Analysis, Modeling, and Simulation (AMS) Testbed Initial Screening Report

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Final Report — November 2013

Publication Number: FHWA-JPO-13-094

U.S. Department of Transportation
Research and Innovative Technology Administration

Produced by Noblis, Inc.
U.S. Department of Transportation
ITS Joint Program Office
Research and Innovative Technology Administration

Notice

Technical Report Documentation Page

1. Report No. FHWA-JPO-13-094	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Analysis, Modeling, and Simulation (AMS) Testbed Initial Screening Report		**5. Report Date** November 2013
		6. Performing Organization Code
7. Author(s) Vaishali Shah, Meenakshy Vasudevan, and Richard Glassco		**8. Performing Organization Report No.**
9. Performing Organization Name And Address Noblis, Inc., 600 Maryland Ave, SW, Suite 755, Washington, DC 20024		**10. Work Unit No. (TRAIS)**
		11. Contract or Grant No. DTFH61-11-D-00018
12. Sponsoring Agency Name and Address ITS Joint Program Office (ITS JPO) 1200 New Jersey Avenue, SE, Washington, DC 20590		**13. Type of Report and Period Covered** FINAL
		14. Sponsoring Agency Code USDOT RITA JPO

15. Supplementary Notes

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16. Abstract

Analysis Modeling and Simulation (AMS) Testbeds can make significant contributions in identifying the benefits of more effective, more active systems management, resulting from integrating transformative applications enabled by new data from wirelessly connected vehicles, travelers, and infrastructure. To this end, the Dynamic Mobility Applications (DMA) and Active Transportation and Demand Management (ATDM) Programs have jointly sponsored the planning of multiple AMS Testbeds to support the two programs in evaluating and demonstrating the system-wide impacts of deploying application bundles and strategies in an AMS environment.

The purpose of this report is to document an initial screening of AMS Testbed locations that was conducted to identify seven to ten potential candidate locations that may be further down-selected in a future effort for developing AMS Testbeds to conduct an evaluation of DMA and ATDM applications and strategies. The criteria used for screening the testbed locations include: 1. geographic scope, 2. temporal scope, 3. temporal resolution, 4. multi-modal, 5. level of congestion, 6. multi-source, 7. calibrated AMS models, 8. ease of adaptability, and 9. existing deployments and or research.

Based on the preliminary assessment, the following are the nine AMS testbed locations that may be considered for further down-selection as a testbed location to support AMS activities for DMA and ATDM Programs: 1. Integrated Corridor Management (ICM) San Diego, 2. ICM Dallas, 3.Research Data Exchange (RDE) Test Data Set Pasadena, 4. Connected Vehicle (CV) Testbed Anthem, 5. CV Testbed Palo Alto, 6. SHRP 2 C10 Sacramento, 7. Weather-Chicago, 8. CV Testbed Novi, and 9. SHRP 2 C10 Jacksonville.

17. Key Words DMA, ATDM, connected vehicles, modeling, AMS testbed locations, screening criteria	**18. Distribution Statement**		
19. Security Classif. (of this report)	**20. Security Classif. (of this page)**	**21. No. of Pages** 68	**22. Price**

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Acknowledgements

The authors wish to acknowledge several contributors to this study:

DMA-ATDM AMS Testbed Key Content Review Team: James Colyar (FHWA Operations; Noblis Task Manager), John Halkias (FHWA Operations), Kate Hartman (RITA/ITS JPO; DMA Program Manager), Joe Bared (FHWA R&D), Randy Butler (FHWA Operations), Taylor Lochrane (FHWA R&D), Robert Sheehan (RITA/ITS JPO), James Sturrock (FHWA Resource Center), Chung Tran (FHWA Resource Center), Eric Pihl (FHWA Resource Center), for their review and comments.

AMS Stakeholders: Alex Gerodimos (TSS), Brian Gardner (US DOT), David Roden (AECOM), Jing-Quan Li (PATH), Joe Castiglione (RSG Inc.), Kaan Ozbay (New York University), Larry Head (University of Arizona), Steve Shladover (PATH), and Vassili Alexiadis (Cambridge Systematics), for providing information on the testbeds.

Noblis: Karl Wunderlich for his review, and Aaron Casey, Drennan Hicks, and Aretha Howard for formatting and 508-conversion of the report.

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6. SHRP 2 C10 Sacramento
7. Weather-Chicago
8. CV Testbed Novi
9. SHRP 2 C10 Jacksonville

1 Introduction

1.1 Background

Effective congestion management involves a systematic process that enhances mobility and safety of people and goods, and reduces emissions and fuel consumption through innovative, practical, and cost-effective strategies and technologies. In response, the Federal Highway Administration (FHWA) Office of Operations initiated the Active Transportation and Demand Management (ATDM) Program to seek active, integrated and performance based solutions to improve safety, maximize system productivity, and enhance individual mobility in multi-modal surface transportation systems [1]. ATDM is the dynamic management, control, and influence of travel demand, traffic demand, and traffic flow of transportation facilities. Through the use of available tools and assets, traffic flow is managed and traveler behavior is influenced in real-time to achieve operational objectives, such as preventing or delaying breakdown conditions, improving safety, promoting sustainable travel modes, reducing emissions, or maximizing system efficiency. Under an ATDM approach, the transportation system is continuously monitored. Using historical and real-time data, predictions of traffic conditions are generated and actions are performed in real-time to achieve or maintain system performance. The ATDM Program is intended to support agencies and regions considering moving towards an active management approach. Through ATDM, regions attain the capability to monitor, control, and influence travel, traffic, and facility demand of the entire transportation system and over a traveler's entire trip chain. This notion of dynamically managing across the trip chain is the ultimate vision of ATDM. ATDM builds upon existing capabilities, assets, and programs and enables agencies to leverage existing investments - creating a more efficient and effective system and extending the service life of existing capital investments. All agencies and entities operating transportation systems can advance towards a more active management philosophy.

While active management can be applied to any part of our transportation system (such as implementing dynamic pricing on a facility to manage congestion, or informing travelers of specific or compatible transit operations for their trip), it is most beneficial when the relationships and synergies to other parts of the system are considered. For example, an agency could apply adaptive ramp metering to improve freeway traffic flow. However, if the effect of ramp metering on connecting arterials is not considered or if dynamic actions to manage overall demand are not implemented, some of the system-wide performance gains from the ramp metering system may be compromised. The ATDM Program has identified 23 strategies that fall under three major categories (Active Demand Management, Active Traffic Management, Active Parking Management) are documented in the ATDM Analysis, Modeling, and Simulation (AMS) Concept of Operations [2]. These strategies (Table 1-1) are not intended to be inclusive, but are intended to demonstrate how the ATDM concept of dynamically managing the entire trip chain can be manifested in individual strategies.

Figure 1-1 illustrates the five stages in a trip chain that represent a series of decisions that affect demand and utilization of the network.

Table 1-1: List of ATDM Strategies

Active Demand Management	Active Traffic Management Strategies	Active Parking Management Strategies
Dynamic Fare Reduction	Adaptive Ramp Metering	Dynamic Overflow Transit Parking
Dynamic HOV/Managed Lanes	Adaptive Traffic Signal Control	Dynamic Parking Reservation
Dynamic Pricing	Dynamic Junction Control	Dynamic Wayfinding
Dynamic Ridesharing	Dynamic Lane Reversal or Contraflow Lane Reversal	Dynamically Priced Parking
Dynamic Routing	Dynamic Lane Use Control	
Dynamic Transit Capacity Assignment	Dynamic Merge Control	
On-Demand Transit	Dynamic Shoulder Lanes	
Predictive Traveler Information	Dynamic Speed Limits	
Transfer Connection Protection	Queue Warning	
	Transit Signal Priority	

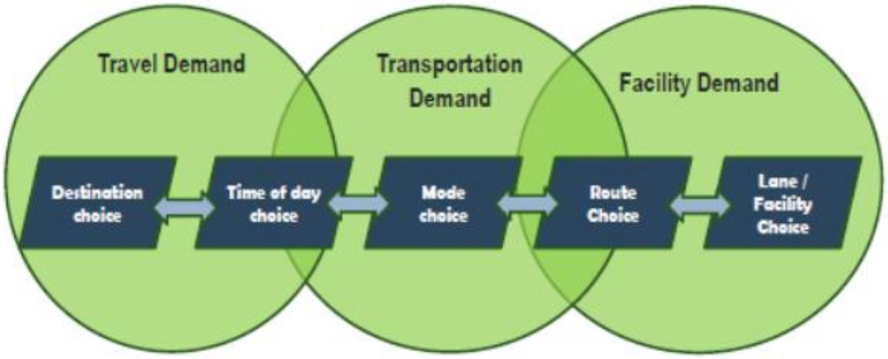

Figure 1-1: Trip Chain and Relation to Demand Activities [2]

Simultaneously, the USDOT initiated connected vehicle research to evaluate the merit of applications that leverage connected vehicles, travelers, and ITS infrastructure to enhance current operational practices and transform future surface transportation systems management. According to the USDOT, “Connected vehicles refer to the ability of vehicles of all types to communicate wirelessly with other vehicles and roadway equipment, such as traffic signals, to support a range of safety, mobility and environmental applications of interest to the public and private sectors. Vehicles include light, heavy and transit vehicles. The concept also extends to compatible aftermarket devices brought into vehicles and to pedestrians, motorcycles, cyclists and transit users carrying compatible devices, which could make these vulnerable users more visible to surrounding traffic.” This research program is a collaborative initiative spanning the Intelligent Transportation Systems Joint Program Office (ITS JPO), Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the Federal Motor Carrier Safety Administration (FMCSA) and the National Highway Traffic Safety Administration (NHTSA). One foundational element of the connected vehicle research is the Dynamic Mobility Applications (DMA) Program [3]. The DMA Program seeks to create applications that fully leverage frequently collected and rapidly disseminated multi-source data gathered from connected travelers, vehicles and infrastructure, and that increase efficiency and improve individual mobility while reducing negative environmental impacts and safety risks. The objectives of the DMA Program include:

- Create applications using frequently collected and rapidly disseminated multi-source data from connected travelers, vehicles (automobiles, transit, freight) and infrastructure;
- Develop and assess applications showing potential to improve the nature, accuracy, precision and/or speed of dynamic decision making by both system managers and system users;
- Demonstrate applications predicted to improve the capability of the transportation system to provide safe, and reliable movement of goods and people; and
- Determine required infrastructure for transformative applications implementation, along with associated costs and benefits

In 2011, the DMA Program identified seven high priority bundles of transformative mobility applications that have the potential to improve the nature, accuracy, precision and/or speed of dynamic decision making by system managers and system users (Table 1-2). As a first step, the DMA Program partnered with the research community to further develop six of these high-priority transformative concepts (i.e., EnableATIS, FRATIS, IDTO, INFLO, MMITSS, and R.E.S.C.U.M.E.), and identify corresponding data and communications needs. The seventh bundle on Next Generation ICM (Integrated Corridor Management) may be developed at a later date.

Table 1-2: List of DMA Bundles

Bundle Acronym	Objective
EnableATIS	*Enable Advanced Traveler Information System* seeks to provide a framework for multi-source, multimodal data to enable the development of new advanced traveler information applications and strategies.
FRATIS	*Freight Advanced Traveler Information System* seeks to provide freight-specific route guidance and optimizes drayage operations so that load movements are coordinated between freight facilities to reduce empty-load trips.
IDTO	*Integrated Dynamic Transit Operations* seeks to facilitate passenger connection protection, provide dynamic scheduling, dispatching, and routing of transit vehicles, and facilitate dynamic ridesharing.
INFLO	*Intelligent Network Flow Optimization* seeks to optimize network flow on freeway and arterials by informing motorists of existing and impending queues and bottlenecks; providing target speeds by location and lane; and allowing capability to form ad hoc platoons of uniform speed.
MMITSS	*Multi-Modal Intelligent Traffic Signal System* is a comprehensive traffic signal system for complex arterial networks including passenger vehicles, transit, pedestrians, freight, and emergency vehicles.
R.E.S.C.U.M.E.	*Response, Emergency Staging and Communications, Uniform Management, and Evacuation* is an advanced vehicle-to-vehicle safety messaging over DSRC to improve safety of emergency responders and travelers.
Next Gen ICM	*Next Generation Integrated Corridor Management* seeks to optimize corridor mobility through a system-wide integration of enhanced operational practices and information Services.

The DMA Program is currently sponsoring several efforts to develop a prototype and conduct a small-scale demonstration for each of the six bundles to test if the bundles can be successfully prototyped and deployed in the future. The DMA Program is also sponsoring separate, multiple efforts (one for each bundle) to conduct an independent assessment of the impacts of the prototype as well as the impacts of the bundle when deployed at various levels of potential future market acceptance in the region where a small-scale demonstration of the prototype will be conducted. The data and findings from the small-scale demonstrations and impacts assessments will help USDOT make more informed decisions regarding the technical feasibility and potential impacts of deploying the bundles more widely. Both DMA and ATDM Programs have similar overarching goals. However, each program has a unique research approach seeking to meet these goals. The DMA Program focuses on exploiting new forms of data from wirelessly connected vehicles, travelers, and the infrastructure to enable transformative mobility applications. The ATDM Program focuses its research efforts on accelerating the pace of dynamic control within transportation systems management through operational practices that incorporate predictive and active responses to changing operational conditions1. While on the surface, these two research agendas may seem independent, the DMA and ATDM research approaches are really two sides of the same research coin. The more active forms of control envisioned by the ATDM Program will rely on new forms of data from connected vehicles, travelers, and infrastructure to hone predictions and tailor management responses. Likewise, the transformative applications developed in the DMA Program must be incorporated within current and future dynamic system-wide management practices in order to realize their full potential.

In order to explore potential transformations in transportation systems performance, both programs require an AMS capability. AMS tools and methodologies offer a cost-effective approach to addressing complex questions on optimization of longer-range investments, shorter-term operational practices, and overall system performance. Both programs have invested significant resources in the development of advanced concepts and foundational research, but the potential impacts from deployment are uncertain and poorly quantified. Each program recognizes the need to test these concepts, applications, and operational practices as a key next step in the process of moving research from concept towards deployment. The two programs must identify the technologies, applications, and operational approaches that work cost-effectively in concert with each other in order to justify large-scale demonstrations and pilot deployments.

A capable, reliable AMS Testbed provides a valuable mechanism to address this shared need by providing a laboratory for the refinement and integration of research concepts in a virtual computer-based AMS environment prior to field deployment. An AMS Testbed as envisioned here refers to a set of computer models that can replicate the effects of public agencies and private sector in a region implementing concepts, bundles, and strategies associated with the DMA and ATDM Programs. The AMS Testbed will be implemented in a laboratory setting in that the modeling conducted will not be directly connected to the systems, algorithms, or Traffic Management Center (TMC) operators that make real-time traffic management decisions. However, it is the intent to make the AMS Testbed as closely based in reality as possible by modeling an actual metropolitan region’s transportation system

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[1] Operational conditions describe the frequency and intensity of specific travel conditions experienced by a traveler over the course of a year. Operational conditions are identified by a combination of specific travel and traffic demand levels and patterns (e.g., low, medium or high demand), weather (e.g., clear, rain, snow, ice, fog, poor visibility), incident (e.g., no impact, medium impact, high impact), and other planned disruptions (e.g., work zones).

(e.g., road, transit, and parking networks), transportation demand (e.g., persons, vehicles, transit), and DMA and ATDM concepts, bundles, and strategies.

A joint DMA-ATDM AMS Testbed can make significant contributions in identifying the benefits of more effective, more active systems management, resulting from integrating transformative applications enabled by new data from wirelessly connected vehicles, travelers, and infrastructure. To this end, the DMA and ATDM Programs have jointly sponsored the planning of multiple AMS Testbeds to support the two programs in evaluating and demonstrating the system-wide impacts of deploying application bundles and strategies in an AMS environment. This planning effort has resulted in a series of reports, including:

- AMS Testbed High Level Requirements for DMA and ATDM Programs [4]
- AMS Testbed Preliminary Evaluation Plan for DMA Program [5]
- AMS Testbed Preliminary Evaluation Plan for ATDM Program [6]
- AMS Testbed Framework for DMA and ATDM Programs [7]
- AMS Testbed Initial Screening Report (this report)

It is envisioned that multiple AMS Testbeds will be developed to both mitigate technical risk and enable a more rigorous evaluation of the impacts and benefits of applying DMA and ATDM approaches, given differences in regional characteristics and varying combinations of bundles and strategies. As mentioned previously, it is the intent to make these AMS Testbeds as closely based in reality as possible by modeling actual metropolitan region's transportation systems (e.g., road, transit, and parking networks), transportation demand (e.g., persons, vehicles, transit), and DMA and ATDM concepts, bundles, and strategies.

1.2 Purpose

The purpose of this report is to document an initial screening of AMS Testbed locations that was conducted to identify seven to ten potential candidate locations that may be further down-selected in a future effort for developing AMS Testbeds to conduct an evaluation of DMA and ATDM applications and strategies.

As previously mentioned, although an AMS Testbed is a "virtual laboratory" where we can hypothetically model and test an application or a strategy, the expectation is that the testbed will be based on a real-world location so that the results are realistic and credible.

The screening criteria are described in detail in Section 2. Section 3 provides a summary assessment of the testbed locations and characterizes the testbed locations into the four AMS Testbed technical approaches described in the AMS Framework report. Section 4 provides a detailed assessment of the testbed locations against the criteria.

2 Criteria for AMS Testbed Consideration

This section presents the criteria used for an initial screening of AMS testbed locations to shortlist seven to ten potential candidate locations that may be further down-selected to develop AMS Testbeds for three to five locations. Tradeoffs among all criteria will be considered for down-selecting the seven to ten candidate locations. In reviewing the pool of potential AMS testbed locations, attention was given to acquire information relevant to the nine criteria listed below.

The criteria used for evaluating the potential AMS testbed locations are as follows:

1. **Geographic Scope**
   The testbed location shall be capable of generating data for sufficient geographic scope to represent the impacts of the DMA and ATDM applications and strategies, including being able to capture and represent changes in demand and demand patterns due to changes in traveler behaviors. The location shall be of sufficient complexity, and shall include multiple facilities (e.g., freeways, arterials, parking facilities, intermodal terminals) and offer feasible options for route diversions. The sub-area that is modeled shall not be limited just to a corridor and shall be broad enough to capture demand and travel behavioral changes.

2. **Temporal Scope**
   The testbed location shall be capable of generating data of sufficient temporal scale to represent the impacts of the DMA and ATDM applications and strategies, including congestion buildup and dissipation, completion of freight and transit trips, incident clearance, and changes in trip departure times or tour-making.

3. **Temporal Resolution**
   The testbed location shall be capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies. For example, if a testbed location is only capable of generating data every hour, then the data might not be of sufficient temporal resolution to model the location using a microscopic model or a communications model. The down-selected testbed locations should collectively be capable of representing all DMA and ATDM applications and strategies.

4. **Multi-Modal**
   The testbed location shall include multiple modes to represent impacts of mode shifts and/or transit operations, HOV operations, etc.

5. **Level of Congestion**
   The testbed location shall have significant congestion that necessitates finding solutions achievable through DMA and ATDM applications and strategies.

6. **Multi-Source**

The testbed location should be capable of generating data needed for AMS from multiple sources, including data from existing in-roadway sensors and over-roadway sensors, data from wireless communications (such as DSRC, cell phones, Bluetooth, Wi-Fi), travel demand data, data on traveler behaviors/choices, transit-specific data, freight-specific data, road-weather data. The testbed location shall also have archives of quality data for calibration, preferably for each component of the AMS Testbed Framework.

7. **Calibrated AMS Models**
   The testbed location shall have corresponding AMS and or communications models that are available for use by others and are well-calibrated using data within the last 10 years.

8. **Ease of Adaptability**
   The testbed location shall be such that AMS and communications models may be developed or enhanced for the testbed location and calibrated within the available resources and the schedule of the DMA-ATDM AMS Testbed effort; and shall not be constrained by schedules of other efforts.

9. **Existing Deployments and or Research**
   The testbed location should have ATDM strategies in operation and/or research and testing of DMA applications planned or in place.

Each testbed location will be assessed against the above criteria. The testbed locations will also be characterized based on their capabilities into one of the four AMS testbed technical approaches identified in the AMS Framework document [7]. The overall objective of the AMS Testbed screening effort is to help guide the process of selecting testbeds that can collectively address the AMS testbed requirements (detailed in [4]). Testbed locations with similar capabilities are unlikely to address all 103 requirements without expending significant resources to enhance them. A diverse portfolio of testbed locations is thus needed to mitigate technical and schedule risks. The AMS testbed technical approach is not an evaluation criterion but a method to group testbed locations that are comparable so that the down-selection process does not result in testbed locations that have similar strengths and weaknesses.

3 Summary Assessment of AMS Testbed Locations

This section presents a summary assessment of the testbed locations and characterizes them into the four AMS Testbed technical approaches based on a high level assessment of the testbed locations.

A high-level assessment using the criteria defined in Section 2 was conducted initially for over 50 AMS testbed locations. This set of over 50 was reduced to 21 potential testbed locations, including:

- Three ICM AMS testbed locations – San Diego, California; Dallas, Texas; and Minneapolis, Minnesota
- Three connected vehicle testbeds – Novi, Michigan; Palo Alto, California; and Anthem, Arizona
- Three testbed locations with SHRP 2-related DTA models – Sacramento, California; Jacksonville, Florida; and Portland, Oregon
- Three testbed locations with weather-response models – New York, Chicago; and Salt Lake City, UT
- Nine testbed locations with regional or corridor-level simulation models

Each of these 21 testbed locations are defined in greater detail in the next section. Note that the assessment was done based on publicly available literature, and limited discussions with the testbed developers. A summary assessment of the testbed locations using the nine criteria is highlighted in Table 3-1. Each testbed is scored against the nine criteria and an average score is computed. Table 3-2 identifies the specific simulation tools that are applied for each of the 21 potential locations.

A categorization of the testbed locations based on the four AMS Testbed technical approaches [7] is shown in Table 3-3. The categorization is based on the current capabilities of the testbed models to capture the inherent nature and purpose of the modeling approach that was used. The four technical approaches include:

1. **Strategic Traveler Behavior Focus**: This technical approach aims to accurately represent traveler's trip making choices prior to trip start in response to travel experiences and traffic conditions at a metropolitan regional level.
2. **Tactical Traveler Behavior Focus**: This technical approach aims to accurately represent individual vehicle and pedestrian movements and interactions between them.
3. **Multi-Resolution Modeling Approach**: This technical approach aims to accurately represent traveler's trip making choices prior to trip start as well as individual vehicle and pedestrian movements and interactions between them.
4. **Communications/Management Latency Focus**: This technical approach aims to accurately represent communications between vehicles, devices, and the infrastructure, as well as system managers' decision making.

Based on the preliminary assessment, the following are the nine AMS testbed locations that may be considered for further down-selection as a testbed location to support AMS activities for DMA and ATDM Programs:

1. Integrated Corridor Management (ICM) San Diego (#1)
2. ICM Dallas (#2)
3. Research Data Exchange (RDE) Test Data Set Pasadena (#21)
4. CV Testbed Anthem (#7)
5. CV Testbed Palo Alto (#6)
6. SHRP 2 C10 Sacramento (#8)
7. Weather-Chicago (#18)
8. CV Testbed Novi (#4)
9. SHRP 2 C10 Jacksonville (#9)

Together, the above nine locations cover the four technical approaches. ICM San Diego and ICM Dallas were chosen since they have highest score (2.6), and both use multi-resolution modeling approach. The ease of adaptability is high for both models. The RDE Test Data Set Pasadena project testbed makes use of multi-source data, including data from AirSage, which was not noted for any of the other testbed locations, and is thus a strong candidate for further down-selection. It had a high score of 2.5. At a minimum at least one of the three may be considered for further down-selection. Weather-Chicago was chosen as it was one of the three testbeds that specifically modeled VMS under inclement weather, and is thus another strong candidate for further down-selection. The three CV testbeds were chosen since all three are potential demonstrations sites for DMA bundles, and have communications models. At a minimum, at least one may be considered as a candidate for further down-selection. The SHRP 2 models for Sacramento and Jacksonville are two strategic models in the list of 21.

To capture the full impacts of the DMA and ATDM applications and strategies under various scenarios, the down-selection process that will take place outside of this effort should try to capture diversity in weather and driver behaviors seen across regions. That is, the final list shouldn’t comprise locations that are all from a single state or coast.

Table 3-1: Summary Assessment of Potential Testbed Locations Using the Nine Criteria

ID	Potential Testbed Location	Geographic Scope	Temporal Scope	Temporal Resolution	Multi-Modal	Level of Congestion	Multi-Source	Calibrated AMS Models	Ease of Adaptability	Existing Deployments and or Research	Average Score Against Nine Criteria
1	ICM San Diego, CA	3	3	3	2	3	2	3	2	2	2.6
2	ICM Dallas, TX	3	3	3	3	2	2	3	2	2	2.6
3	ICM Minneapolis, MN	3	3	3	3	3	2	3	2	1	2.6
4	CV Testbed, Novi, MI	3	3	3	1	1	3	1	1	1	1.9
5	MTM Model, Manhattan, NY	3	N/A	3	3	3	3	2	1	1	2.4
6	CV Testbed, Palo Alto, CA	1	N/A	N/A	1	3	3	2	3	3	2.3
7	CV Testbed, Anthem, AZ	1	N/A	N/A	3	2	3	2	3	3	2.4
8	SHRP C10 Sacramento, CA	2	N/A	N/A	3	3	1	2	2	1	2.0
9	SHRP C10 Jacksonville, FL	3	N/A	3	N/A	1	N/A	1	2	1	1.8
10	SHRP C05 DTA Portland, OR	3	1	N/A	1	3	1	1	1	1	1.5
11	ARC's DTA Studies, Atlanta, GA	2	3	N/A	3	N/A	2	N/A	1	1	2.0
12	San Francisco's DTA Anyway	3	1	N/A	3	3	2	3	1	2	2.3
13	Presidio Pkwy Traffic Mgmt	2	1	N/A	3	3	2	3	1	1	2.0
14	Geary Blvd BRT	1	N/A	N/A	3	3	2	2	1	1	1.9
15	DTA Platform Bellevue, WA	2	1	N/A	3	3	2	1	1	1	1.8
16	Alaska Way Viaduct, Seattle, WA	2	2	N/A	3	3	2	N/A	1	1	2.0
17	White House Area Transportation Study	2	3	3	3	3	1	3	2	1	2.3
18	Weather - Chicago	3	2	N/A	2	3	1	2	1	2	2.0
19	Weather - Salt Lake	3	2	N/A	2	1	1	2	1	2	1.8
20	Weather - New York	3	2	N/A	2	3	1	1	1	2	1.9
21	Research Data Exchange (RDE) Test Data Set - Pasadena	3	3	N/A	2	3	3	3	2	1	2.5

N/A: Information not available from literature

Table 3-2: Simulation Tools Applied for Potential Testbed Locations

ID	Potential Testbed Location	Macroscopic	Mesoscopic	Microscopic	Communications
1	ICM San Diego, CA	Aimsum Online TSS		TransModeler	
2	ICM Dallas, TX		DIRECT	VISSIM	
3	ICM Minneapolis, MN		DynusT		
4	CV Testbed, Novi, MI			Paramics	NS2
5	MTM Model, Manhattan, NY	TransCad		Aimsum	
6	CV Testbed, Palo Alto, CA			Paramics	
7	CV Testbed, Anthem, AZ			VISSIM	APIs for signal control and NTCIP 204 messaging
8	SHRP C10 Sacramento, CA	SACSIM/DaySim	Dynus T		
9	SHRP C10 Jacksonville, FL		TRANSIMS, DaySim		
10	SHRP C05 DTA Portland, OR			Dynasmart-P	
11	ARC's DTA Studies, Atlanta, GA	Cube Voyager TP+	Cube Avenue DTA	VISSIM	
12	San Francisco's DTA Anyway	Cube	Dynameq, DynusT		
13	Presidio Pkwy Traffic Mgmt		Dynameq		
14	Geary Blvd BRT		Dynameq	VISSIM	
15	DTA Platform Bellevue, WA				
16	Alaska Way Viaduct, Seattle, WA		Dynameq		
17	White House Area Transportation Study		TRANSIMS2		
18	Weather - Chicago			Dynasmart-X	
19	Weather - Salt Lake			Dynasmart-X	
20	Weather - New York			Dynasmart-X	
21	Research Data Exchange (RDE) Test Data Set - Pasadena	VISUM		VISSIM	

Table 3-3: Categorization of Potential Testbed Locations

ID	Potential Testbed Location	Strategic	Tactical	Multi-Resolution	Communications	Average Score Against Nine Criteria
1	ICM San Diego, CA			✓		2.6
2	ICM Dallas, TX			✓		2.6
3	ICM Minneapolis, MN			✓		2.6
4	CV Testbed, Novi, MI		✓		✓	1.9
5	MTM Model, Manhattan, NY		✓			2.4
6	CV Testbed, Palo Alto, CA		✓		✓	2.3
7	CV Testbed, Anthem, AZ		✓		✓	2.4
8	SHRP C10 Sacramento, CA	✓		✓		2.0
9	SHRP C10 Jacksonville, FL	✓		✓		1.8
10	SHRP C05 DTA Portland, OR			✓		1.5
11	ARC's DTA Studies, Atlanta, GA			✓		2.0
12	San Francisco's DTA Anyway			✓		2.3
13	Presidio Pkwy Traffic Mgmt			✓		2.0
14	Geary Blvd BRT			✓		1.9
15	DTA Platform Bellevue, WA			✓		1.8
16	Alaska Way Viaduct, Seattle, WA			✓		2.0
17	White House Area Transportation Study			✓		2.3
18	Weather - Chicago			✓		2.0
19	Weather - Salt Lake			✓		1.8
20	Weather - New York			✓		1.9
21	Research Data Exchange (RDE) Test Data Set - Pasadena	✓		✓		2.5

4 Potential AMS Testbed Candidates

This section discusses the 21 testbed locations. A high-level assessment using the criteria defined in Section 2 was conducted initially for over 50 AMS testbed locations. These 50 AMS testbed locations included: six connected vehicle testbeds, each with an associated regional AMS capability; four testbed locations with SHRP 2-related Dynamic Traffic Assignment (DTA)-models; three ICM AMS testbed locations; three testbed locations with weather-response models; and several other locations with corresponding regional, corridor, or facility-level simulation models. This set of over 50 was reduced to 21 potential testbed locations due to several factors, including lack of well-calibrated AMS models, ease of adaptability, relevant information, etc. Each of these 21 models is discussed in greater detail in the subsections below.

4.1 ICM San Diego, CA

The San Diego I-15 ICM corridor was chosen as a site for AMS of Integrated Corridor Management (ICM) strategies [8-11]. The site has also been chosen for demonstration of ICM strategies. The I-15 corridor (Figure 4-1) is one of three primary north-south transportation corridors in San Diego. I-15 is the primary north-south highway in inland San Diego County. The corridor is a heavily-utilized regional commuter route connecting communities in northern San Diego County with major regional employment centers. The corridor is situated within a major interregional goods movement corridor, connecting Mexico with Riverside and San Bernardino Counties, as well as Las Vegas, Nevada.

One of San Diego's core ICM strategies is the configuration and implementation of a Decision Support System (DSS). The DSS is a “smart” traffic management system that gives system managers comprehensive awareness of the current and likely performance of the entire corridor. The DSS will allow operators to take proactive steps to prevent system breakdown using enhanced controls across multi-jurisdictional devices such as traffic signals, ramp meters, and dynamic message signs.

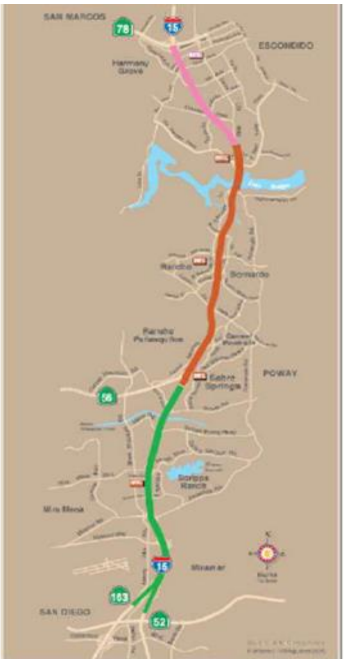


Figure 4-1:ICM Corridor [9]

The I-15 Corridor was simulated with the TransModeler microsimulation tool. Various versions of Transmodeler were utilized as additional capabilities became available. The Aimsun online DSS tool was used to model a mesoscopic level network.

Four scenarios were modeled:

- Daily Operations (no incident)
- Freeway Incident
- Arterial Incident
- Disaster Response

The following ICM strategies were tested:

- Pre-Trip Traveler Information
- En-Route Traveler Information
- Freeway Ramp Metering
- Signal Coordination on Arterials with Freeway Ramp Metering
- Physical Bus Priority
- Congestion Pricing on Managed Lanes

The base scenario was calibrated to 2003 demand levels while the future baseline scenario was calibrated with 2012 demand levels. The final four AMS scenarios, consisting of daily operations without incident, freeway incident, arterial incident, and disaster response, were tested and evaluated in both with and without DSS settings during the morning peak period.

The I-15 Corridor AMS results showed significant benefits, resulting from the deployment of ICM strategies:

- Overall, deployment of ICM on the I-15 Corridor produces $13.7 million in user benefits per year. Over the 10-year life cycle of the ICM systems, benefits produced a total benefit of $115.9 million.
- Costs to deploy ICM on the I 15 Corridor are estimated to be $1.42 million annualized over the 10-year life cycle of the project. The total life-cycle cost to deploy the ICM system is estimated at $12.0 million.
- The estimated benefit/cost ratio for the ICM deployment over the 10 life cycle of the project is approximated at 9.7:1.

Geographic Scope

The ICM San Diego testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The San Diego simulation platform covers a 20-mile section of I-15 from just north of SR 52 in the City of San Diego to SR 78 in the City of Escondido, including I-15 Express lanes and major arterial routes on either side of I-15 within a couple miles of the freeway. The section of I-15 freeway modeled has 8 to 10 lanes. The express lanes run along eight miles from SR 163 to Ted Williams Parkway (SR 56). The arterials roadways include:

- Centre City Parkway,
- Pomerado Road,
- Rancho Bernardo Road,
- Camino Del Norte Road,
- Ted Williams Parkway,
- Black Mountain Road, and
- Scripps Parkway.

Temporal Scope

For the base year (2003), the time period from 6 to 9 AM was modeled as it showed the highest levels of travel demand during the AM period for the entire network, and an additional 30 minutes was modeled as ramp up time and as many as one to two hours was added for the clearing of traffic demand in future scenarios. The current year Baseline Scenario was calibrated to 2003 demand levels and the Future Baseline Scenario was calibrated to 2012 demand levels.

Temporal Resolution

The testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The testbed location has 8 to 10 general purpose freeway lanes, two high-occupancy vehicle (HOV) reversible lanes that are eight miles long, and adjacent arterial facilities. Transit operations are not included in the model.

Level of Congestion

The region is a highly congested area.

Data Sources

The primary source of data was the PeMS system. Details on PeMS data assembly and cleanup, and field data collection efforts are provided online. In 2009 travel time runs as well as 2-week AM turning movements were also collected by Caltrans. The testbed location has limited capability to generate data from wireless communications, transit-specific data, or freight-specific data.

Calibration Status

Overall, the calibration status is judged to be good. For the ICM San Diego testbed location, the main source of data was the automatic detection on the freeway available through the PeMS database maintained by Caltrans. Year 2003 was chosen as the base year for model calibration. San Diego Association of Governments (SANDAG) collected turning movement count and travel time data off the freeway sections in order to help create hybrid data sets for the model calibration and validation processes. The primary data created using these multiple sources was volumes at freeway mainline and ramp locations, and speed contours from PeMS for year 2003.

A total of 110 freeway link counts on the I-15 corridor were compared against the modeled count output from the TransModeler simulation runs. The PeMS database provided 5-minute speed data between 6:00 AM and 9:00 AM at 16 locations along the southbound I-15 corridor and at 15 locations along the northbound I-15 corridor.

The model adequately replicates traffic volumes, bottlenecks, travel times, and congestion on the I-15 Corridor for an incident day. For the incident scenario, modeled freeway bottleneck locations are consistent in location, design, and attributes of the representative roadway section. Duration of incident-related congestion – duration where observable within the desired 25 percent. The extent of queue propagation was within 30 percent of observed data, and diversion flows with expected increase in ramp volumes were representative.

Ease of Adaptability

The AMS testbed location has a well-calibrated model of sufficient geographic and temporal scope, and temporal resolution. The AMS model will need to be extended to represent prediction and active management for ATDM strategies and communications for DMA applications. These extensions will require low to medium level of effort, depending on the strategy or application being modeled at this location.

Existing Deployments and or Research

The testbed location represents traveler information, but not predictive traveler information. A few ADM and ATM strategies are being deployed at this location, but no DMA application is being deployed or researched at this location.

4.2 ICM Dallas, TX

The Dallas US-75 corridor was the second site chosen for AMS and demonstration of ICM strategies [8, 11, 12]. The US-75 Corridor consists of multiple independent networks: Freeway, Managed High Occupancy Vehicle (HOV) Lanes, Tollway, Arterials, Bus, and Light Rail. The goal of the ICM Dallas effort is to operate the US 75 Corridor in a true multimodal, integrated, efficient, and safe fashion where the focus is on the transportation customer. This corridor includes multiple traffic management centers, and a number of systems - DART Data Portal, Interagency Information Exchange Network, Decision Support System, Expanded Traveler Information / 511, Real Time Weather Information, Infrastructure - Arterial Street Monitoring System, Adaptive Signal System, Bus Signal Priority, and Video Sharing Network.

The DIRECT model was used to reflect the effects of corridor operational changes on the larger regional network of 4,600 nodes, 11,270 links, 230 zones, and 1.7 million travelers. Departure time and model choices were modeled along with en-route changes in travel decisions. Figure 4-2 shows the Dallas network modeled using DIRECT.

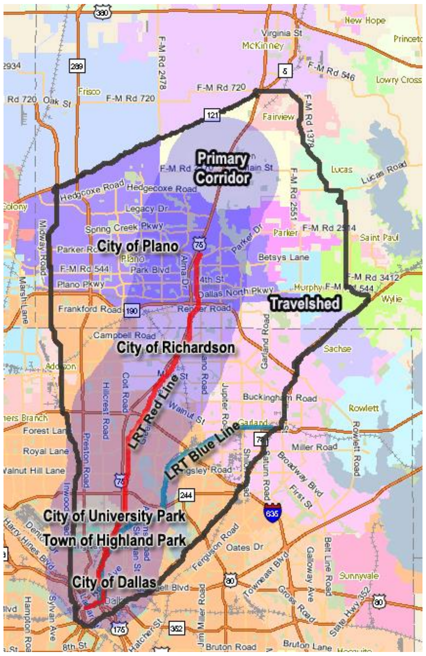


Figure 4-2: ICM Dallas Region [12]

Three key scenarios were modeled:

- Daily Operations - No Incident
- Major Incident Freeway
- Minor Incident Freeway

The U.S. 75 Corridor AMS results show significant benefits, resulting from the deployment of ICM/ITS strategies at the U.S. 75 corridor – both the benefit-cost ratio and 10-year net benefits are positive and significant.740K person-hours saving, 3% reduction travel time variance, 981K gallons of fuel saved, and 10-year benefit-cost ratio of 20:1.

Geographic Scope

The ICM Dallas testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The US-75 Corridor is a major north-south radial of approximately 28 miles in length. It is over 10 miles in width at its widest. This corridor connects downtown Dallas with many of the suburbs and cities north of Dallas. The primary corridor consists of:

- 28 miles of freeway segment with continuous frontage roads,
- 167 miles of arterials roads,
- light-rail line,
- Dallas Area Rapid Transit (DART) transit bus service,
- park-and-ride lots,
- major regional arterial streets,
- bike trails,
- high occupancy vehicle lanes, and
- Dallas North Tollway.

The modeled region contains 900 signals, 272 lane-miles of freeways and frontage roads, 32 lane-miles of HOV facilities, 2 light rail transit lines with 20 stations, 30 bus routes, 9 park and ride lots and 105 lane-miles of tollways.

Temporal Scope

The time period that was modeled is the morning peak period from 5:30 AM to 11:00 AM.

Temporal Resolution

The testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The testbed location is multi-modal, with HOVs, toll lanes, light rail transit, buses, and park and ride facilities.

Level of Congestion

The freeway mainlines carry over 250,000 vehicles a day, with another 20,000-30,000 on the frontage roads. There is moderate level of congestion on this corridor.

Data Sources

This testbed includes many sources of data including loop detector data, incident data, and transit-specific data as well as North Central Texas Council of Governments (NCTCOG) trip tables and networks available for 2007. A DART on-board survey to develop an estimate of the transit origin-destination (OD) trip table was also noted. However, the testbed location has limited capability to generate data from wireless communications, or freight-specific data.

Calibration Status

The ICM Dallas calibration level was judged to be moderate based on the available documentation. The Stage 2 AMS model calibration effort was performed for year 2007. All future models for year 2011 were created using the 2007 calibrated model as a base. During the Stage 2 AMS effort, the 2007 baseline model calibration effort was deemed comprehensive and sufficient.

In order to ensure that the future year models adequately represent observed travel conditions along the U.S. 75 corridor, an assessment was to verify and ensure that the future year baseline or daily operations model is consistent travel conditions along the corridor in year 2011. This will then serve to validate the capability of the pre-ICM model to accurately represent traffic conditions and congestion patterns. Volume and speed data were collected along three screen lines. Additional detectors also generated relevant data.

Ease of Adaptability

The AMS testbed location has a reasonably-calibrated model of sufficient geographic and temporal scope, and temporal resolution. The AMS model will need to be extended to represent prediction and active management for ATDM strategies and communications for DMA applications. These extensions will require low to medium level of effort, depending on the strategy or application being modeled at this location.

Existing Deployments and or Research

The testbed location represents variations of two ATDM strategies, including traveler information and smart parking system. No specific DMA application is being deployed or researched at this location.

4.3 ICM Minneapolis, MN

The Minneapolis I-394 corridor was the third site chosen for AMS of ICM strategies, but wasn't selected for ICM demonstration [8, 11, 13]. The I-394 corridor is the primary east-west connector between the Minneapolis central business district (CBD) and the western suburbs. Unique within the Twin Cities region, the facility also has two reversible, barrier-separated high-occupancy vehicle (HOV) lanes located in the center median between I 94 and Trunk Highway 100 (TH 100). Historically, these lanes were open only to bus and carpools with two or more passengers in the inbound (eastbound) direction from 6:00 AM to 1:00 PM, and open in the outbound (westbound) direction from 2:00 PM to midnight on weekdays. These lanes were also opened to buses and HOV traffic on a limited basis on weekends, usually in support of special event traffic. The lanes were closed at all other times. This portion of the I 394 HOV corridor is referenced as the reversible lane section.

The Minneapolis ICM corridor goals include improved coordination and traffic management during incidents; improved travel time; and increased modal shifts. ICM strategies modeled in Minneapolis include:

- earlier dissemination of traveler information

- comparative travel times
- parking availability at park-and-ride
- incident signal retiming plans
- predefined freeway closure points
- HOT lanes
- dynamic rerouting
- transit signal priority

The DynusT model for the I-394 corridor replicated the 2008 baseline operating conditions well as evidenced by the comparisons of observed and modeled volumes, travel times, and speed contours on I-394. Furthermore, the simulated known incident exhibited consistent traffic diversions, speed reductions, duration, and queue propagation with the actual data. Figure 4-3 shows the Minneapolis network modeled using DynusT.

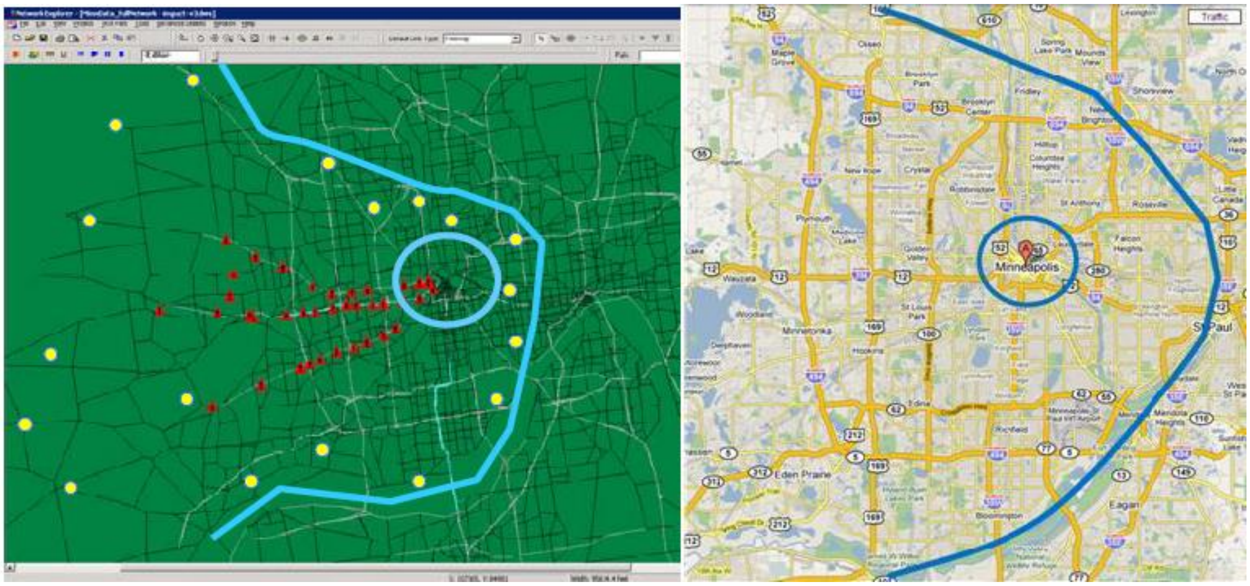


Figure 4-3: DynusT Model of Minneapolis ICM [13]

Geographic Scope

The ICM Minneapolis testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The I-394 corridor study area is approximately 25 miles in length beginning at the Minneapolis CBD and extending to the western suburbs. The corridor fans out as it moves westward including I-694 to the north and I-495 to the south, and point west just beyond Lake Minnetonka. The key highway facilities include I-394, I-495, I-694/I-94, and I-35W. North-south major facilities include Routes 100, 169, and 52.

The 2008 transit schedules represented in the I-394 corridor are composed of 47 routes that were extracted from the 2006 Cube Transit file. Key transit routes include:

- a BlueXpress route
- 13 Plymouth Metrolink routes

- 9 SouthWest Transit routes
- 24 Metro Transit routes

The ICM Minneapolis corridor is composed of 558 zones (including 60 external zones); 2,837 nodes, 6,871 links, and 1.5 million vehicles. The broader regional DynusT DTA models 1236 zones, 4965 nodes, 12462 links, and 2.2 M vehicles.

Temporal Scope

For the I-394 corridor study area, the simulation period is defined to be 5:00 AM to 11:30 AM, in which 5:00 AM to 6:00 AM is the “pre-loading” period. The analysis period lasts from 6:00 AM to 11:00 AM, while the AM peak period is defined to be from 6:45 AM to 8:45 AM.

Temporal Resolution

The testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The testbed location is multi-modal, with two reversible HOT lanes, buses, and park and ride facilities.

Level of Congestion

The corridor experiences recurring and non-recurring congestion, especially during incident and special event activity.

Data Sources

MnDOT or a local transit agency automatically records by field sensors or monitoring devices much of the data required for model validation. Data from 186 freeway sensors were utilized from the MnDOT records. For arterial data, traffic counts in close proximity to I-394 were collected in 2008 at 16 arterial locations over three days. However, the testbed location has limited capability to generate data from wireless communications, or freight-specific data.

Calibration Status

In modeling the I-394 corridor, macroscopic and mesoscopic approaches were utilized. Microscopic tools were considered, but were not used since the selected mesoscopic tools allowed for the modeling of all required ICM strategies on the large scale required.

Calibration involved matching speed density curves, volumes, speeds, and travel times on road facilities as well as transit route and park and ride demand/utilization. Further, an incident event was modeled and calibration of bottleneck location on freeway, duration of incident-related congestion, extent of queue propagation, diversion of flows, and arterial breakdown pattern was generally consistent with what is observed or expected.

The calibration iterations improve the matching of the observed and simulated counts over the OD iterations. Approximately 1.5 million trips were generated before calibration. After calibration, approximately 1.6 million trips were generated, a trip increase of less than 7 percent. The model met AMS criteria that 88.5 percent of the links are within 15-percent error. The primary 112 links exhibit a volume within -4.4 percent of observed and the secondary 202 links yields an average -4.9-percent error. Both were within the 5-percent limit set within the experimental plan. Probe vehicles collected travel times on TH-55, TH-7, and I-394 in both EB and analysis of data suggested that while the majority of runs are within the within the 15-percent range for east and west-bound, the WB travel times are slightly lower. All of the simulation travel times were within 30% of the measured probe data.

The calibration is judged to be good based on the available documentation.

Ease of Adaptability

The AMS testbed location has a reasonably-calibrated model of sufficient geographic and temporal scope, and temporal resolution. The AMS model will need to be extended to represent prediction and active management for ATDM strategies and communications for DMA applications. These extensions will require low to medium level of effort, depending on the strategy or application being modeled at this location.

Existing Deployments and or Research

A few ATDM strategies, such as traveler information and transit signal priority, were modeled. However, no specific DMA application is known to being deployed or researched at this location.

4.4 Connected Vehicle (CV) Testbed in Novi, MI

The Michigan National Connected Vehicle (CV) Testbed has been developed jointly by USDOT, Michigan Department of Transportation, and several state partners. The connected vehicle testbed was established in Novi, Michigan in 2007 as a proof of concept to test connected vehicle technologies in a real-world environment. It has since undergone a number of changes and improvements. The Novi testbed consists of a network of 58 roadside equipment (RSE) units installed along various segments of live interstate roadways, arterials, and signalized and unsignalized intersections. The initial test included fifty-four dedicated short-range communications (DSRC) units spread across twenty square miles using a twenty-five-car fleet.

The goals of the Paramics simulation model of the testbed included evaluating data sampling errors, data generation using snapshots, studying the effect of privacy safeguards on probe data, information communication to ‘affected’ subsets of vehicles, broadcasting signal phasing and timing information to vehicles approaching intersections, design of data routing protocols, design of car-following algorithms less sensitive to information delays, and provision to the USDOT of a sample dataset of vehicle snapshots capturing the information that could be collected in a network under full market penetration scenario [14,15]. Figure 4-4 shows the Michigan National Connected Vehicle Testbed map and the corresponding Paramics model.

Figure 4-4:Michigan National Connected Vehicle Testbed [15]

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The testbed is located in Oakland County, Michigan (in the western suburbs of Detroit), including the cities of Novi, Farmington, Farmington Hills, and Livonia with some expansion into Southfield. The geographic scope of the model and the RSE installation covers 45 square miles, comprising 75 center-line miles made up of 32 interstate and divided highway and 43 arterial miles. The ongoing Michigan expansion will cover an additional 6 arterial center-line miles.

Temporal Scope

The time period that was modeled is the AM peak period on weekdays from 6 AM to 11 AM.

Temporal Resolution

The testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The three key freeway facilities include I-96, I-696, and I-275. A number of arterials are also represented in the network. The network models only automobile travel; no other modes are represented.

Level of Congestion

The road network generally replicates observed traffic flow patterns during typical weekday mornings, allowing the evaluation of connected vehicle applications by considering up to 18,000 vehicles communicating simultaneously, and up to 78,000 vehicles traveling across the modeled network in the highest demand hour. The level of congestion in this network is moderate to low.

Data Sources

The presence of RSEs across the Testbed provides opportunities for connected vehicles-specific data collection. However, the testbed location has limited capability to generate transit-specific or freight-specific data.

Calibration Status

Origin-destination matrices were developed using link flow data from hourly intersection flow counts that had been conducted between 2006 and 2008 by the Southeast Michigan Council of Governments. The model serves to test connected vehicle communications. The level of calibration was lower than what was observed for the ICM AMS testbeds.

The calibration level of this model was judged to be low based on the available documentation.

Ease of Adaptability

A microsimulation modeling of the primary road network covering the Novi, MI testbed was developed in Paramics. An external virtual simulator enables the following capabilities:

- Model of the SAE J2735 draft protocols
- Define, and change, key connected vehicle system and application parameters
- Development of dynamic routing algorithms replicating the operations of on-board vehicle navigation systems
- Traffic signal controllers to broadcast current signal phasing and timing (SPaT) information to approaching vehicles and for vehicles to respond to these messages
- Simulate vehicle-to-vehicle and vehicle-infrastructure wireless communication during a Paramics simulation using the NS-2 or other wireless communication simulator
- Development of graphical functions allowing to display onscreen the range of roadside communication units and communicating vehicles.

Although the AMS model represents communications modeling, the model was developed by the University of Michigan Transportation Research Institute (UMTRI). As such, the model may not be available for use by others. Even if the UMTRI model is available for use, the ease of adaptability will still be low as the models will need to be extended to represent the DMA applications and or ATDM strategies, and will have to be calibrated. These extensions will require high level of effort making the ease of adaptability low.

Existing Deployments and or Research

The DMA INFLO Prototype Developer might conduct a demonstration of the prototype of speed harmonization and queue warning at the testbed. A selection has not yet been made. No specific ATDM strategy is known to being deployed at this location.

4.5 Manhattan Traffic Model Network, Manhattan, NY

The Manhattan Traffic Model (MTM) is a multi-tier model developed for New York City Department of Transportation (NYCDOT) by Cambridge Systematics, STV and TSS-Transport Simulation Systems to assess traffic operations for Manhattan, New York [16-20]. The integrated traffic modeling program analyzes at macroscopic, mesoscopic, and microscopic levels traffic impacts from various projects. Figure 4-5 shows the multi-tiered model for Manhattan. NYCDOT is working with other regional agencies to coordinate modeling activities where the MTM network will be made available to address cumulative network impacts of construction projects, roadway closures and traffic operations plans, as well as to provide a point of departure for future work and the creation of a sustainable regional model.

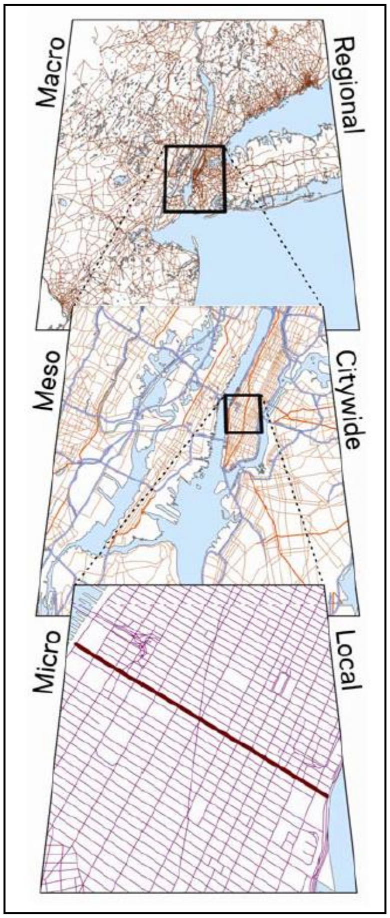


Figure 4-5: Manhattan Models [17]

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The macroscopic model covers the whole of the island of Manhattan in addition to parts of New Jersey, the Bronx, and Brooklyn. The microscopic model focuses on the 34th Street transit way project.

Temporal Scope

The specific time of day was not identified in the literature.

Temporal Resolution

The testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The microscopic model includes pedestrian simulation and curb parking. The MTM model includes parking, pedestrian and bikes, buses, taxis, truck deliveries, traffic signal coordination, bridge tunnel operation, and trip purpose.

Level of Congestion

Extreme levels of congestion exist throughout the day.

Data Sources

The testbed location has sufficient capability to generate multi-source data. Taxi GPS speed data and SkyComp aerial data were used to validate the MTM platform. Signal timing data was acquired from the NYC DOT signals division. Traffic measurements counts were available at 120 locations. Additionally screenline counts, travel speed runs, bridge counts, and a Lincoln Tunnel origin-destination survey were conducted. Queens-Midtown Tunnel (QMT) volumes and O-D were also surveyed.

Calibration Status

The data used to calibrate this model was collected in 2009 including traffic and transit specific data. The calibration level for this model is judged to be moderate based on the available documentation.

Ease of Adaptability

The meso- and microscopic models apply the Aimsun modeling platform while BPM-TransCad serves as the macroscopic model. However, the models may not be available for use by others. In addition, the models will need to be extended to represent the DMA applications and or ATDM strategies, and will have to be calibrated. These extensions will require high level of effort making the ease of adaptability low.

Existing Deployments and or Research

A few ATDM strategies, such as managed lanes and transit signal priority, were modeled. However, no specific DMA application is known to being deployed or researched at this location.

4.6 CV Testbed in Palo Alto, CA

During 2005-2006, Caltrans and Metropolitan Transportation Commission (MTC) funded the development and operation of a testbed environment for DSRC communications along El Camino Real in Palo Alto, CA. That testbed relied on an early generation of DSRC radios. At the end of 2012 those DSRC radios were replaced with ones consistent with the Safety Pilot Model Deployment in Michigan. The remainder of its infrastructure is being largely re-used. This corridor is modeled both in VISSIM by Cambridge Systematics and in Paramics by Booz Allen Hamilton. The VISSIM model, shown in **Error! Reference source not found.** was directly related to the CV effort and included the conduct of a bicycle crossing study [21, 22].

The purpose of this testbed is to evaluate real-world implementations of connected vehicles, inform future investment decisions on system management programs, assets, vehicles, applications and infrastructure components.

Transit vehicle priority and eco-transit signal priority are the two points of analysis conducted within this corridor. Two passive and three active strategies are considered:

- Passive - optimize signal timing, coordinate successive signals
- Active – green extension, early green, early red, phase rotation, actuated transit phase, and phase insertion.

Modeling has analyzed the relative effect on emissions for all vehicles and specifically buses in alternatives with and without transit signal priority model. This effort will expand through development and application of emission prediction function, eco-priority algorithm, and objective functions that consider delay and emissions.

Figure 4-6: El Camino Real Model [22]

Geographic Scope

This testbed location has limited geographic scope and complexity to represent the impacts of multiple DMA and ATDM applications or strategies. The 6-mile segment of El Camino Real, SR 82, connected vehicle testbed located in Palo Alto is a single facility with three lanes in each direction and 27 signalized intersections, some of which are actuated and coordinated. The segment parallels US-101. No surrounding area is modeled.

Temporal Scope

The specific time of day was not identified in the literature.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

One application of the model represents bicycle movements, but in general is lacking in representation of multiple modes.

Level of Congestion

The El Camino Real testbed experiences heavy congestion.

Data Sources

The testbed location has sufficient capability to generate multi-source data. The El Camino Real network is in the data-rich San Francisco region where a number of other simulation studies such as the DTA Anyway effort has been implemented. However, no specific information on the availability of data for this testbed was identified.

Calibration Status

Vehicle demands and their origin-destination (OD) patterns were calibrated to a typical weekday in summer 2005. The OD table for the morning peak period was estimated from turning movement count data obtained from the California Department of Transportation and the Santa Clara Valley Transportation Authority. Signal settings in the model are based on the parameter values exported from the actual traffic signal system in July 2005.

Roadway geometric characteristics, including number of lanes, lane width, and horizontal curvature, were coded based on digital maps and verified through field visits. Other roadway attributes, such as speed limit, lane marking (e.g., through-only lane or shared through/right-turn lane), were obtained from the field visits. The calibrated model was validated by comparing modeled link volumes against observed link volumes at traffic count locations along the corridor. Also in VISSIM, larger (21 intersections), but not as detailed in signal controller and messaging, API development was undertaken.

The calibration level of this model was judged to be moderate based on the available documentation.

Ease of Adaptability

The DMA-Multi Modal Intelligent Signal System (MMITSS) bundle will be prototyped at this location, and the AMS and communications models developed will be made open source. Thus, the ease of adaptability is high for modeling DMA applications. However, the AMS model will need to be extended to represent prediction and active management for ATDM strategies.

Existing Deployments and or Research

The MMITSS bundle will be prototyped at this location. However, no specific ATDM strategy is known to being deployed at this location.

4.7 CV Testbed in Anthem, AZ

The Anthem, AZ testbed, shown in (Figure 4-7), is a part of the Maricopa County Department of Transportation (MCDOT) SMART Drive Field Test Network. The network is located north of Phoenix, Arizona. MCDOT, the Arizona Department of Transportation (ADOT), the Federal Highway Administration, the University of Arizona, Arizona State University, Kimley-Horn and OZ Engineering demonstrated the SMARTDrive program in Anthem, Arizona. The projects include V2I and V2V applications to improve incident management, prototype development, lab test, field test, and advanced signal operations [22, 26].

The three specific applications that were evaluated include traffic signal priority for emergency vehicles and transit, smart cross graphical user interface for use on mobile devices identifying pedestrian crosswalk status with sound enabled, and traveler information through OBE dissemination to in-vehicle, cell phone, and TMC.

The multi-modal priority control system was demonstrated in the region and the results showed that the discussed priority control system has the potential to provide safer and more efficient multi- modal traffic signal operations. The priority control system focused on multiple emergency vehicle response (e.g., police cars, fire trucks, and ambulance) converging at a single intersection with collision potential.

The pedestrian assistance for intersection crosswalks for the visually impaired and those with limited mobility was also demonstrated. In this demonstration the pedestrian was given a hand-held device displaying the green light and countdown information displayed on the cross-street signal.

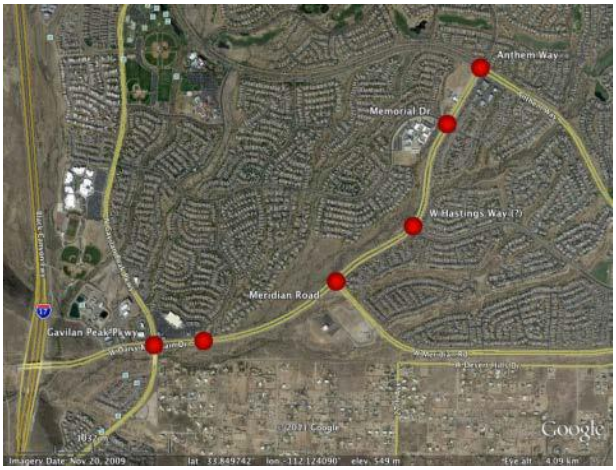


Figure 4-7: Anthem, AZ Model [22]

Geographic Scope

This testbed location has limited geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The network is located north of Phoenix, Arizona in Anthem. A 2.3-mile stretch of Daisy Mountain Drive, including six intersections, constitutes this testbed. No adjacent or parallel facilities are modeled.

Temporal Scope

The specific time of day was not identified in the literature.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The testbed location represents multiple modes, including transit, pedestrians, and emergency vehicles. This corridor does not have transit service; however, for demonstration purposes, a Valley Metro bus was employed.

Level of Congestion

Travel demand along this corridor is heavy during the peak periods but very low during the mid-day and off peak times. Overall, moderate to low levels of congestion are present at this testbed location.

Data Sources

The testbed location has sufficient capability to generate multi-source data. Within this region, as a part of the testbed, six pole-mounted RSEs (Savari StreetWave) were integrated with signal controller (Econolite ASC3) and have DSRC, Wi-Fi/Bluetooth capabilities. Also present along this facility are traffic signal priority applications, fiber communications along the testbed, CCTV, and loop detection.

Calibration Status

Bluetooth travel time data are available to calibrate and validate delay, travel time, arrival on red/green, and queue length. Additional calibration information could not be identified through this effort. The calibration level of this model was judged to be moderate based on the available documentation.

Ease of Adaptability

The DMA-Multi Modal Intelligent Signal System (MMITSS) bundle will be prototyped at this location, and the AMS and communications models developed will be made open source. Thus, the ease of adaptability is high for modeling DMA applications. However, the AMS model will need to be extended to represent prediction and active management for ATDM strategies. These extensions will require medium level of effort.

Existing Deployments and or Research

The MMITSS bundle will be prototyped at this location. However, no specific ATDM strategy is known to being deployed at this location.

4.8 SHRP 2 C10 Sacramento, CA

The Sacramento metropolitan area is the 26th largest in the United States. It experiences significant congestion during peak periods. This region was selected for mesoscopic dynamic traffic assignment (DTA) modeling through the SHRP 2 C10 project. Key partners in developing this testbed include Cambridge Systematics, Sacramento Council of Governments (SACOG), the University of Arizona, the University of Illinois, Sonoma Technology, and Fehr&Peers [27-29].

The goals of the SHRP 2 C10 Sacramento model include improving the modeling process and developing capabilities based on challenges identified when developing the SHRP 2 C10 Jacksonville model. Key operational advances are in demand model integration with fine-grained, time-dependent networks, including linking of individual person records with microsimulation vehicle and transit trips, incorporating reliability and other model enhancements, and creating an interface between SACSIM (Sacramento Activity-Based Travel Simulation Model), which has within it DaySim, and DynusT and MOVES. A transit simulation component, FastTrips, was added to the model. Figure 4-8 shows the Sacramento network modeled in SACSIM.

As of October 2013, the model development is complete. Testing by SACOG was expected to be completed by the end of October 2013; however the status of this activity is unknown. One iterative loop between SACSIM and DynusT currently requires approximately one day and includes approximately ten DynusT simulations. The specific policies tested by SACOG between the original SACSIM model and the integrated model include an operations-oriented interchange project, a new transit line, and a freeway bottleneck analysis. Projects tested only with the integrated model include arterial signal coordination, transit schedule coverage change, and a HOT lane project.

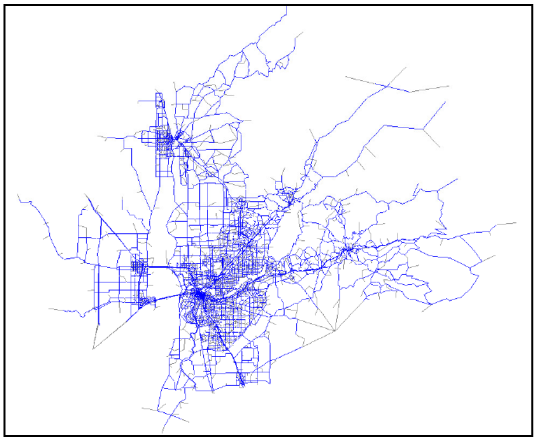


Figure 4-8: SACSIM TP+ Network [28]

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The SACSIM transportation network includes approximately 6,000 square miles. Nominally, roadway networks include the "collector-and-above" freeways, expressways, arterials, and collectors. The geographic scope of the Sacramento DynusT model could not be ascertained from the literature.

Temporal Scope

The specific time of day was not identified in the literature.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The models represent multiple modes, including HOV, light rail, buses, bikes, and pedestrians. The DaySim model person tours and trips are translated to DynusT and FAST-Trips auto and transit simulation. Truck and airport vehicle trips are exogenous and introduced within DynusT.

Level of Congestion

The testbed experiences moderate to significant congestion.

Data Sources

The testbed location has limited capability to generate multi-source data, including data from wireless communications.

Calibration Status

While information on the planned calibration and validation of the model along with available and data newly needed were defined in a "Model Design Plan" document, the actual data on the specific calibration were very limited. The 2005 SACSIM model is the base of the effort. Some speed, volume, intersection turning movement, and screenline data acquisition was undertaken in 2010 to validate the model.

The set of data defined as available in the "Model Design Plan" included:

- socioeconomic data from SACOG of good quality
- Traveler behavior data from census and a 2001 Household Travel survey with mode choice for trip purpose of good quality
- Parcel-level geography, park-and-ride facilities, and railroad crossings of good quality
- Roadway network, lane, functional classification, and traffic signal timing of fair quality

Validation tests for usual work and school location, auto ownership, day pattern, tour primary destination and main mode, as well as primary activity scheduling choices were defined with regard to validation measure and expected outcomes for the mesoscopic model.

The calibration level of this model was judged to be moderate based on the available documentation.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. These extensions will require medium level of effort.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.9 SHRP 2 C10 Jacksonville, FL

The primary objective of this project was to make operational an integrated, advanced travel-demand model with a fine-grained, time-dependent network, and to demonstrate the model's performance through validation tests and policy analyses. For this region, DaySim was linked to Transims as well as to MOVES for air quality analysis [30-32].

The North Florida Transportation Planning Organization (NFTPO) region, which covers the Jacksonville metropolitan area, is the fifth most populous of Florida's 26 metropolitan planning organization (MPO) regions with 1.2 million people. Interstate 95 passes through the city, leading to substantial freight and interregional passenger car volumes on the region's transportation backbone. Figure 4-9 shows an aerial view of Jacksonville as well as the corresponding TRANSIMS model.

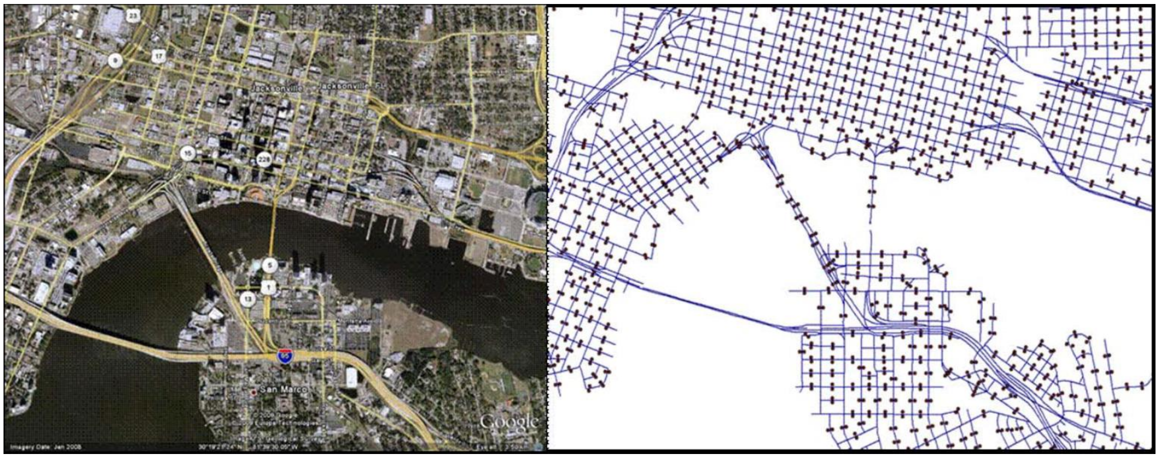


Figure 4-9: Jacksonville Aerial View and Model Representation [32]

The supply side models proposed for the Jacksonville SHRP 2 C10 project are based on the TRANSIMS network and travel assignment process. It is modeled iteratively with DaySim to general equilibrium while MOVES is applied for emissions estimation. Specifically, the DaySim activity based model generated individual minute-level travel based on a synthetic generation.

Two types of pricing tests were evaluated as part of this effort. In the first, a number of scenarios were defined in which freeway tolls were varied by time of day. In the second, a number of scenarios were defined in which auto operating costs were modified from the "baseline" condition. The analysis also assessed the impacts of a flexible work schedule in which workers worked fewer days but longer hours on those days, and in which the overall time spent in work activities was held fixed. As of October 2013, a snapshot of the model is available, and the model findings report will be available shortly.

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The TRANSIMS model encompasses the Jacksonville, FL downtown network while the DaySim activity-based model encompasses the broader regional network.

Temporal Scope

The specific time of day was not identified in the literature.

Temporal Resolution

The testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies. While SACSIM has four temporal resolutions (AM peak, PM peak, mid-day, and night), the DaySim simulates 24-hour itineraries for individuals with spatial resolution as fine as individual parcels and half-hour temporal resolution. The TRANSIMS router in concert with DaySim enables temporal resolution within a range of one to 15 minutes. The TRANSIMS microsimuator enables temporal resolution range between one to ten seconds.

Modes Represented

It is unknown from the literature if there are multiple modes.

Level of Congestion

The level of congestion in this model is relatively low.

Data Sources

It is unknown from the literature if the testbed location is capable of generating data from multiple sources.

Calibration Status

The North Florida Household Travel Survey and the Northeast Florida External Travel Survey, both collected in the year 2000, have been acquired for use in calibrating the DaySim model.

Regional traffic counts support model calibration and validation. This dataset includes ITS sensor data as well as loop detector data. The sensor data is available for 190 locations on I-95 and I-295 (approximately every ½ mile), and includes total traffic counts at 5-minute intervals. Loop detector data are available for approximately 20 permanent stations, and similar detailed data are available for hundreds of other locations collected using portable detectors.

The calibration level of this model was judged to be low based on the available documentation.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. These extensions will require medium level of effort.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.10 SHRP 2 C05 DTA Portland, OR

The SHRP 2 C05 DTA activity was first implemented in a small subarea of Dallas/Ft. Worth, Texas, and then applied to the Portland area. Kittelson and Associates are the developers of this testbed [33-34].

The purpose of this research was to develop a rigorous and computationally efficient tool to assess corridor and network-wide effects of pricing and crash-reduction strategies on recurring and non-recurring congestion. The resulting open-source dynamic traffic assignment model is a practical everyday use for a large-scale metropolitan area network. This was achieved by modifying the internal logic of DYNASMART-P (Dynamic Network Traffic Planning Tool). DynusT and DTALite were also used in this effort. Figure 4-10 shows the Portland, OR network modeled in DYNASMART-P.

It was found that both DYNASMART-P and DynusT were able to perform acceptably when modeling the smaller subarea network: a single simulated 4-hour day could be completed with DYNASMART-P in about 30 minutes using the hardware environment described above, and in only 7-10 minutes when the computer processing environment was increased from two to eight cores working in parallel. The DTALite model fared much better. Using the same hardware environment and without any aggregation of zones, a single 4-hour analysis period of simulated time for the entire Portland area network required only about 5 minutes to complete using DTALite. At the time the models were built, DTALite was still in some level of development and was not fully comparable to either DYNASMART-P or DynusT. Hence, the DTALite was used to model the entire Portland metropolitan area network for a period of 50 simulated days. The results of the DTALite model were used to create an O-D matrix for the much smaller subarea network, and this became the basis for the DYNASMART-P modeling of the subarea that followed.

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The subarea is located in the southwestern part of the Portland, Oregon metropolitan area. It encompasses a fairly large area and includes facilities that have statewide, regional, and/or local significance. The sub area is bounded by the roadways Highway 26, Highway 217, Farmington Road, and River Road. The network is about 10 miles in length. The subarea of the Portland, Oregon metropolitan area encompasses approximately 210 traffic analysis zones, 860 nodes, and 2,000 links.

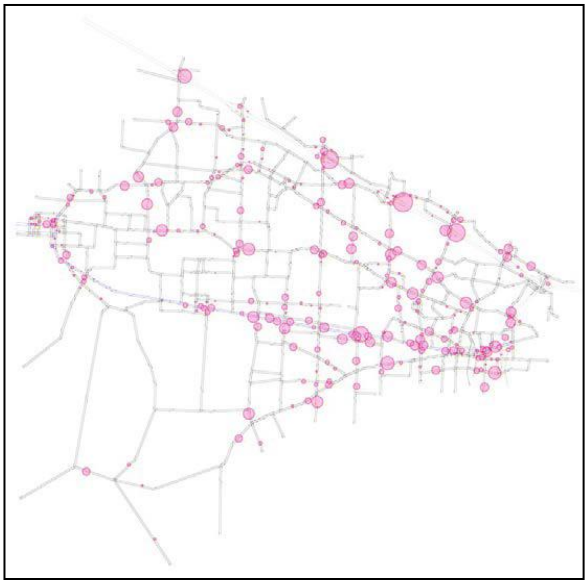


Figure 4-10: Portland, OR Model [33]

Temporal Scope

Trips were initiated in the network during a four-hour weekday time interval from 3 to 7 PM.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The models lack in representation of multiple modes.

Level of Congestion

The area is characterized by significant congestion on both freeway and arterial segments during typical weekday evening peak hours. Over 200,000 vehicle trips were initiated during a four-hour weekday time interval between 3 and 7 PM.

Data Sources

The testbed location has limited capability to generate multi-source data.

Calibration Status

Calibration for this project is defined as poor because some inaccuracies (relative to true existing conditions) were purposely introduced into the network structure to ensure this exercise is used only to demonstrate the new methods and model capabilities. For example, the number and length of through lanes and some arterials were modified [33]. However, it is unknown if a well-calibrated model prior to the introduction of these inaccuracies exists.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies and multiple modes. Finally, the model will need to be thoroughly calibrated. These extensions will require significant level of effort. Thus, the ease of adaptability is low.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.11 ARC's DTA Studies Atlanta, GA

Atlanta's Memorial Drive DTA Case Study is a part of Atlanta Regional Commission's (ARC) Strategic Regional Thoroughfare Plan and Regional Thoroughfare Network. This effort sponsored by the ARC involves modeling regional, subarea and corridor network components by applying the right-size modeling platform to meet the objectives of the study. Five case studies were conducted, each with arterial and highway facilities using a mesoscopic model, and a slim corridor for microscopic modeling [35-40]. Figure 4-11 shows a map defining the Moreland Ave study area.

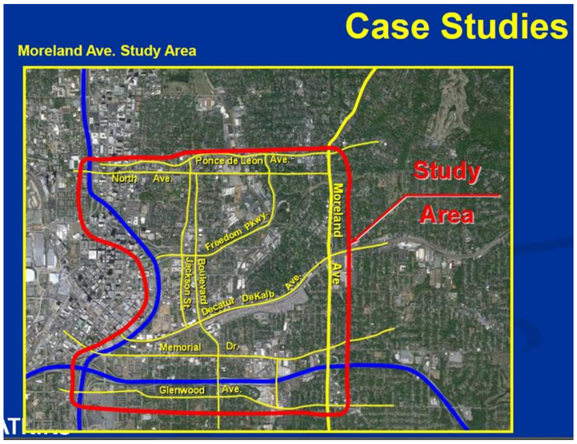


Figure 4-11: Atlanta Moreland Avenue Case Study [35]

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The five Atlanta Memorial Drive DTA case studies each model a 10-square miles area of arterials and highways. Slim corridors within the larger areas were also studied. The key facility in each study area are listed below:

- Aviation Blvd./Conley Road – Clayton County
- Moreland Ave – Fulton County – 3x2mi area (Figure 4-11)
- Memorial Dr. – DeKalb County
- Roswell Rd. (SR 9) – Sandy Springs/Roswell
- McDonough Rd. (SR 155) – Henry County

Temporal Scope

The case studies model the AM and PM peak periods.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The five case studies represent multiple modes, including SOVs, transit, and pedestrians. The Moreland Ave, Fulton County model included pedestrian signal and BRT. The Roswell Rd. (SR 9) – Sandy Springs / Roswell includes pedestrian and buses.

Level of Congestion

Information on levels of congestion was unclear from the literature.

Data Sources

The testbed location has moderate capability to generate multi-source data, including data from Transit Automated Vehicle Locators (AVL).

Calibration Status

Information on model calibration was not identified in the literature.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies but needs to be thoroughly calibrated. These extensions will require significant level of effort. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.12 San Francisco DTA Anyway

The San Francisco Bay area regional network has over 2400 zones and is expected to support 30 million daily trips by 2030. The DTA modeling effort aimed to transform a key section of the regional network for use as a mesoscopic model enabling dynamic traffic assignment. Figure 4-12 shows the San Francisco mesoscopic model [41-42].

The DTA model development team included the San Francisco County Transportation Authority (SFCTA), Parsons Brinckerhoff, and a Peer Review Team of industry experts. The key hypotheses to be assessed through the creation and application of the mesoscopic model include:

- How does DTA perform in a dense and highly congested grid network?
- How can DTA be used to study the interaction of the street network with the transit system?
- What benefits might DTA provide in evaluating congestion pricing policies?

DTA predicted more diversion. The BRT scenario demonstrated that under the congested conditions tested, that the DTA model predicts more diversion than the static model run for the same scenario. This project demonstrated that a DTA model of this scale could be reasonably well calibrated and validated without relying on origin-destination matrix estimation. This model, as with all DTA models, is subject to cliff effects, a single bottleneck can cause the entire network to become gridlocked, and a data driven approach provides a valuable starting point.

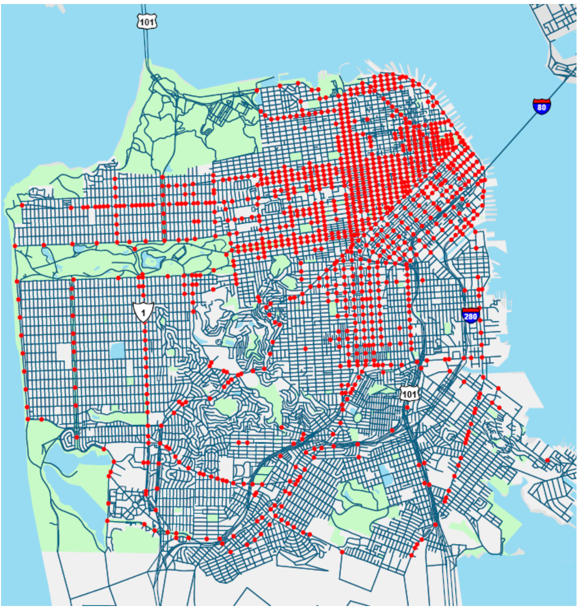


Figure 4-12: San Francisco Model [42]

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The San Francisco network test network consists of a tight grid network and only four major entry points. The four major entry points are U.S. 101 North (the Golden Gate Bridge) to Marin County, I-80 East (the Bay Bridge) to Treasure Island and Oakland, and U.S. 101 and I-280 South, to the San Francisco peninsula and Silicon Valley/San Jose.

Temporal Scope

The time period that was included is the three-hour PM peak period from 3:30 to 6:30 PM. In 2008, this time period had 550,000 vehicle trips.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The San Francisco network is a tight grid network that consists of auto and transit.

Level of Congestion

The region is a highly congested area.

Data Sources

The testbed location has moderate capability to generate multi-source data. For example, data from wireless communications are not available.

Data used in this simulation included count and travel time data available in the San Francisco County. Demand data was derived from household survey data and observed characteristics of traffic count.

SFCTA's Count Dracula database from 2009-2011 was queried to pull over 1,000 movement counts. PeMS data on freeway 30 lanes was used to establish flow-density relationships and estimate free-flow speed, backwards wave speed, and saturation flow. Free-flow speed, saturation flow, response time for freeways was estimated using PeMS data, while jam density was inferred. For arterials, the San Francisco Metropolitan Authority (SFMTA) speed survey established free-flow speed while other parameters were estimated because of data limitations. Traffic flow parameters on locals and collectors were mostly inferred from arterial data.

In estimating travel times, free flow speed was reduced to proxy the lost time from acceleration and deceleration. Bus land permission was approximated to reflect real world lane permission because full bus lanes caused gridlock.

Calibration Status

Overall, out of the 1200 signals found in the study area the study team successfully converted 900 using the following steps. The timing parameters for the remaining 300 were calculated using Webster's method. Static estimates of the demand from the SF-CHAMP activity-based demand model were converted into 15-minute intervals using a straightforward process of allocating demand based upon observed diurnal distributions.

SFCTA's traffic counts database, Count Dracula, was used to pull mid-week counts from 2009 through 2011 with count movement aggregated at 5-minute or 15 minute levels for the most part.

The calibration level for the model was judged to be good.

Ease of Adaptability

A seamless process has been established for exporting data from SF-CHAMP regional planning model to the DTA model such that the trips run on a consistent set of networks and with a consistent trip table. The DTA Anyway platform can read Cube networks and read/write Dynameq ASCII (American Standard Code for Information Interchange) files, write GIS shape files for nodes and links, and perform link splitting or attaching. DTA Anyway does not have a direct GUI or read/write DTA networks for other DTA software. A suite of Python scripts takes static networks and projects and creates DTA networks and projects. Every single highway, street, alleyway, and turn penalty is already coded into the street network within San Francisco, making additional coding minimal.

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

The SFCTA is continuing efforts for future developments to the DTA Anyway simulation platform beginning with transit representation and further model stability investigations, followed by development of a robust parking model and truck/commercial vehicle model. Smart parking is both a DMA and an ATDM application.

4.13 Presidio Parkway, San Francisco, CA

Presidio Parkway is the replacement for Doyle Drive, a 2-mile long southern approach to the Golden Gate Bridge, which serves as the primary highway and transit link from San Francisco and the South Bay to the North Bay Counties as well as an essential east-west connection for trips within San Francisco. Plans for the replacement of the 60-year old Doyle Drive have been underway since the 1970s. The final funding gap was closed by the American Recovery and Reinvestment Act of 2009 (ARRA). SFCTA decided to implement Dynamic Traffic Assignment (DTA) for this quadrant of the city to quickly identify potential bottlenecks and queues as a result of the construction and to test possible solutions to these issues [43-45].

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. This 2 mile by 5 mile stretch of road includes freeways, major and minor arterials, and a transit network. The Doyle Drive corridor network is a portion of San Francisco County that extends from the west coast to Van Ness Avenue. Its northern boundary is the Golden Gate Bridge and its southern frontier is Fulton Street. The Corridor consists of 200 internal zones and 60 external zones with demand being on the order of 160,000 vehicles for the PM peak period. There are approximately 3,000 nodes, 7,000 links, and 240 signalized intersections coded within the Dynameq model. Figure 4-13 shows the Dynameq model of the Presidio Parkway.

This network has two limited access facilities (US 101/Doyle Drive and CA 1/Park Presidio/Veteran's Boulevard), several rural park roads within the Presidio National Park, low volume stop-controlled city streets to the west, and high-volume city streets to the east with coordinated signals.

Figure 4-13: Presidio Parkway Model [45]

Temporal Scope

The network simulates a three-hour PM peak period.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The model represents multiple modes, including SOVs and transit.

Level of Congestion

The testbed experiences significant congestion. The corridor carries 160,000 vehicles during the PM peak period.

Data Sources

The testbed location has moderate capability to generate multi-source data. For example, data from wireless communications are not available.

Calibration Status

Demand matrices were assigned in the Dynameq DTA software package to begin calibration. Scenarios represent 2011 network prior to construction and a 2012 network during construction. A penalty was introduced for turning movement to mitigate zigzag route choices across the grid network.

The calibrated DTA converged to a maximum 4% relative gap among all departure intervals, indicating a close to dynamic equilibrium assignment. The calibrated flows matched the mainline and turning counts closely with a R^2 level between 92% and 95%.

Observed travel times from SFCTA's April 2009 Level of Service Monitoring were compared with

simulated speeds for 27 routes during the PM peak. The average length of these routes is 1.5 miles. The average observed travel time was compared to the simulated travel time. The regression for all 27 routes had slope R^2 of 91%.

The calibration level for this model was judged to be good.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.14 Geary Boulevard BRT, San Francisco, CA

SFCTA linked the SF-CHAMP regional activity-based travel demand model with the subarea DTA model to estimate the impacts and benefits of a potential Geary Boulevard Bus Rapid Transit service. The DTA model provided reasonable intersection-level data for use in a traffic microsimulation model. The project team developed open-source Python-based tools to make quick work of most calibration, validation, and model input, output, and summary tasks. Figure 4-14 shows a map of the Geary Boulevard Corridor as well as the links between the SF-CHAMP and DTA models [46].

The DTA model provided two main benefits: (1) a needed link between a regional travel demand model and a traffic microsimulation model able to more reliable way to model traffic diversions in the corridor; (2) more reliable travel time and Level of Service (LOS) outputs of different scenarios for areas that were not scoped to be modeled by traffic microsimulation.

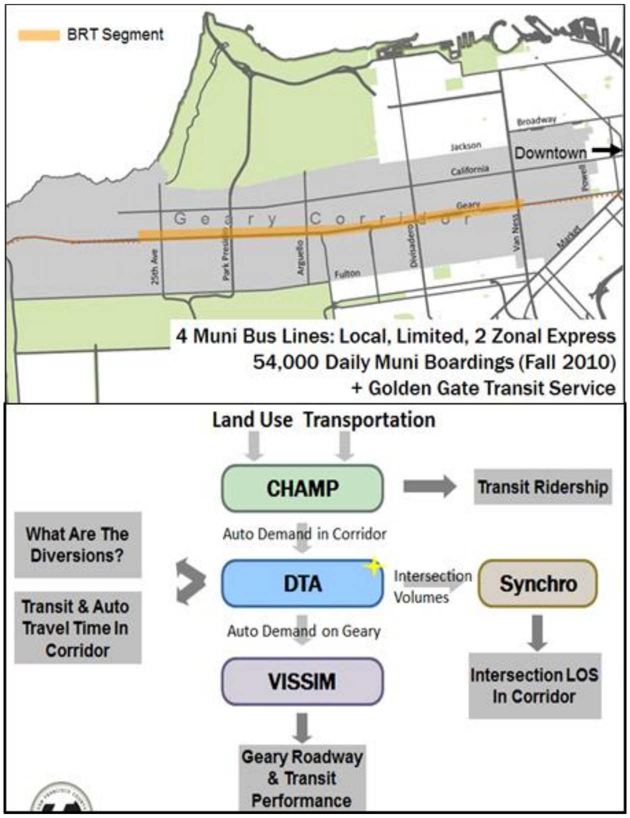


Figure 4-14: Geary Boulevard DTA Model [46]

Geographic Scope

This testbed location has limited geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. Geary Boulevard is located in the northwest quadrant of San Francisco, CA. It is a mixed-use arterial. The BRT segment of Geary Boulevard stretches about 3.5 miles.

Temporal Scope

The time period that was modeled is unknown.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

This single facility project was to model the impacts and benefits of a potential Geary Boulevard Bus Rapid Transit within the grid networked city of San Francisco, CA. This is a sub area of the Presidio network as well as the DTA Anyway network.

Level of Congestion

There is a high level of congestion in this region.

Data Sources

The testbed location has moderate capability to generate multi-source data. For example, data from wireless communications are not available.

SFMTA signal cards were read in for signal timing, Synchro files were used for intersection geometry, the City stop sign shapefile read for unsignalized intersections, and SF-CHAMP files were used for trip tables, transit lines, and transit dwell times.

Calibration Status

The level of calibration for this model is medium with vehicle paths analyzed at various iterations, and free flow speeds and traffic flow parameters modified, where justified. The raw SF-CHAMP trip tables for the base and future years were directly pulled into the DTA model.

Calibration required reduction of free flow speed on parallel routes. The DTA model was validated to 74 mainline counts and 700+ turn counts. Nearly 30 travel time routes were also calibrated.

The level of calibration for this model was judged to be moderate.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.15 DTA Platform Bellevue, WA

The City of Bellevue Modeling and Analysis Group (MAG) has a series of EMME four-step travel demand models for various horizon years to evaluate the impacts of future changes in land use and transportation facilities on the City of Bellevue's transportation network system. Because the travel demand model is not sensitive enough to capture smaller network, demand and operations shifts, MAG staff built several Dynameq models to simulate citywide traffic dynamics, including base and future year models for different horizon years. These models are expected to be maintained and updated on a regular basis. Figure 4-15 shows the Bellevue, WA network modeled using Dynameq [47].

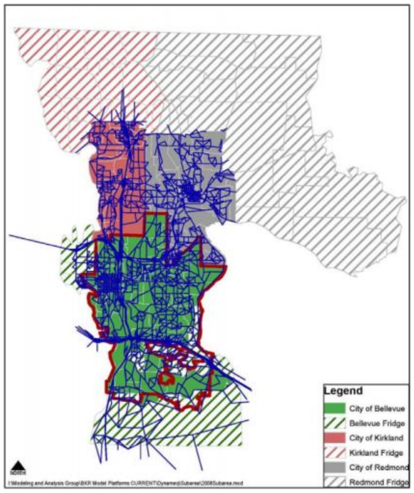


Figure 4-15: Bellevue, WA Model [47]

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The Dynameq model covers City of Bellevue, Bellevue fringe area, City of Kirkland and City of Redmond. Due to the limited budget, only the network in the City of Bellevue and its fringe area were fine tuned to reflect field geometry, intersection channelization and traffic control. The study area contained 574 zones, 2,300 nodes, 7,000 links, 20,300 movements, 100+ traffic signals, and 350+ stop sign controlled intersections

Temporal Scope

The Dynameq model represents the afternoon peak period.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

Two vehicle classes simulated in this Dynameq model were SOVs and HOVs.

Level of Congestion

The region has moderate to significant congestion during the PM peak period.

Data Sources

The testbed location has limited capability to generate multi-source data. For example, data from wireless communications are not available.

Two data input parameters include: demand OD matrices and free flow speed. Existing traffic control types, signal phasing, and timing data came from a 2008 PM peak hour Synchro model. Aerial photos were also used for verification of control type and locations.

Calibration Status

Calibration procedures included using 15-minute assignment intervals and calibrating segment travel time over eighteen routes to the 2008 field survey.

The calibration level was judged to be low.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.16 Alaskan Way Viaduct Seattle, WA

The Alaskan Way Viaduct is a double-decked elevated section of State Route 99 that runs along the Elliott Bay waterfront in the industrial district and downtown of Seattle. It carries up to 110,000 vehicles per day. In 2009, the state of Washington, King County, the city of Seattle, and the Port of Seattle agreed to replace the viaduct with a four-lane, 2-mile (3.2 km) long underground tunnel. Through funding from Washington State DOT, Parsons Brinkerhoff and Parametrics addressed questions regarding strategies to mitigate traffic during construction through the development of the Dynameq model. The model development began in year 2011 with planned completion in late 2012. A previous effort in 2006-2007 applied the Synchro macroscopic modeling platform to an overlapping section of this region. Figure 4-16 shows a map of the Alaskan Way Viaduct DTA Model are with both the existing State Route 99 and the proposed State Route 99 tunnel [48].

Figure 4-16: Alaskan Way Viaduct [48]

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The Alaskan Way Viaduct study area includes the City of Seattle downtown and surrounding neighborhoods. It is approximately 7 miles along its longest section and 3 miles along its widest section.

Temporal Scope

The simulation period is from 1:00 PM to 6:00 PM to allow for adequate time to capture both a typical PM peak hour, a midday afternoon hour, and to allow for the time required for network loading and dissipation.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

Modes represented within this arterial grid include automobiles, freight, and toll roads. The key north-south facility are SR 99 and I-5. All primary arterials are represented in the network.

Level of Congestion

The Alaskan Way Viaduct carries up to 110,000 vehicles daily through downtown Seattle. There is a high level of congestion on this roadway during the PM peak.

Data Sources

The testbed location has moderate capability to generate multi-source data. For example, data from wireless communications are not available.

Data was provided by the Washington State DOT (WSDOT) and the Seattle DOT (SDOT). The data included databases of traffic counts, signal control data, and lane geometry data. King County provided GIS and transit-related data while the Port of Seattle and their consultants shared freight movement forecasts, routes, and information relating to typical operating procedures.

Calibration Status

There is not much reported on calibration for this model. Little information could be acquired on modeling resolution beyond the use of the Dynameq model. The calibration status is unknown.

Ease of Adaptability

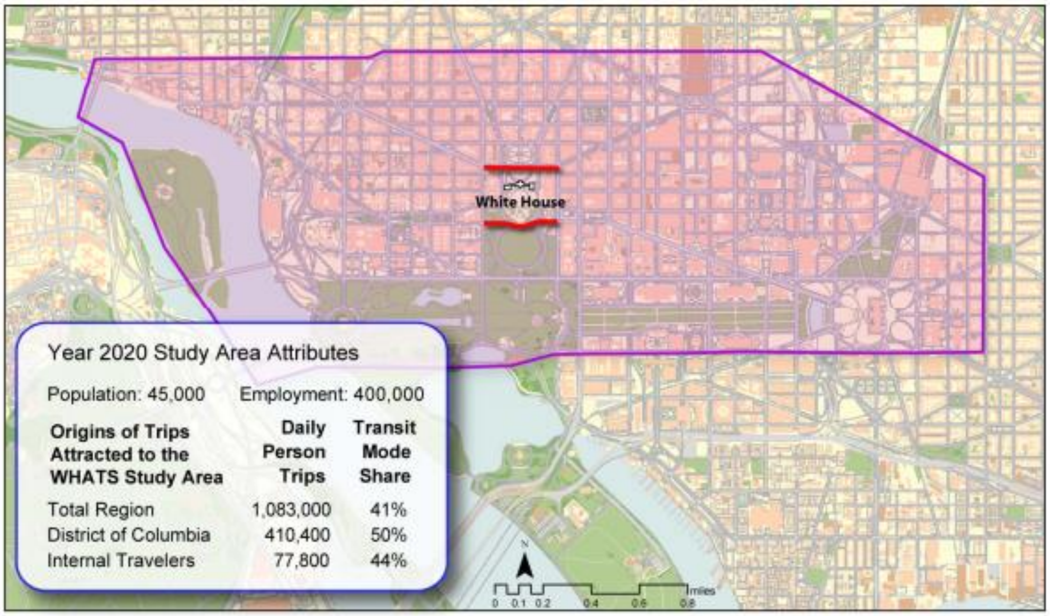
The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.17 White House Area Transportation Study

The goal of the White House Area Transportation Study was to evaluate the overall health and resiliency of the downtown transportation system and develop mitigation plans to compensate for the security-based closures enacted around the White House. Figure 4-17 shows a map with a depiction of the area modeled around the White House [49-51].



Year 2020 Study Area Attributes

Population: 45,000 Employment: 400,000

Origins of Trips Attracted to the WHATS Study Area	Daily Person Trips	Transit Mode Share
Total Region	1,083,000	41%
District of Columbia	410,400	50%
Internal Travelers	77,800	44%

Figure 4-17: Area Modeled Around the White House [49]

Geographic Scope

This testbed location has moderately sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. Scope of this model includes the downtown street of Washington D.C. and Arlington, VA within 1-3 miles of the White House.

Temporal Scope

All vehicular travel and person travel is simulated for a 24-hour period.

Temporal Resolution

All vehicular travel and person travel is simulated on a second-by-second basis, while person travel by other modes are modeled at a one minute resolution.

Modes Represented

The testbed represents multiple modes, including pedestrians, buses, rail, and streetcars.

Level of Congestion

Roughly 1.5 million trips are made to, from, or through the study area on a typical workday and approximately one third of these trips cross or circumvent the 16th Street or President's Park, the areas with closures present. This is a highly congested region.

Data Sources

The testbed location has limited capability to generate multi-source data. For example, data from wireless communications are not available. Non-motorized travel data was estimated and motorized travel data was supplied by the monthly working group consisting of Federal, District, and regional agencies.

Calibration Status

Extensive data collection, field verification, and peer reviews were employed to calibrate the model. Travel time estimates are based on the Metropolitan Washington Council of Governments (MWCOG) regional travel demand model and the Washing Metropolitan Area Transit Authority (WMATA) transit mode choice and routing model.

The level of calibration was judged to be good.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. Thus, the ease of adaptability is medium.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

4.18 Weather Responsive Traffic Estimation- Chicago, IL

The goal of this activity was to develop a framework and procedures for implementing and evaluating weather-responsive traffic management (WRTM) strategies. This was accomplished by using Traffic Estimation and Prediction System (TrEPS) methodologies to support the decision making process for addressing the disruptive effect of inclement weather on the traffic system. Tools were developed, calibrated and tested in Salt Lake City, UT, New York's Long Island Expressway Area and Chicago, IL based on the application of the DYNASMART-X model. This section describes the effort that calibrated weather-specific speed density curves and weather adjustment factors (WAF) for Chicago, Illinois [52].

The focus for this model was to determine the value of four strategies (advisory VMS, mandatory VMS, speed management, and signal control) in response to severe weather conditions such as blizzards, and for light to moderate snows. The demand and supply sides of the Dynasmart model are modified to capture the effect of weather on traffic patterns. Analyses indicated that the use of WAF successfully replicated the weather effects on both link speed and flows. Figure 4-18 shows the Chicago area network modeled in DYNASMART-X.

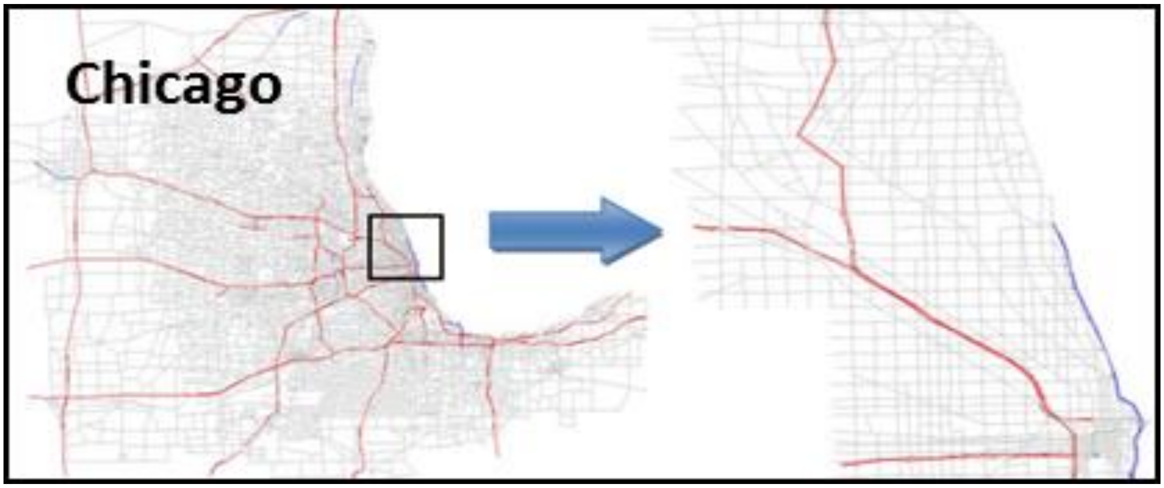


Figure 4-18: Study Area in Chicago [52]

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The Chicago complete network includes 40,443 links that are tolled and open freeways, highways, ramps, and arterials. The network is based on 1961 zones and 13,093 nodes. The sub-network includes 4800 links (freeways, highways, ramps, metered ramps, and arterials) and 1580 nodes (545 signalized intersections).

Temporal Scope

The Chicago model is based on demand from 5 AM to 11 AM.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The model represents single occupancy and high occupancy vehicles.

Level of Congestion

The Chicago network demand between 5 and 11 AM was 800,000.

Data Sources

The Chicago network was selected based on availability of historical detector data from GCM for years 2004 through 2008 at a 5-minute resolution. Further historic weather data from 5 Automated Surface Observation System s (ASOS) station at 5-minute resolution was available beginning year 2000. Additionally, Clarus (ESS) data at 20-minute resolution was also available from December 2008 increasing from one to 5 stations.

The testbed location has limited capability to generate multi-source data. For example, data from wireless communications are not available. Historical loop detector data with 5-minute aggregation intervals are used for this model.

Calibration Status

The level of calibration is moderate.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

The testbed models VMS under inclement weather, which is of interest to both DMA and ATDM.

4.19 Weather Responsive Traffic Estimation-New York, NY

The goal of this activity was to develop a framework and procedures for implementing and evaluating weather-responsive traffic management (WRTM) strategies. This was accomplished by using Traffic Estimation and Prediction System (TrEPS) methodologies to support the decision making process for addressing the disruptive effect of inclement weather on the traffic system. Tools were developed, calibrated and tested in Salt Lake City, UT, New York's Long Island Expressway Area and Chicago, IL based on the application of the DYNASMART-X model. This section describes the effort that calibrated weather-specific speed density curves and weather adjustment factors (WAF) for New York. Figure 4-19 shows the New York area network modeled in DYNASMART-X [52].

The specific weather strategies modeled include demand management, variable speed limit, VMS, and weather-responsive incident management using VMS.

Analyses indicated that the use of WAF successfully replicated the weather effects on both link speed and flows.

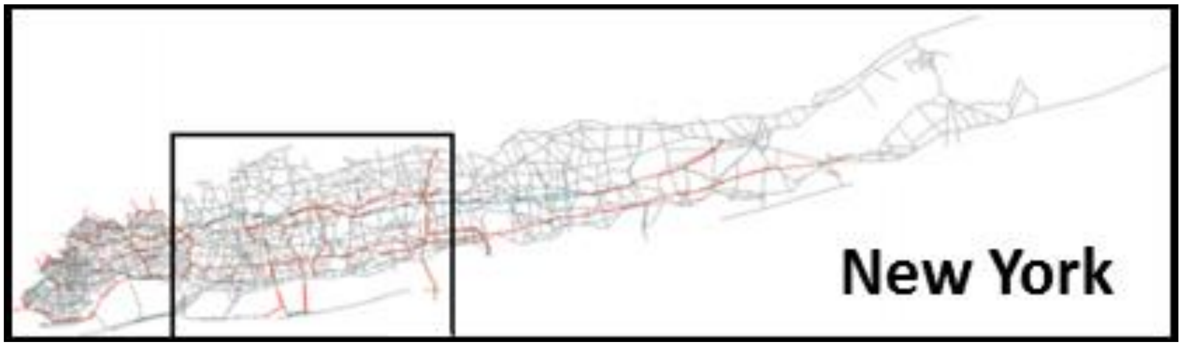


Figure 4-19: Original Network and Sub-network for Long Island Model [52]

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The Long Island regional network consists of 1431 zones, 21791 links (arterials, freeways, highways, ramps, HOV facilities, and toll facilities), and 9402 nodes of which 1772 are signalized intersections. The Long Island sub-network included 393 zones, 8120 links (arterials, freeways, highways, ramps, and HOV facilities), 3692 nodes (582 signalized intersections).

Temporal Scope

The New York original network is based on a 6 AM – 10 AM period while in the sub-network model the demand horizon is from 6 AM – 11 AM.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The model represents single occupancy and high occupancy vehicles.

Level of Congestion

The Long Island sub-network demand between 6 and 11 AM was 780,000 SOV passenger-car trips and 300,000 HOV passenger car trips.

Data Sources

Partial historical detector data was available through the NYDOT (year 2008), CTDOT (year 2007), and NJDOT (year 2006) websites having 5, 10, and 15 minute resolution. ASOS data at 9 stations was available at 50-minute resolution from years 2000 onward. Additionally, Clarus (ESS) data was available from Dec 2008 onward for 10-15 stations at 20-minute resolution. The availability of traffic data on freeways is characterized as very good (ranking of 4 on a scale of 5-1) while the availability of traffic data for arterials is characterized as fair (ranking of 2 on a scale of 5-1).

The testbed location has limited capability to generate multi-source data. For example, data from wireless communications are not available. Historical loop detector data with 5-minute aggregation intervals are used for this model.

Calibration Status

Traffic and weather data for the purpose of calibrating the weather-sensitive traffic flow model parameters were obtained from the nearby greater Baltimore area due to unavailability of comprehensive data sources for all desired items from the Long Island area. Thus, the level of calibration is low.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

The testbed models VMS under inclement weather, which is of interest to both DMA and ATDM.

4.20 Weather Responsive Traffic Estimation-Salt Lake City, UT

The goal of this activity was to develop a framework and procedures for implementing and evaluating weather-responsive traffic management (WRTM) strategies. This was accomplished by using Traffic Estimation and Prediction System (TrEPS) methodologies to support the decision making process for addressing the disruptive effect of inclement weather on the traffic system. Tools were developed, calibrated and tested in Salt Lake City, UT, New York's Long Island Expressway Area and Chicago, IL based on the application of the DYNASMART-X model. This section describes the effort that calibrated weather-specific speed density curves and weather adjustment factors (WAF) for Salt Lake City. Figure 4-20 shows the Salt Lake City area network modeled in DYNASMART-X [52].

The scope of this model included a real-time system that interacts continuously with loop detectors, roadside sensors, and vehicle probes, providing real-time estimates of traffic conditions, network flow patterns, and routing information. The specific weather strategies modeled include demand management, variable speed limit, VMS, and weather-responsive incident management using VMS. Analyses indicated that the use of WAF successfully replicated the weather effects on both link speed and flows.

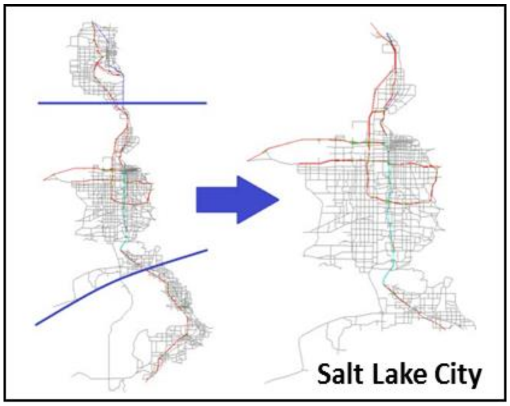


Figure 4-20: Study Area in Salt Lake City, UT [52]

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. The original Salt Lake City network consists of 2250 zones, 17945 links (arterials, ramps, highways, freeways, and HOV facilities). The Salt Lake City sub-network consists of 1280 zones, 8300 links (arterials, ramps, highways, freeways, and HOV facilities), and 3715 nodes (of which 422 are signalized intersections).

Temporal Scope

The Salt Lake City model is based on demand from 6 AM – 10 AM.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The model represents single and high occupancy vehicles.

Level of Congestion

The Salt Lake City network demand is unknown, but it is expected that the network faces limited congestion compared to the other networks.

Data Sources

Historical detector data was available from Wasatch Front Regional Council for over a 3-year time period with a 5-minute resolution. Additionally, historic weather data including ASOS and Clarus (ESS) was available. The ASOS data included a single station with records from year 2000 onward at 5-minute resolution, while the ESS records are from December 2008 to present at 20-minute resolution for 1-5 stations.

The testbed location has limited capability to generate multi-source data. For example, data from wireless communications are not available. Historical loop detector data with 5-minute aggregation intervals are used for this model.

Calibration Status

The level of calibration is moderate.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent ATDM strategies. It is also unknown if the model is available for use by others. Thus, the ease of adaptability is low.

Existing Deployments and or Research

The testbed models VMS under inclement weather, which is of interest to both DMA and ATDM.

4.21 RDE Test Data Set - Pasadena, CA

The Pasadena project implemented by Mygistics uses a combination of real/observed data and modeled/synthetic data to predict travel time on paths for consumption by end users. Data were generated using the Pasadena network to support the U.S. DOT Real-Time Data Capture and Management Program. The foundation to the modeling process comprises macroscopic VISUM static volume models. The macroscopic traffic models are then further refined into within-day dynamic traffic assignment models on 15 min loading intervals by way of the dynamic user equilibrium assignment (DUE) module in VISUM. Figure 4-21 shows the Pasadena area network modeled in VISUM and graphical representation of various VISUM model aspects [53].

A VISSIM model microscopically simulates operational field conditions for traffic, transit and pedestrians. The OPTIMA online model projects travel time based on input from the coarse suite of models and from real-time data.

The last step of this project's multi-resolution modeling approach converts the offline DUE models into OPTIMA™4 real-time online traffic models. Figure 4-18 depicts the multiresolution traffic modeling approach as applied to this project along with the Pasadena network.

The model consists of the following key network attributes: 14,698 links, 792 centerline miles, and several freeways, expressways, arterials, collectors, and HOV links. The OPTIMA real-time traffic simulation model as configured for the Pasadena project generates a 30 minute rolling forecast horizon in 5 min increments. Mygistics used the VISUM tool set including its macroscopic origin-based assignment procedure (known as Linear User Cost Equilibrium or LUCE) and TFlowFuzzy OD matrix estimation to define a static traffic demand on an hourly basis.

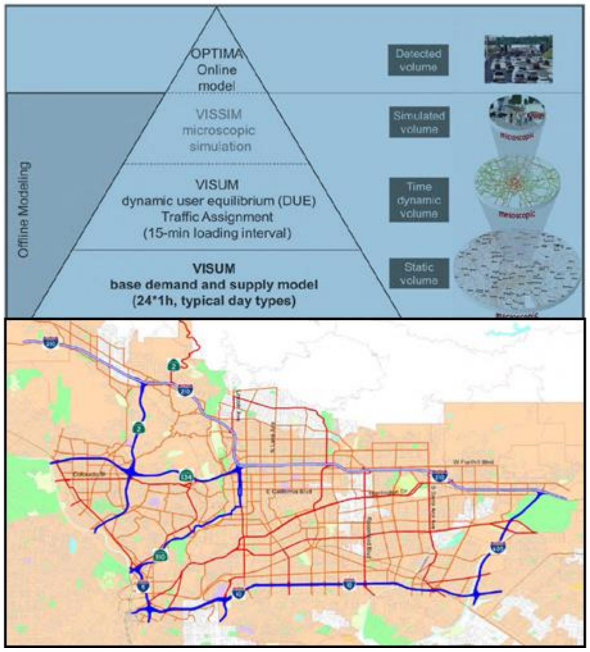


Figure 4-21: Pasadena Model [53]

Geographic Scope

This testbed location has sufficient geographic scope and complexity to represent the impacts of the DMA and ATDM applications and strategies. Roadways included in this region of study are I-10, I-5, I-605, SR 2, SR 134, and SR 110.

Temporal Scope

This model has OD tables for all hours of the day, so it can be run for any time period.

Temporal Resolution

It is unknown from the literature if the testbed location is capable of generating data of sufficient temporal resolution to model and represent the impacts of DMA and ATDM applications and strategies.

Modes Represented

The mesoscopic model of a freeway and arterial grid includes 14,700 links with 792 centerline miles. Among these links, 123 are HOV links.

Level of Congestion

The level of congestion in this region is high during the peak periods.

Data Sources

The testbed is capable of generating multi-source data. The data environment covers a diverse roadway network in and around Pasadena, CA. Fourteen separate datasets are accessed. These include the Pasadena highway network, census block groups, mobile sightings, hourly OD flow, link and turn volumes, link capacity and speeds, turn capacity and delays, work zone information, incident data , weather data, closed-circuit television (CCTV) snapshots, changeable message sign (CMS) text, detector influence factor, and signal phase data.

Calibration Status

This model implements a proprietary process that uses AirSage mobile sighting data, public socio-economic data to project mobile based OD. This Mobile-based OD is combined with a model network developed through NAVTEQ navigation data, again using a proprietary process, to develop path flows. The third level of proprietary processes combines the path flows with traffic counts from various traffic detectors to generate a “Mobile OD” that varies by time of day and day of week.

The AirSage data applied for Pasadena was for the months of September and October 2010.

Link based capacities are based on Highway Capacity Manuals. Intersection control and lane geometry were defined in the model based on data from the City of Pasadena (signals) and through other processes. Traffic analysis zones (TAZ) for the Pasadena network correspond to census block groups to match up with MobileOD trip tables.

The level of calibration was judged to be good.

Ease of Adaptability

The AMS model was not developed for specifically testing any of the DMA applications, and does not include any communications modeling. However, the AMS model can be extended to represent DMA and ATDM strategies; this might require some effort. Thus, the ease of adaptability is medium.

Existing Deployments and or Research

No specific ATDM strategy or DMA application is known to being deployed or researched at this location.

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APPENDIX A. List of Acronyms

Acronym	Name
ADOT	Arizona Department of Transportation
AMS	Analysis Modeling and Simulation
API	Application Program Interface
APTA	American Public Transportation Association
ARC	Atlanta Regional Council
ARRA	American Recovery and Reinvestment Act
ASC3	Advanced System Controllers 3
ASCII	American Standard Code for Information Interchange
ASOS	Automated Surface Observation System
ATDM	Active Transportation Demand Management
ATIS	Advanced Traveler Information Systems
AVL	Automatic Vehicle Location
BRT	Bus Rapid Transit
CACC	Cooperative Adaptive Cruise Control
CBD	Central Business District
CCTV	Closed Circuit Television
CMS	Changeable Message Sign
CTDOT	Connecticut Department of Transportation
DART	Dallas Area Rapid Transit
DMA	Dynamic Mobility Applications
DOT	Department of Transportation
DRG	Dynamic Routing of Vehicles
D-RIDE	Dynamic Ridesharing
DR-OPT	Drayage Optimization
DSRC	Dedicated Short Range Communications
DSS	Decision Supply System
DTA	Dynamic Traffic Assignment
DYNASMART	Dynamic Network Traffic Planning Tool
ECO	Connected Eco Driving
EFP	Electronic Fare Payment
EnableATIS	Enable Advanced Traveler Information System

Acronym	Name
ESS	Environmental Sensor Stations
ETC	Electronic Toll Collection System
EVAC	Emergency Communications and Evacuation
F-ATIS	Freight Real-time Traveler Information with Performance Monitoring
F-DRG	Freight Dynamic Route Guidance
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRATIS	Freight Advanced Traveler Information Systems
FSP	Freight Signal Priority
FTA	Federal Transit Administration
GCM	Greater Chicago Midwest
GIS	Geographical Information System
GPS	Global Positioning System
GUI	Graphic User Interface
HOT	High Occupancy Toll
HOV	High-Occupancy Vehicle
ICM	Integrated Corridor Management
ICMS	Integrated Control Management System
IDTO	Integrated Dynamic Transit Operations
INC-ZONE	Incident Scene Workzone Alerts for Drivers and Workers
INFLO	Intelligent Network Flow Optimization
I-SIG	Intelligent Traffic Signal System
ITS	Intelligent Transportation System
JPO	Joint Program Office
LOS	Level of Service
LUCE	Linear User Cost Equilibrium
MAG	Maricopa Association of Governments
MAYDAY	Mayday Relay
MCDOT	Maricopa County Department of Transportation
MDSS	Maintenance Decision Support System
M-ISIG	Multi-Modal Intelligent Traffic Signal System
MMITSS	Multi-Modal Intelligent Signal Systems
MOVES	Motor Vehicle Emission Simulator
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission

Acronym	Name
MTM	Manhattan Traffic Model
MWCOG	Metropolitan Washington Council of Governments
NCTCOG	North Central Texas Council of Governments
NFTPO	North Florida Transportation Planning Organization
NHTSA	National Highway Traffic Safety Administration
NJDOT	New Jersey Department of Transportation
NS2	Network Simulator 2
NTCIP	National Transportation Communications for ITS Protocol
NYC	New York City
NYCDOT	New York City Department of Transportation
NYDOT	New York Department of Transportation
OBE	On-Board Equipment
O-D	Origin and Destination
PED-SIG	Mobile Accessible Pedestrian Signal System
PREEMPT	Emergency Vehicle Preemption
QMT	Queens-Midtown Tunnel
Q-WARN	Queue Warning
RAMP	Next Generation Ramp Metering System
RDE	Research Data Exchange
RESP-STG	Incident Scene Pre-Arrival Staging and Guidance for Emergency Responders
RITA	Research and Innovative Technology Administration
RSE	Roadside Equipment
SACOG	Sacramento Council of Governments
SACSIM	Sacramento Activity Based Travel Simulation Model
SAE	Society of Automotive Engineers
SAIC	Science Applications International Corp
SANDAG	San Diego Association of Governments
SDOT	Seattle Department of Transportation
SF-CHAMP	San Francisco Chained Activity Modeling Process
SFCTA	San Francisco County Transportation Authority
SFMTA	San Francisco Metropolitan Authority
SHRP	Strategic Highway Research Program
S-PARK	Smart Park and Ride
SPaT	Signal Phasing and Timing

Acronym	Name
SPD-HARM	Dynamic Speed Harmonization
T-CONNECT	Connection Protection
T-DISP	Dynamic Transit Operations
T-MAP	Universal Map Application
TSP	Transit Signal Priority
USDOT	United States Department of Transportation
VMT	Mileage Based User Fees
WX-INFO	Real-Time Route Specific Weather
WX-MDSS	Enhanced MDSS Communications

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