key systems from secure web-based connections. The MCDOT TMC is activated after hours during REACT response.
- **City of Scottsdale:** The Scottsdale TMC is staffed 6:00 a.m. to 6:00 p.m. on weekdays and includes five staff members (ITS manager, ITS engineer, ITS operators, and assistants) who monitor and manage the arterial network in Scottsdale. The TMC manages more than 300 traffic signals, 140 arterial CCTVs, and 30 message boards. Staff is experienced in modifying signal timing plans to better respond to real-time conditions. (They have 18 flexible plans for each intersection.) Scottsdale TMC staff has remote access to the city's traffic management system if an issue arises outside of business hours.
- **AZDPS:** Arizona DPS is staffed 24/7 at its dispatch center and with patrol operations. Officers respond to freeway incidents and crashes and will request the ALERT Response Team through the ADOT TOC if needed.
- **Scottsdale PD:** The Scottsdale Police Department is staffed 24/7 at its dispatch center and with patrol officers. There is close coordination between the Scottsdale Police and Scottsdale TMC.
- **Scottsdale Fire:** Scottsdale Fire Department responds to freeway and arterial incidents in Scottsdale and coordinates with AZDPS on-scene for freeway incidents.
- **Salt River Pima-Maricopa Indian Community:** Portions of the Loop 101 corridor are located in the SRPMIC fire response area. If an incident occurs in this area, SRPMIC Fire can be a first responder and will coordinate with AZDPS on-scene.

Is there a DOT TMC or an interjurisdictional TMC?

No. Each agency has its own TMC; for Loop 101, this includes the ADOT, Scottsdale, and MCDOT TMCs. Through the AZTech partnership, agencies in the region have developed regional operational guidelines. Real-time data is exchanged between the agencies through the RADS and ARIS for interjurisdictional operations support. MCDOT TMC provides e-mail alerts to AZTech partners.

Concept: How (and why) did you pick your corridor? What is its vision?

What is your region's definition of ICM?

As previously stated, the region's ITS strategic plan defines ICM strategies that will support real-time system operations needs during nonrecurring events (e.g., a major incident on the freeway that diverts traffic onto arterials) as well as day-to-day congestion management and mobility options for travelers in the region.

The Loop 101 ICM focuses only on an event-based operations scenario involving a freeway closure and the associated emergency rerouting onto arterials. There is recognition that an incident-caused freeway closure puts a tremendous strain on freeway mobility and on the surrounding arterial network that must handle the increased volume of diverting traffic. AZTech partners see ICM as an essential strategy to better leverage the existing traffic management systems and tools, as well as enhance coordination among partners to improve freeway/arterial coordination during freeway closures.

What criteria were used to select which freeway corridors/arterials are a part of the ICM? Describe the operating characteristics/challenges pre-ICM.

ICM planning initiatives are underway for I-10 and for the I-17/I-10 Spine. This response focuses on the Loop 101 context.

In 2006 (updated in 2012), the City of Scottsdale's ITS manager prepared the Freeway-Arterial Operations AZTech White Paper[69], which outlined several issues regarding traffic interchange signal coordination and operations. This helped elevate the dialogue on freeway/arterial operations within AZTech committees. It also outlined initial recommendations for physical connectivity among key centers, leveraging staff resources and expertise, enhancing coordination among agencies, and elevating the knowledge among local agencies about different traffic interchange control strategies.

The Loop 101 plan development was triggered by a detailed debrief led by an AZTech TIM Coalition and ATIS Working Group. The debrief pertained to an incident that occurred on Loop 101 in 2012 and which closed the freeway from approximately 3:00 a.m. to 10:00 a.m. on a

69 Freeway-Arterial Operations, AZTech™ White Paper, Approved 4/19/06, http://www.aztech.org/docs/FAO-TI_4-19-06.pdf

Friday. This closure diverted freeway traffic onto the arterial street networks near the incident. This detailed debrief, an analysis of diverting traffic patterns and their associated effects, and an assessment of the sequence of events (e.g., notifications and strategy implementation), identified several gaps that the AZTech TIM and ATIS groups recommended be addressed. These included: implementing improved freeway incident notification processes, particularly for local traffic management agencies; better use of available systems, tools, and data feeds for real-time information; and improved coordination on preferred arterial alternate routes for diverting traffic.

The City of Scottsdale is unique in that it has a dense arterial ITS infrastructure and an experienced TMC operations staff that could have initiated arterial management strategies had it been notified before the center's 6:00 a.m. operating start time. Scottsdale has some arterials that are better suited for freeway traffic diversions than others are, and without a coordination plan in place, freeway responders diverting traffic were not aware of potential arterial effects or preferred arterial alternate routes. Furthermore, traffic that diverted east of the Loop 101 freeway was diverted onto the SRPMIC roads, which do not have sufficient lane capacity to handle freeway traffic volumes.

With all of these factors, the AZTech partnership opted to move forward with a pilot project to develop a formal, coordinated strategy for using ICM during freeway closures on the Loop 101.

Please explain the timeframe, from initial planning to deployment.

The Loop 101 plan was initiated in January 2013 and completed the following January. Implementation is in progress. A multiagency tabletop exercise was performed in May 2014 to review and validate the processes identified in the plan.

The operational strategies for Loop 101 did not require the implementation of any additional infrastructure and represent a low-cost option, given current funding constraints. The focus for the initial pilot was to improve processes, agency coordination, and communications; develop arterial routing strategies; and test new tools to provide local agencies with additional decision support and situational awareness. Future phases will look at needed tools or additional interfaces to support improved coordination and communications among partners.

What are the key objectives of the ICM deployment?

The key partners involved in the Loop 101 ICM pilot program established the following overarching goals for this corridor:

- Reduce secondary crashes
- Improve response and clearance time
- Provide notification and traveler information to agencies and public
- Provide efficient and effective incident and traffic management

Key partner agencies also identified the following specific goals for their operations, which were incorporated into the Loop 101 ICM plan and associated recommendations:

Agency	Goals
ADOT	■ Reduce secondary crashes
ADOT	■ Reduce secondary crashes ■ Improve response and clearance time ■ Mitigate freeway traffic ■ Provide better traveler information ■ Hold debriefing sessions to identify opportunities for improvement
AZDPS	■ Improve safety of first responders ■ Improve response and clearance time ■ Reduce secondary crashes ■ Enhance services and skill sets to support incident response and management
City of Scottsdale	■ Receive early notification of incident/closure ■ Implement a set of response plans ■ Identify performance metrics to measure benefits of ICM strategies ■ Identify a communication plan with agencies ■ Improve the communication between departments and agencies
MCDOT	■ Provide arterial traffic management ■ Provide alternate route information and detour guidance ■ Reduce secondary crashes ■ Support localized response to incidents to DPS and local law enforcement with REACT ■ Support notification of incidents where applicable

How did you define success?

Success will be measured through the performance measures. Preliminary performance measures include:

- Agency notification time (dispatch/dispatch and dispatch/TMC)
- Incident measures (time to respond, duration, clearance off roadway, and recovery [time to return to normal traffic conditions])
- Secondary crashes

- Local traffic signal measures (number of signal timing changes and time that signals are in adjusted timing plans)
- Travel times (on freeways and arterials)
- Traffic throughput

REACT measures (number of call-outs, response time, clearance time, and DMS messages posted)

- Freeway Service Patrol (FSP)/ALERT measures (similar to REACT)
- Number of media-initiated contacts (social media posts, press releases, newscasts via radio/TV, e-mail messages)
- System usage (Video Distribution System (VDS) access, 511 phone/web, Computer Aided Dispatch (CAD) entries, Highway Closure and Restriction System (HCRS)/RADS)
- Joint operations activities (number of times local agency used another agency's camera, Department of Public Safety (DPS) used ADOT's cameras)
- After-action meetings after every major closure
- Emissions and fuel consumption
- Public response

Which agencies were involved with defining the corridor?

The following agencies had a key role in defining the Loop 101 ICM pilot corridor:

- ADOT: Traffic Operations Center, Communications/PIO, ALERT Response Team
- Arizona Department of Public Safety: Dispatch, Patrol
- MCDOT: Traffic Engineering, Traffic Management Center, REACT
- Maricopa Association of Governments: Modeling and Analysis
- City of Scottsdale: Traffic, Transportation Management Center, Police
- Salt River Pima-Maricopa Indian Community (SRPMIC): Fire

The City of Scottsdale TMC staff was key to identifying arterial routing issues and challenges, including the concept of zones for the Loop 101 corridor (based on geography, available routes and route characteristics, and arterial route constraints).

Evaluation – Performance Measures

What evaluation method was used to identify potential ICM strategies and their benefits?

The focus of the Loop 101 ICM is on incident-related closures. A detailed assessment of an actual incident and freeway closure was performed to identify gaps in processes, communications, and operational activities. From there, specific strategies were identified to address those gaps and achieve the goals identified by partners.

What criteria were used as part of the evaluation of potential strategies?

Strategies for Loop 101 were dependent on several different thresholds on which partners agreed. These thresholds were based on full freeway closure, half or more of the freeway lanes closed, or less than half of freeway lanes closed. Specific strategies were identified for each scenario.

Scenario	Description	ICM strategies
Full closures of the freeway	All traffic diverted to arterial network	■ Full ICM implementation, including notification of local agencies, support team assistance, coordinated response strategies, arterial management, and traveler information services ■ Coordinated incident support strategies ■ Arterial management/monitoring of traffic and could warrant implementation of some pre-set detour planning (e.g., CCTV surveillance, DMS messages, and timing plans) ■ Notification of local agencies ■ Request for support team assistance (REACT, ALERT, FSP as needed).
Half or more of all lanes closed on the freeway	Most traffic will naturally divert to arterial network to avoid congestion; some traffic may stay on freeway	■ Apply some or all of the ICM strategies listed above at a scale warranted by congestion caused by incident on freeways and arterials
Less than half of all lanes closed on the freeway	Some traffic will naturally divert to arterial network to avoid congestion; most traffic may stay on freeway	■ Normal operations not necessarily requiring ICM implementation

What modeling was used as part of the evaluation methodology?

MAG provided assistance with the regional DynusT model (with DTA) to evaluate traffic movements along the Loop 101 corridor based on a full freeway closure. This modeling effort was based on the worst-case scenario for arterial effects from freeway traffic (i.e., a full freeway closure in the peak direction of travel for that sector). MAG ran the DynusT model for 12 freeway closure scenarios for Loop 101: three sectors with one northbound and one southbound crash scenario each in the peak direction of travel. The results of the modeling effort included:

- The DynusT model provided new insights to traffic diversion patterns.
- Generally, the detour routing chosen by City of Scottsdale representatives based on experience matched the model's outputs of driver behavior during a full-closure scenario in each of the three sectors. No major changes were made to planned detour routing based on the model outcomes.
- Traffic detoured as short a distance as possible away from the freeway, causing some smaller capacity in-between streets to be used that were not anticipated.

What analysis was used as part of the development and implementation approach?

For Loop 101, two types of traffic analyses were conducted to determine the effect of Loop 101 freeway traffic routed onto the City of Scottsdale's arterial network, and in particular the impact on intersections.

A traffic flow analysis using Volume to Capacity ratio (v/c) data was conducted for six proposed detour routes from Loop 101. Volume-to-capacity ratios were calculated for each roadway segment of each detour route for both a morning and evening incident. Capacity analysis was not completed for turning movements due to the extreme volumes anticipated in detour scenarios.

A traffic flow analysis tool was developed to project the potential effects of a complete closure of Loop 101 northbound and southbound lanes on Scottsdale arterial streets. By initiating a multitude of scenarios, with different travel routes supported by general traveler behavior, the tool highlights intersections and street segments that may be heavily affected by incident-related traffic. This tool highlighted the need to consider directing other movements away from incidents and away from known bottlenecks in the arterial network, not just away from the freeway.

What performance measures are in place? Who is collecting the data? What reporting is being done, including how and with whom is it shared?

The Loop 101 ICM plan identified broad performance measures , and those measures are shown here in response to Question 16. Specific measures will be developed for this corridor. The data is collected by the respective agencies and archived in RADS. Reporting is done at the lessons-learned meetings. At the tabletop exercise, an actual incident was used as an example to identify the gaps.

Is a study available?

Yes. Two studies for Loop 101 are available:

- Loop 101 Freeway Incident Closure Case Study from Friday, March 16, 2012 (presented to the AZTech TIM Coalition and ATIS Working Group in June 2012)
- Loop 101 ICM Program – Incident Management Operations Plan (MCDOT), January 2014.

What are the lessons learned?

The following lessons learned were documented from the Loop 101 Tabletop exercise:

- Scottsdale will coordinate with ADOT for remote access to the Loop 101 traffic interchange signals from Indian Bend south to the city limits.
- Scottsdale will help develop a more detailed detour booklet based on scenarios. REACT and other responders will use this booklet as a quick reference guide to preferred and problematic arterial routes.
- MCDOT will research the Manual on Uniform Traffic Control Devices[70] and subject matter experts for the feasibility and details of installing emergency dual left and/or dual right at turn lanes.
- SRPMIC will research the possibility with the community of using local roads for detours under extraordinary conditions.
- REACT will respond to all incidents for Scottsdale when ALERT is called out.

Technology

What technologies have been considered, updated, deployed, and integrated as part of your ICM?

- Adaptive ramp metering? What controllers and firmware is planned/used?
  - ADOT is currently studying the ramp meter operations enhancements.
- Traffic signal systems (e.g., traffic responsive or adaptive)? If it is included, what system was chosen? Multijurisdictional control?
  - Scottsdale uses TranSuite[71] traffic management software. Scottsdale maintains several timing plans to implement, and staff is able to modify timing plans based on real-time conditions. Signal timing data is also provided to RADS for multijurisdictional signal timing planning and coordination. Future strategies include Highway Advisory Radio in Scottsdale.

70 Manual on Uniform Traffic Control Devices, Federal Highway Administration, http://mutcd.fhwa.dot.gov/

71 TranSuite, https://www.transcore.com/intelligent-transportation-systems

- Parking management?
  - N/A
- 511 systems/traveler information kiosks/apps?
  - AZ511.gov, ARIS
- Travel times for alternate routes?
  - Travel time is available for Loop 101, and alternate freeway route speed data is available. Probe speed data is available on some arterials; travel time for arterial routes is not yet available, but is being considered in the near-term.
- Private sector/public authorities?
  - HERE[72] historical data for the region is available at MAG for freeways and arterials. Some arterials in the Loop 101 ICM area also have real-time HERE data; probe data is available for Hayden Road, a key alternate for the Loop 101. This data is integrated in RADS, monitored by MCDOT, and shared with Scottsdale.
- Center to center?
  - C2C communications and coordination is achieved through a variety of established systems. Scottsdale has access to RADS, which provides freeway information, travel times, and Phoenix Fire CAD data, and supports sharing of traffic signal timing data. Video sharing is accomplished over the regional community network. The MCDOT ARIS provides agency-customized real-time incident information and status, in addition to alerts/notifications to local TMCs.
- HOT lanes?
  - N/A
- AVL/APC on transit?
  - Yes, Transit vehicles are equipped with automatic vehicle location, and the Valley Metro Transit Dispatch Center can monitor the location of RAPID, express and local buses in Scottsdale. Passenger counters do not currently provide occupancy data in real-time. This information is collected; however, it is stored and used for transit planning purposes, not real-time operations.
- Transit signal priority?
  - None at this time.

72 HERE, www.here.com

- Provide data to public?
  - There are several methods of providing information to the public in the event of a closure and emergency traffic reroute on Loop 101:
    - 511 and AZ511.gov provide alerts and travel conditions information. There is also a mobile application with a freeway speed map and corridor travel times.
    - ADOT has PIO staff on-site at the ADOT TOC to distribute notifications and updates via social media (i.e., Twitter and Facebook). The ADOT PIO and the AZDPS PIO coordinate on information dissemination to the public in the event of a major freeway incident.
    - Local TV media have access to ADOT's CCTV cameras to provide real-time visuals of corridor conditions. Radio stations work directly with agencies or as part of Clear Channel[73] to provide updates on major incidents and closures.
    - Maricopa County TMC distributes e-mail alerts to agencies and the media when a freeway closure will affect peak travel.
    - Several private sector entities (including media) subscribe to an FTP site that provides them with real-time updates on local traffic conditions.
    - The Sky Harbor Airport Rental Car Center has travel time displays that will indicate if there is a closure on Loop 101 or other freeway corridors.
- TDM strategies?
  - N/A
- Weather/environmental sensors?
  - Although the Flood Control District of Maricopa County has several rain gauges near the Loop 101 Corridor and in Scottsdale, no real-time link currently exists between FCD and Loop 101 operations. A couple of areas in Scottsdale can be susceptible to flooding if there is a significant rainstorm. Although not a frequent occurrence, rain could make some arterials in Scottsdale problematic for diverting freeway traffic.
- Hard shoulder running?
  - N/A

Funding

What is the level of funding for deployment?

Funding for operations is limited. Each agency funds its own respective system operations. No specific funding is dedicated to ICM operations. The region has identified ICM as a priority

73 iHeartMedia, Inc., http://www.clearchannel.com/Pages/Home.aspx

for ITS infrastructure only. As such, project applications through the MAG TIP programming process that identify their link to ICM support will be identified as supporting a regional transportation priority.

What is the level of funding for long-term operations?

No long-term operations funding is specifically identified for ICM. All operations activities are supported with local agency funding and resources.

How are equipment upgrades handled and funded?

Each agency maintains and upgrades its respective equipment. Agency TMCs and ITS field equipment are eligible for funding through the MAG TIP programming process. Many agencies use this resource to upgrade and expand TMC and field equipment.

What resource sharing is done (e.g., fiber sharing, cabinet sharing)?

Fiber sharing between ADOT and local agencies is through the Regional Community Network (RCN). For Loop 101 operations, Scottsdale currently operates the ADOT signals at most of the interchanges on the Loop 101 freeway in Scottsdale.

Operation

Is there a standardization of equipment (e.g., signal controllers and signal poles)?

Scottsdale uses Econolite ASC-3 signal controllers at nearly 100% of its intersections. Signal hardware and replacement parts are in stock.

Transit capacity increases during incidents?

This has not been analyzed yet.

Common objectives for operations (e.g., signal timing plans across jurisdictions)?

For the traffic diverted from the Loop 101 freeway, partners have a common objective to provide enhanced arterial traffic management through advanced traffic signal management (Scottsdale) and REACT arterial traffic incident management. Scottsdale and ADOT have agreed to collaborate on predefined freeway DMS messages so ADOT can post preferred arterial detour routes/exits on freeway DMSs near and in advance of the closure area.

What Traffic Incident Management (TIM) programs are in place?

The TIM Coalition plans and schedules incident-responder training. Incident debriefs are presented at TIM meetings and are scheduled separately for major incidents as needed.

Do you have enabling legislation for quick clearance?

> Arizona has legislation for agency quick clearance, as well as a vehicle removal law for motorist clearance of minor incidents (i.e., move to shoulder). Incident training programs in the region emphasize quick clearance processes for minor incidents on freeways. AZDPS, ALERT, fire/Emergency Medical Services, and towing operators are involved in this multi-agency training.

Public Awareness

What traveler information strategies were considered and deployed?

- Comparative travel times (freeway, arterial, transit)?
  - Comparative speeds for both arterial and freeways; travel times on freeways and on arterials in the future
- 511/travel apps?
  - AZ511.gov and 511 Phone have been deployed. ADOT has plans for enhanced mobile apps, e-mail alerts, Twitter. ADOT's PIO makes extensive use of Twitter to provide freeway incident and closure notifications and updates on incidents in progress.
- Parking availability?
  - N/A
- Travel times on DMS?
  - Only for freeways (arterials in future)
- Data portal to public?
  - Entities can access an FTP site. The media, app developers, and other third parties primarily access it, and then make information available to the public.
- Other strategies?
  - E-mail distribution from ADOT PIO, MCDOT TMC, and Scottsdale PIO to media and the public; also Twitter. A highway advisory radio for Scottsdale is planned for the near future.

How is your public outreach measured?

The AZTech Advanced Traveler Information Systems Working Group measures monthly 511 web site visits, 511 calls, tweets, e-mail alerts, and calls to the transit center.

What has been the public perception post-deployment?

No formal public outreach about ICM or the Loop 101 ICM has been conducted. The initial pilot deployment on Loop 101 has not resulted in any new visible infrastructure. Scottsdale recently opened a new TMC facility, and there was extensive news coverage and features about the center's capabilities and what the staff does to keep traffic moving safely.

What has been the public perception post-deployment?

The Loop 101 ICM is in the implementation stages. Post-deployment perception has yet to be measured.

San Diego

Building Blocks

What agreements/MOUs are in place for operations and maintenance among agencies in the region? Is there one agreement covering the broad spectrum or multiple agreements?

> Throughout the project process a number of documents have been undertaken and are anticipated will be completed subject to the data collection/documentation, lessons-learned experienced through the ongoing operations. Initial related documentation included the completion of a project charter, followed by the completion of individual MOUs. Such documents provided high-level guidance on needed coordination and cooperation. During the design and development of the ICMS, the focus turned to the needed operational consensus. Such agreements were documented through agency-level memorandums, which served as the platform for an ICMS operational framework document. The operational framework establishes and sets the conditions for using the individual network assets under the ICMS environment and reflects input/agreement by all partner agencies.

Is there an established traffic incident management program/partnership?

> No.

What are your interjurisdictional challenges (e.g., political, institutional, and operational)?

> There is no one specific challenge that stands out since all challenges experienced were generally dependent on each other. However, the observation to share is that the greatest challenge was associated with ensuring that the project partners received appropriate transportation, engineering, and operational input, which was then translated into the software design process during the ICMS system design.

What data sharing (e.g., center-to-center and video) exists among the agencies?

> Prior to the implementation of ICM there was little direct sharing of data between the project partners. The following summarizes the pre-ICM data sharing:
>
> - Caltrans provided performance data to Performance Measurement System (PEMS). This archive data would be made available to partners who requested it.
> - Additionally, Caltrans ATMS events were made available to MTS operators; however, this feed was unfiltered and burdensome for San Diego Metropolitan Transit System (MTS) to use, so it was rarely accessed.

- Finally, traffic signal timing data was shared via the Regional Arterial Management System (RAMS) between the local agencies and Caltrans signal operations.

What existing multiagency working groups/committees are established?

- Weekly meetings: operational review (all project team partners)
- Biweekly meetings: core project management team (SANDAG and consultant teams)
- Monthly meetings: project development team (all partners, including management level)

Is there a multi-jurisdiction oversight/advisory committee created for the region?

> Yes. However, these are standing committees that were established back in the late 1990s, which generally provide the venue for recommendation and discussion on multi-agency, project/program-related efforts, and SANDAG region-wide strategies. These committees include the City and County Traffic Engineer's Council and The City and County Transportation Advisory Committee (city engineers and public works directors). SANDAG staff used these committees as a sounding board for input and discussion throughout the ICM project. These committees report to and provide recommendations to our Transportation Committee (policy).

What funding sources are available?

> ICM is considering as key TSM strategy in the region and part of the regional transportation plan. Future efforts are focused on establishing and identifying specific project corridors to consider for funding as part of the next regional transportation plan.

ICM Organization

How many agencies are involved?

> Six agencies

Is there one lead agency?

> SANDAG

What is the staffing? Is contracted staff involved? What is the organizational structure? Are inter-jurisdictional staff co-located?

> SANDAG serves as project/contract lead. Contract staff is involved, but for providing project development, coordination, operational/technical support, and ICM system interface, design, and implementation. All other agencies have committed appropriate staff to participate.

Is there a DOT TMC or an interjurisdictional TMC?

State DOT (Caltrans District 11) TMC, Transit Operations Center, Metropolitan Transit Center (MTC), and individual local agency traffic signal systems. ICM does not replace these centers, but rather is integrated with all of them

Concept: How (and why) did you pick your corridor? What is its vision?

What is your region's definition of ICM?

ICM is the ability to manage and operate a transportation system based on a performance management approach that is multimodal and multiagency.

What criteria were used to select which freeway corridors/arterials are a part of the ICM?

The application of the ICM along the I-15 corridor served as the perfect site due to the corridor's multimodal/network-level characteristics. The corridor also serves as one of two major north/south, heavily used travel corridors in the region.

Describe the operating characteristics/challenges pre ICM.

Given the limited number of alternative routes, the peak-period delays experienced within the corridor generally range between 30 and 45 minutes. As travel demand grows and transportation costs and revenues become constrained, and despite the Express Lanes and BRT operational improvements, the I-15 corridor is faced with the problem of maintaining and maximizing system efficiency and mobility to improve travel times and address overall congestion along the corridor. Accordingly, the purpose of the ICM project is to proactively manage congestion by serving as the tool for accommodating and integrating all transportation systems to work as a unified system in an effort to maximize overall corridor system efficiency and mobility

Please explain the timeframe, from initial planning to deployment.

Stage 3 Implementation

- Kickoff – February 2010
- Completion of project management documentation and definition of system requirements February 2010 – March 2011
- Coordination with partners to define operational framework and interdependencies – April through December 2011
- Design of ICMS – mid-2011 through March 2013
- System shakedown and testing – March 2013 through January 2014
- ICMS placed into full operations – February 2014

What are the key objectives of the ICM deployment?

Provide the tools and platform for establishing multi-agency coordination for proactively managing congestion across all modes and as a unified transportation system to maximize overall corridor system efficiency and mobility.

How did you define success?

Maintain focus on overall vision, which is that the ICM system/project will become the norm in the transportation industry for ongoing real-time operations and management.

Which agencies were involved with defining the corridor?

All project partners

Evaluation - Performance Measures

What evaluation method was used to identify potential ICM strategies and their benefits?

Strategies were first defined by available assets and existing management systems. The approach of the San Diego site ICM was to focus on multi-agency/system integration and thus provide a venue to implementation of the ICM concept. Below is the list of benefits achieved via AMS Stage 2 results.

- En-route traveler information
- Pre-trip traveler information
- Corridor ramp metering
- Signal coordination on arterials with freeway ramp metering
- Proactive corridor congestion management during recurring congestion and incidents
- Improve transit information and transit routing
- Improve corridor system performance monitoring

AMS Results

- An estimated 246,000 person hours in annual travel time savings
- A 10.6 percent improvement in travel time reliability
- An estimated 323,000 gallons of fuel saved annually

- An estimated 3,100 tons of mobile emissions saved annually
- Improved accessibility to travel options for all transportation system users
- An enhanced level of mobility through the corridor for corridor travelers since the management techniques are coordinated and holistic

What criteria were used as part of the evaluation of potential strategies?

> Having the field infrastructure/subsystems in place, then having knowledge of likely possible ripple effects or outside factors that will need to be addressed for considering a multi-agency strategy. While one potential strategy might sound good in theory, it may not be the appropriate solution from an operational perspective and may require additional infrastructure resources or political/management buy-in to implement. All of this needs to be identified or addressed up front before it is considered in the design of the ICMS system, at the least, understand that it may be considered as a future user need or system requirement.

What modeling was used as part of the evaluation methodology?

> The microscopic component of TransModeler was used for the AMS analysis of this corridor. For further details, please see AMS Stage 2 Analysis Plan.

What analysis was used as part of the development and implementation approach?

> Because the ICMS is model driven, numerous performance metrics are available; all of these metrics are being captured for post-analysis. The focus on performance measures for the ICMS was on evaluating across multiple modes. The various performance metrics were reviewed for applicability to all modes and network segments.

What performance measures are in place? Who is collecting the data? What reporting is being done, including how and with whom is it shared?

> Average person delay is the key performance metric for evaluating a response plan. Speed and delay are used to identify and categorize event impacts, and travel time is used to validate model outputs. The data is being collected from each of the project partners into the ICMS by way of the regional data hub. This hub collects and stores field data as well as ICMS response plans and corridor performance metrics. The ICMS data is shared with the project partners live via the ICMS graphic user interface. Travel time comparisons and project speed effects are shared with the public via the 511 app.

Is a study available?

> AMS Stage 2 analysis is available and defer to RITA[74] team for availability. For ongoing ICM

74 RITA ICM website: http://www.its.dot.gov/icms/

operational efforts, some documentation will be available via the RITA web site.

What are the lessons learned?

See key highlights below.

Design Perspective (things are more complex than you think they are)

- Data
    - Format
    - TMDD
    - Not designed for web services interoperability
    - Optional fields often left unpopulated
    - Not designed for this specific task; required that extensions for additional fields be added
- Size (system generates gigabytes of data each day)
- Initial sensor data gaps (freeways are well covered, but not arterials)
- Assets
- Availability
- Maintain focus on scope, but open to expansion
- Understanding the subsystems upfront
- Gain buy-in on operational design early enough in the process

Technical/Institutional Perspective

- Follow structured technical platform /path – system engineering process
- Conduct a requirements walkthrough
- Explain individually, discuss as a group
- Require performance
- Realize that time is the greatest commodity; provide a venue for common purpose/ understanding, and opportunity to really understand individual issues
- Maintain operational respectfulness/constraints

  - All bring value to the table
  - Follow foundational docs
  - Be honest: we don't know what we don't know

Technology

What technologies have been considered, updated, deployed, and integrated as part of your ICM?

- Adaptive ramp metering? What controllers and firmware are planned/used?
  - Under development by Caltrans
- Traffic signal systems (e.g., traffic responsive or adaptive)? If it is included, what system was chosen? Multijurisdictional control?
  - All signals in the San Diego region are on the RAMS interagency signal network. The system supporting this network is the McCain QuicNet Pro75. Select corridors are running the McCain traffic responsive for north/south progression.
- Parking management?
  - Parking systems around the I-15 corridor are being implemented to capture data for ICMS. These are not being upgraded by the ICMS project
- 511 systems/traveler information kiosks/apps?
  - A 511 app was developed to open up the ICMS outputs to the public and to provide alternate routing options.
- Travel times for alternate routes?
  - Yes these were developed – specifically for transit operators.
- Private sector/public authorities?
  - N/A
- Center to center?
  - N/A
- HOT lanes?
  - N/A

75 QuicNet® Central Software, McCain, Inc., http://www.mccain-inc.com/traffic.html?view=item&item_id=93

- AVL/APC on transit?
  - N/A
- Transit signal priority?
  - N/A
- Provide data to public?
  - Yes via the App as well as by changeable message signs on the freeway and new rotary drum signs to be installed on the arterials
- TDM strategies?
  - N/A
- Weather/environmental sensors?
  - The ICMS uses weather station data as an input to the network prediction system.
- Hard shoulder running?
  - N/A
- Others?
  - N/A

Funding

What is the level of funding for deployment?

The estimated total is $10.2 million dollars, which includes ICM initiative grant and match.

What is the level of funding for long-term operations?

Unknown at this time

How are equipment upgrades handled and funded?

By individual agency

What resource sharing is done (e.g., fiber sharing or cabinet sharing)?

Currently this is not taking place other than at a few select signalized intersections that are in close proximity to freeway ramps. In some cases the local agency has turned over control to Caltrans for daily operations; the local agency retains ownership and maintenance responsibility.

Operation

Is there a standardization of equipment (e.g., signal controllers and signal poles)?

Typically 170 or 170E controllers with 200, 223, or 233 firmware

Transit capacity increases during incidents?

N/A

Common objectives for operations (e.g., signal timing plans across jurisdictions)?

Signal timing on Pomerado Road (San Diego and Poway) was developed to maintain throughput in the northern section of Pomerado.

What Traffic Incident Management (TIM) programs are in place?

A TIM program is in place for management of the I-15 Express Lanes.

Do you have enabling legislation for quick clearance?

N/A

Public Awareness

What traveler information strategies were considered and deployed?

- Comparative travel times (freeway, arterial, transit)?
  - Travel times are provided, but not on a comparable form.
- 511/travel apps?
  - Yes. 511 San Diego is available at the Google Store and Apple Store.
- Parking availability?
  - Parking information is provided via ICMS; however, it is not in use as a strategy at this time.
- Travel times on DMS?
  - Yes.
- Data portal to public?
  - Yes. Data is provided via XML feed for third-party applications

How is your public outreach measured?

The project team has been working with the SANDAG communications team through project outreach efforts, including during the project rollout media event, post-community meeting outreach presentations, and newspaper and radio slots. Additional information on media/ outreach elements will provided during meeting.

What public outreach was done as part of the process?

See previous answer

What has been the public perception post-deployment?

To be determined

Do Nothing 0.00
Plan B 3.19
Map
Hidden Meadows
Jesmond Dene
Daley Ranch
Marcos
Rancho Bernardo
Escondido Fwy
Center City TRAVEL TIME
VIA 95 45 MIN
VIA SEPTA 30
Collins Blvd
Arapaho Rd
Belt Line
Spring Valley